Commission
on Storage of High-Level Radioactive Waste

FINAL REPORT

Responsibility for the Future

A fair, transparent procedure for the selection of a national disposal site

Contents

PREAMBLE

Sustainability –responsibility and justice

The safe handling of radioactive waste is one of the great challenges we face today. All over the world, almost none of the countries that operate, or have operated, nuclear power plants have yet found solutions for the permanently safe disposal of, in particular, high-level radioactive waste. In view of the complexity of the task, the long timescales and the highly conflictual nature of the issues, conventional forms of problem solving come up against their limits. A new approach is necessary.

To date, the risks from these materials have overwhelmingly been analysed on the basis of liability, insurance cover and regulatory law. This has been intended to ensure accidents or other undesirable impacts of technology are manageable or calculable, or are at least compensated for. However, the far-reaching impacts of the use of nuclear energy require a great deal more. Scientific/technical knowledge is a necessary condition for the permanently safe disposal of radioactive waste, but is not sufficient if we are to arrive at an accepted solution. It must be accompanied by participation-oriented procedures and intelligently designed institutional structures, focussed on the ambition to take responsibility for the future and ensure justice for future generations.

After four decades of heated debates about the use of nuclear energy, the Commission wishes to prepare the ground for steps to arrive at the best-possible solution for the safe disposal of, in particular, high-level radioactive waste in Germany that reflects the recent advances in our knowledge. In seeking to do this, it has oriented itself towards the guiding principle of *sustainable development*[1]. Sustainability[2] is understood as development that 'meets the needs of the present without compromising the ability of future generations to meet their own needs.[3]

Sustainability sets the framework for this by offering ethically informed criteria, implying a long-term approach to assessment and bringing together important societal goals. It demands more participation and greater democratic involvement in policymaking. By these means, it seeks to prevent industrial modernisation processes from taking on a character that endangers the future as a result of continued rationalisation, high levels of differentiation, acceleration and internationalisation.

The starting point for the establishment of the principle of sustainability was the finding of the first United Nations Conference on the Human Environment in 1972 at Stockholm that the increasing pressure on and exploitation of nature could cause collective harm to humanity. In 1987, sustainability became the central recommendation of the World Commission on Environment and Development in what is known as the Brundtland Report. Five years later, in

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[1] Sustainable development

[2] On this issue, see also section B 3.3 of the present report.

[3] The UN Commission on Environment and Development chaired by Gro Harlem Brundtland gave the following definition in 1987: 'Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs.' United Nations (1987), Report of the World Commission on Environment and Development: Our Common Future, 'From One Earth to One World', para. 27.

1992, the Earth Summit at Rio de Janeiro made it the guiding objective for politics, business and society. Sustainability expands the scope of decisions by giving them a long-term perspective and links them to qualitative conditions for social justice and ecological compatibility so they do justice to the requirements of a world that is growing together, but is overpopulated, overburdened, polluted and easily disrupted.

The guiding principle of sustainability requires us to adhere to what Hans Jonas described as the *imperative of responsibility*:[4] 'Act so that the effects of your action are compatible with the permanence of genuine human life.'[5] Indeed, the constant expansion of technical possibilities is not only changing how we live today, but also extending its effects ever further into the future. The undisputed opportunities for progress contrast with creeping global dangers – such as climate change or developments that overstep the planetary boundaries within which it is safe for our economy to grow.[6] Frequently, society only becomes aware of the implications of these dangers at a late stage, often when disasters occur.

As a result of their technological capabilities, human beings have risen in the last few decades to become the strongest geophysical force on the planet. Against this background, the Nobel Prize winner Paul Crutzen suggested in 2002 that our geological epoch should no longer be referred to as the Holocene, but as the Anthropocene, the epoch dominated by humans.[7] As humans' technological power has expanded, so has their responsibility become more onerous as well.

The human is the only species that is consciously capable of taking on responsibility for the world and also has to exercise that responsibility. We will only live up to this responsibility if we are able to foresee more of the consequences and effects of technological processes. This is why Hans Jonas distinguishes between 'technical knowledge' and 'predictive knowledge' when it comes to interventions in nature and the resultant repercussions for humans, nature and society. Ideally, predictive knowledge would enable us to comprehend the whole chain of impacts. Yet, even though we know so much, this is not possible for fundamental reasons. Attempts to predict the possible effects of new technologies at different levels are characterised by uncertainties: in the innovation process itself, in the practical processes by which technologies are implemented, and in the processes by which they are disseminated, with their social, ecological and economic repercussions.

That is why we must clearly state what we know, as well as what we do not know or are unable to know if we are to deal rationally with ignorance and uncertainty. Only this will allow us to rationally assess whether our actions and ways of thinking are adequate to foreseeable or conceivable challenges. With regard to the permanently safe disposal of radioactive waste, the challenge is not the empirical question of whether there is a *de facto* willingness to take risks and acceptance of such risks, but whether and how a well founded consensus about

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[4] On this issue, see also section B 3.1 of the present report.

[5] Cf. Hans Jonas. (1979), The Imperative of Responsibility: In Search of an Ethics for the Technological Age, p. 11.

[6] On this issue, cf., by way of example: Intergovernmental Panel on Climate Change (2014), Fifth Assessment Report; and also: Johan Rockström et al. (2009): 'A safe operating space for humanity', in: Nature 461, pp. 472–475.

[7] Cf. Paul Crutzen et al. (2011), Das Raumschiff Erde hat keinen Notausgang, p. 7; Paul Crutzen (2002), 'Geology of mankind', in: Nature 415, p. 23.

their acceptability can be reached. What is at stake is how we exercise our socio-political responsibilities in view of long-term impacts that are difficult to estimate.

As far as the use of nuclear power is concerned, the problems posed by the permanently safe disposal of radioactive waste were neglected for a long time, in particular the extremely long timescale for any measures that might be taken. The lesson that is to be drawn from this experience goes far beyond nuclear energy and the disposal of its waste. For, in view of the fact that were it not for the possibilities of technology modern human beings would be incapable of surviving, and the fact that further progress is necessary if only to correct undesirable developments, but is also desirable in order to shape a good life, the possibilities of forecasting and technology strategy must generally be expanded in order to promote desirable technological developments in a targeted manner, to place restrictions on technology in certain circumstances, and to rule out unintended social and ecological collateral consequences from the outset.

The vision of sustainability does justice to the imperative of responsibility because it combines factual knowledge and values with one another. Sustainability is a regulating principle that prescribes the kinds of binding common rules and principles for action we need to observe. This is indispensable not just for the protection of humans and nature, but also for the preservation and further development of freedom and progress.[8] Such an approach will allow us to choose between alternatives and options, instead of having our actions determined by practical constraints and their inevitable consequences.

However, there is a need for clarification about what is to be understood by sustainability in concrete terms. The implementation of the vision of sustainability is pervaded by conflicts at different levels. They range from the interpretation and significance of this vision in various respects to issues that relate to practical arrangements and implementation. The central conflict connected with the permanently safe disposal of radioactive waste is that between, on the one hand, sparing future generations the burden imposed by these wastes as much as possible and, on the other hand, keeping options for action open for them. A just settlement between the generations will only be possible under the auspices of transparent, democratic processes.

The history of the handling of radioactive waste in Germany has shown that democracy must not be reduced to a system of formal/representative procedures. This reductive approach has failed in the previous attempts to resolve the issue of the permanently safe disposal of waste. It must be expanded in the spirit of a lively 'deliberative democracy' (Jürgen Habermas) with elements of discourse, dialogue among equals, participation and an understanding of the public interest. In this respect, the Commission is breaking new ground.

In this sense, a future ethics is not an ethics practised in the future, but an ethics that cares for the future today. What we do in freedom will prevent us from being constrained by a future lack of freedom, just as it will prevent unjustifiable risks from being taken. This responsibility is placed on us by the sheer scale of our technological power and demands that our knowledge about the consequences of what we do be maximized, a broad understanding be established as to what should

[8] On this issue, see the detailed discussion in section B 3.1 of the present report.

and should not happen, what is to be permitted and what is to be prevented, and a societal dialogue be conducted about how opportunities and burdens are to be fairly shared.

In order to achieve this, there is a need for *discursive-consensual methods of conflict resolution* that must be inspired by the imperative of preserving human existence and human dignity over the long term. Their foundations will be the spirit of the enlightenment, politics' power to shape the world, a capacity for agreement rooted in rationality and responsibility, and the expansion of freedom and citizens' involvement in democracy.

1. Ten principles

1. The Commission has oriented its work towards the vision of *sustainable development*, in particular the imperative of long-term responsibility. Sustainability means that, in its recommendations on the best possible management of radioactive waste,[9] the Commission has oriented itself towards the needs and interests of both the current and future generations. The Commission has attempted to reconcile different interests on the basis of intergenerational equity.

2. The Commission has based its proposals on six guiding objectives: The primacy of safety; comprehensive transparency and participation rights; a fair, just procedure; broad consensus in society; the polluter-pays principle; and the precautionary principle. Following an open-ended process, the Commission has described a pathway that is scientifically informed and capable of guaranteeing the best possible safety.

3. The Commission has affirmed the *principle of national storage including disposal* for domestically produced radioactive waste. National responsibility is a central foundation for its recommendations. In this respect, the Commission has oriented itself towards a dynamic precautionary approach to the prevention of damage[10] that demands precautionary measures against potential damage to be taken in line with the latest advances in science and technology.

4. With its criteria and recommendations, the Commission has made prearrangements for the search to find a site for the disposal of, in particular, high-level radioactive waste that will guarantee the best possible safety for a period of one million years.[11] At the same time, it wishes to preserve future

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[9] On this issue, see the 'Definition of the site with the best possible safety' given at the end of the present section, p. 23 [p. 9 of this translation].

[10] Here, the Commission has followed the German Federal Constitutional Court's Kalkar-I decision: 'Those precautions against damage must be taken that are held to be required in accordance with the latest scientific findings. If they cannot yet be translated into reality technically, the licence may not be granted; the requisite precautions are therefore not limited by what is currently technologically feasible.' In this passage, the Federal Constitutional Court defined in 1978 the mandatory obligation the legislature introduced by gearing the Atomic Energy Act towards the latest advances in science and technology, which means the Act's legal provisions keep pace with scientific and technological development. According to the Federal Constitutional Court, these considerations also apply with regard to what is referred to as residual risk: 'In particular, with its linkage to the latest advances in science and technology, the Act therefore commits the executive normatively to the principle of the best possible defence against hazards and prevention of risks.' Federal Constitutional Court, decision of 8 August 1978, AZ: 2 BvL 8/77, BVerfGE 49, 89 (136ff).

[11] According to the statement from the Federal Office for Radiation Protection (BfS), the document on safety requirements commissioned from GRS gGmbH ('Sicherheitsanforderungen an die Lagerung wärmeentwickelnder radioaktiver Abfälle – Entwurf der GRS') suggested the period for which protection was to be ensured should be 'in the order of magnitude of one million years.' Cf. Federal Ministry for the

generations' civil liberties and rights to self-determination as far as is practical without limiting the necessary protection of humans and nature.

5. Like the overwhelming majority of the German Bundestag, the Commission assumes the *statutorily anchored phasing-out of nuclear energy* will go ahead. The phasing-out of nuclear energy has defused a major societal conflict. At the same time, the Commission regards the generations that have used, or are using, electricity from nuclear power as bearing a responsibility to ensure the best possible disposal of the waste produced as a result of its use. These generations have a duty to drive ahead the search for the disposal site. On this basis, the Commission wishes to foster a culture of openness to conflict that makes a permanent settlement possible.

6. The Commission understands its work and the subsequent search for a site as a *learning process*. During this process, decisions are to be examined thoroughly to identify possible errors or undesirable developments. Provision is to be made for opportunities to subsequently correct errors. This is also why the public is to be involved broadly in the search from the very beginning. The aim is an open, pluralist discourse. The disposal pathway and alternatives, fundamental safety requirements, selection criteria and opportunities for the correction of errors must be developed in a scientifically based, transparent manner, described precisely and publicly debated before the search for a disposal site actually begins. The same must also be guaranteed if it is subsequently decided to change course or errors are corrected at a later date.

7. It is the Commission's aspiration to gain *broad approval from society* for the recommended selection procedure. It has drawn on the experiences of regions in which sites have been designated or selected in the past. The consensus to which it aspires would also be served by the open-ended evaluation of the Disposal siteSite Selection Act. The greatest possible transparency demands that all the data and information held by the Commission, as well as further decisions on the management of radioactive waste be made publicly accessible and permanently conserved by an institution governed by public law, and that such data and information be made generally accessible.

8. The Commission views the best possible safe management of radioactive waste as a function of the state. Irrespective of the stance each individual has taken in the debate about nuclear energy, there is a societal duty to do everything to ensure that the efforts to cope with this task prove successful. Under the polluter-pays principle, the operators of nuclear power plants and their legal successors are liable for the costs of the management of radioactive waste that are produced as a result of their power generation. A separate commission appointed by the German Federal Government has also been looking at the issue of the costs of the best possible management of radioactive waste.

9. The Commission has surveyed and assessed earlier experiments and projects relating to the disposal of radioactive waste. It has attempted to learn from the conflicts about nuclear energy, disposal facilitiesdisposal facilities or disposal projects, and to avoid the repetition of earlier errors. It wishes to express its great respect for the diverse forms of commitment shown over long periods of

Environment, Nature Conservation and Nuclear Safety (2010), 'Sicherheitsanforderungen an die Endlagerung wärmeentwickelnder Abfälle' (translation: 'Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste'), K-MAT 10.

time by numerous citizens, many scientists, and the environmental and anti-nuclear movements who campaigned for the phasing-out of nuclear power in Germany. It also recognises the hard work done by the employees of nuclear power plants to guarantee the safe operation of the installations and minimise risks. The Commission also wishes to place on record its gratitude for the societal and company-level efforts that are being made to manage the phasing-out of nuclear power in a socially benign manner.

10. Beyond the question of the handling of radioactive waste, the Commission sees its work as a contribution to the more conscious handling of complex technologies that have far-reaching, long-distance effects. It wishes to counter unintended and undesirable collateral consequences by strengthening technology assessment and technology strategy. For this purpose, new technologies and industrial developments are to be examined at an early stage in order to identify harmful or unmanageable collateral consequences so it is possible to choose between different options. The high-level radioactive waste we will leave behind for coming generations stand in an exemplary fashion for the possible collateral consequences of complex industrial developments.

Definition of the site with the best possible safety

The site for a disposal facility that is being sought for, in particular, high-level radioactive waste will offer what is, in accordance with the current level of knowledge, the best possible safety for the permanent protection of humans and the environment against ionising radiation and other harmful effects of such waste for a period of one million years. This site is to be selected in accordance with appropriate requirements in a staged procedure by comparing the sites identified as suitable during each phase. The burdens and obligations placed on future generations are to be kept as small as possible. Guided by the idea of sustainability, the site with the best possible safety in accordance with the latest advances in science and technology will be specified using the selection procedure described in the present report, as well as the applicable criteria and safety analyses it discusses. It must be possible for errors to be corrected during the selection procedure and subsequently at the site that is found.

2. Consensus: The phasing-out of nuclear energy and the energy transition

The conditions for a consensus on the disposal of radioactive waste have improved fundamentally. After four decades of heated debates, there is a broad political and societal consensus in Germany today that the use of nuclear energy should be brought to an end. Our country is the first major industrialised state to have set out on the pathway of an energy transition that combines the phasing-out of nuclear power with the restructuring of its energy supply and the expansion of renewable energies.[12] In setting about this complex, highly conflictual task, one that touches

[12] The energy transition is understood as the transition from a non-sustainable energy supply system to a sustainable energy supply system, in particular by means of the use of renewable energies, the enhancement of efficiency and energy saving. The idea of energy services is of central significance in this context. As long ago as 1976, the American physicist Amory Lovins coined the term ‘soft energy path’ in his book Soft Energy Paths: Toward a Durable Peace (Penguin Books, 1977). Other countries too are pursuing a

on so many interests, our society has been capable of fresh thinking and a new consensus.

However, willingness to reach agreement is not only necessary in relation to specific points, but matters of principle as well. And this is an important precondition if the search to find the site for the disposal of radioactive waste with the best possible safety is to enjoy success. Without downplaying the question of who is responsible for the production of such waste, this is a task for the whole of society that cannot be mastered without conflict. A consensus must be desired by all concerned.

With the phasing-out of nuclear power generation and the beginning of the transformation of the energy system, two important parameters for a consensus of this kind were established in our society. They both hold out opportunities and impose obligations to reach broad agreement on the third parameter as well, the best possible safety with regard to the disposal of radioactive waste. These three tasks have to be seen in a single context.

The Commission has mapped out a pathway that would contain conceivable dangers and keep the burdens on future generations as light as possible. Furthermore, this pathway stands in an exemplary fashion for the handling of complex, modern technologies that are associated with far-reaching consequences. In mapping out this pathway, we have laid foundations that will allow the chapter of nuclear energy to be closed in an orderly manner.

3. A culture capable of handling of conflicts

It is assumed in the Disposal site Selection Act that the disposal of radioactive waste with the best possible safety is only to be achieved if there is a broad societal consensus on the matter. The past has shown that this presupposes a new societal culture of openness to conflict. Such a culture must not ignore earlier debates, but must recognise the roles of those involved and orient them towards constructive conflict management. This is a societal task that, against the background of previous debates, will demand efforts of different kinds from the various actors and groups. It is not only necessary to recognise the roles played by the parties to the conflict. Discursive-consensual conflict resolution also requires reflection on their different interests and aims.

It will be difficult to cope with these challenges, if only on account of the procedures that have been conducted in the past. The acceptance of solutions negotiated in parliament has noticeably declined. The resistance to major projects shows that, despite the responsibility of democratically legitimated structures, markedly more participative formats are needed in order to deal with controversial issues in ways that enjoy societal acceptance. Even though the institutions of democracy have not always shown themselves willing to cooperate in the past, the best possible disposal of radioactive waste is only to be achieved through democracy.

transformation of their energy systems today, but Germany is regarded as a pioneer in the expansion of renewable energies and the phasing-out of nuclear energy.

In order to arrive at an understanding and build up a new kind of fundamental trust, the Commission is proposing extended and novel forms of community participation. They will be the precondition if the actors are to treat each other in a fair, societally responsible manner. The aim of the search for a disposal site is a solution that will endure for generations under as far-reaching as possible a societal consensus.

The handling of the conflicts that arise during this search will be decisive to the acceptance and sustainability of the solution that is found. The procedure itself will always have to work towards consensuses, but will largely be dominated by the handling of different conflicts. The character of the participative search procedure will therefore have to be mediating, negotiating and creative all at the same time. It must not be the case that affected individuals and groups are not involved from the beginning, important facts are kept secret or practical constraints to which there is allegedly no alternative are acted on over the heads of affected citizens.

How we deal with the paradox that the procedure seeks consensus, but is also driven by conflicts will dominate the whole participative search for a disposal site. This will confront the parties that deliver and design the search procedure with particular challenges. On the one hand, it will be necessary to avoid unproductive conflicts over the organisation of the process; on the other hand, there will be a need to take account of conflicts as an essential element in the clarification of the issues.

The Commission recommends that new forms of community participation be anchored in legislation. Comprehensive transparency and early community participation are to be guaranteed during the search for a disposal site. The formats used for democratic participation will also be decisive to the success of the search process. These formats will not replace, but supplement, parliamentary democracy with a new, learning politics.

The democratic public has a comprehensive right to transparency, for only transparency will make it possible to debate the merits of the case on a level playing field. If expert knowledge and experiential knowledge are to come together, the scientific advice supplied to politicians and the administration must be expanded by drawing on the knowledge held by citizens and society. Use is to be made of this knowledge. For, in many cases, civil society initiatives possess a high degree of indispensable expertise.

The Commission looks to a comprehensive discourse that values all participants and, at the same time, also grasps conflicts as opportunities to reach understanding. Opening the search for a disposal site up to society offers the opportunity to use democratic participation to overcome the narrowness of some perspectives, and tap into people’s imagination and understanding of the facts so as to arrive at constructive solutions. When the decision is taken about a disposal site, the German Bundestag will be the central locus for societal debates that will be dominated by considerations of the public interest.

PART A: SUMMARY AND RECOMMENDATIONS

This summary sets out in a condensed form important conclusions on which the Commission on Storage of High-Level Radioactive Waste has reached unanimity in its deliberations, and its recommendations. In view of the complex issues, reaching unanimity does not mean that every formulation and every comment is supported equally and fully by each individual member of the Commission. The detailed recommendations and results of the Commission's work in Part B of the present report will remain authoritative in all cases.

1 DISPOSAL SITE WITH THE BEST POSSIBLE SAFETY

Radioactive waste must be managed in such a way that no dangers are posed to humans and the environment over the short, medium and long term. Safety is the supreme imperative as far as the Commission is concerned. In view of the long half-lives of some radionuclides, the safety of these materials is to be guaranteed for one million years. The extremely long time horizon of the challenge of keeping radioactive waste away from the inhabited surface of the Earth will dominate the search for responsible waste management options. The principle of sustainability to which the Commission has subscribed in its vision commits it to focus this search on the ethical criteria of justice, fairness and responsibility for the future.

The Commission has drawn lessons from the past and, on this basis, set objectives for the pathway to safe waste management. These are the furthest-possible reversibility of decisions and the conduct of the procedure in transparent dialogue with the public. The principle of the reversibility of decisions derives, firstly, from the desire for opportunities to correct errors if unexpected developments occur and, secondly, from the future-directed ethical principle of keeping open or opening up decision-making options for future generations. Public participation in accordance with clear rules and with clear rights is called for in order to foster trust in the procedure and take account of as many perspectives as possible during the search for the option that will provide the best possible safety.

According to Section 1(1) of the Site Selection Act, it is the 'aim of the disposal site selection procedure to find the site for an installation for the final disposal of domestically produced, in particular high-level, radioactive waste that guarantees the best possible safety for a period of one million years.' The achievement of this objective was the central challenge faced by the Commission. The task of determining the site with the best possible safety must be resolved during the site selection procedure. This procedure, with its process steps and decision-making criteria, must be organised in such a way that the site with the best possible safety is arrived at as the outcome in a transparent, readily understandable fashion.

This means short, medium and long-term safety will have priority over all other aspects of the matter. During the site selection procedure, it will be necessary to determine the best possible site from safety points of view. At the same time, the other objectives of reversibility and public participation must be borne in mind.

2 STARTING POINTS FOR THE SEARCH FOR A DISPOSAL SITE

When the last nuclear power plant in Germany shuts down on 31 December 2022, at the latest, the production of high-level radioactive waste will also end almost entirely. Subsequently, about 30,000 cubic metres of high-level radioactive waste will have to be finally disposed of in Germany. Up until this point, the use of nuclear energy in Germany will have produced irradiated fuel elements that contain a total of approximately 17,000 tonnes of nuclear fuel. These figures already allow for fuel elements containing about 850 tonnes of nuclear fuel that may yet come to be deployed at the nuclear power plants currently still in operation during the remainder of their operating lives.

The total volume of low and intermediate-level radioactive waste to be disposed of in Germany could reach 600,000 cubic metres, twenty times the volume of high-level radioactive waste. Nevertheless, the high-level radioactive waste contains about 99 per cent of the radioactivity held by all the radioactive waste in Germany. Their many-times stronger radiation and the considerable quantities of heat they give off will make their safe final disposal a difficult challenge.

Furthermore, some of the low and intermediate-level radioactive waste were of significance for the Commission's recommendations. To date, there is no waste management option in place for the up to 220,000 cubic metres of the mixture of radioactive waste and salt that are to be removed from the Asse mine. Nor is there any final disposal option for the up to 100,000 cubic metres of waste from uranium enrichment to be dealt with under the National Waste Management Programme[13] and the more than 6,000 cubic metres of medium and low-level radioactive waste not suitable for the Konrad mine.[14] The Commission has therefore examined the preconditions under which it would be possible to finally dispose of this waste at the same site as the high-level radioactive waste.

2.1 Lessons from the past

The Commission was mandated by the Site Selection Act to propose a scientifically based procedure for the selection of the site for the disposal of high-level radioactive waste that would be able to guarantee the best possible safety and, when doing so, also to assess experience gained in the past, as well as the decisions taken and specifications adopted with regard to the handling of radioactive waste.

With the Site Selection Act, consequences were drawn from the difficulties encountered by the disposal projects that have been undertaken in Germany in the past. The Act ended the geotechnical exploration of the Gorleben salt dome and requires a new search to find a site for the final disposal of, in particular, high-level radioactive waste. The Commission has learned lessons from the previous

[13] According to the Federal Environment Ministry, the figure of up to 100,000 cubic metres of waste from uranium enrichment to be dealt with under the Waste Management Programme is based on a calculation that assumes enrichment will continue for 40 years. The enrichment facility at Gronau possesses an open-ended operating licence. In contrast to this, the facility's operator, URENCO Deutschland GmbH, stated in a letter to the Commission that it would take until the end of the century for 100,000 cubic metres of depleted uranium to accumulate.
[14] On this issue, cf. sections B 2.3, 'Waste life-cycle analysis', and B 6.6, 'Requirements placed on the emplacement of further radioactive waste.

German disposal projects, reflected on the cultural and societal background to any new understanding and taken account of the further development of science and technology in the field of final disposal.

The open-ended, multistage procedure for the selection of the disposal site that guarantees the best possible safety is the most important and logical consequence drawn from the controversial German final disposal projects that have been undertaken to date. It is an opportunity to overcome old conflicts and arrive at a new understanding. Such a selection procedure will avoid the premature specification of one site prior to the conclusion of the exploration work. Until the final decision is taken, various sites will be investigated in parallel with increasing intensity. At the end, a choice will have to be made between them according to safety points of view. This means the exploration activities will be open-ended and will not be tainted by the suspicion they are only intended to confirm prior assumptions about the disposal site and rubber stamp a political decision to specify one particular site.

The comparative selection procedure will be guided by the geoscientific criteria the Commission has drawn up in the present report,[15] which means the criteria used to find the site with the best possible safety will have been established before the beginning of the selection procedure. This too is a lesson from the history of Gorleben.

Accusations were frequently made that the decision to explore the Gorleben salt dome had been politically motivated. Politics will also play an important role in the new procedure. After every step in the multistage search, the Site Selection Act provides for a decision of the German Bundestag that will be intended to confirm each selection decision that is proposed has been based on the correct application of the criteria and citizens have been consulted. Following a public debate, the German parliament will approve and affirm the results of a scientifically based selection procedure. This is not comparable with an internally prepared cabinet decision of the kind that led to the designation of the site at Gorleben.

The search for the site with the best possible safety will start by looking at the whole territory of the Federal Republic of Germany. It will ensure all potentially suitable types of rock and all potentially suitable sites are looked at during the selection process, and avoid prior specifications that could be interpreted as being motivated by extraneous concerns. The Commission has formulated selection criteria without looking at concrete sites. In so far as this is possible, the criteria are valid for all types of rock in which final disposal is, in principle, feasible. No site will be selected on the basis of what is politically opportune.

During the exploration of the Gorleben salt dome, formal participation by citizens was first provided for during the plan approval procedure to be conducted for all major projects, which was supposed to follow the positive conclusion of the exploration work. This encouraged critics to suspect the intention was to present citizens who would be affected with a *fait accompli*. By contrast to this, the Commission recommends a selection procedure under which citizens will have the right to comprehensive opportunities for participation and involvement early on. With this in mind, it has drawn up a comprehensive concept for public participation in the

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[15] Cf. section B 6.5 of the present report, ‘Decision-making criteria for the selection procedure’.

selection of the disposal site that describes participation rights, participation formats and options to obtain legal redress in detail.[16]

New forms of participation and influence for the population also demand changed behaviour on the part of the authorities. They must involve critical or protesting citizens and always deal with them respectfully. The selection of the new disposal site will only be successful if all actors are capable of learning, and willing to behave in such a way that new trust is built up and it is possible to talk about all problems openly. To this end, the participating authorities must also contribute to transparency by always disclosing the reasons for planned decisions comprehensively and in good time, while engaging with citizens' criticisms at an early stage. Criticism of the authorities' actions is an opportunity to eliminate weaknesses.

Nevertheless, the Commission does not believe the final disposal of high-level radioactive waste is to be implemented in future without any conflicts at all. It has drawn up rules and recommendations for the handling of conflicts.[17] Furthermore, it is convinced that a far-reaching future ethics must be anchored in politics and society.[18]

In the opinion of the Commission, there must already be clarity about the purpose of the site that is being sought before the beginning of the selection procedure. The Commission has consciously focussed its selection criteria on the requirements of the best possible disposal of high-level radioactive waste. It believes that disposing of low and intermediate-level radioactive waste at the same site will only be possible if negative interactions with the high-level radioactive waste are ruled out.[19] However, it recommends that this possibility be taken into account from the outset in the community participation process.[20]

For the population must know from the beginning what it might be in for. Two years after Gorleben was designated a waste management site, the German Federation and the Land Lower Saxony agreed to alter its main purpose from that of a nuclear waste management centre to that of a site to be explored for disposal of radioactive waste.

In the opinion of the Commission, the failure of the final disposal of radioactive waste at the Asse II former salt mine also entails consequences for the treatment of divergent scientific opinions. Early warnings about inflows of water into the Asse mine were not acted upon at the time and even had negative consequences for the scientists who raised them. It would have been possible to correct the misguided course embarked upon at the Asse II mine earlier if critical voices had been taken seriously. The later an error is recognised, the more expensive its correction becomes. Furthermore, the history of the mine shows how indispensable it is to obtain opinions from experts who are independent of operators.

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[16] Cf. section B 7 of the present report, 'Site selection in dialogue with the regions'.
[17] Cf. section B 2.4 of the present report, 'Principles for the handling of conflicts in the participative search procedure'.
[18] Cf. section B 3 of the present report, 'The imperative of responsibility'.
[19] Cf. section B 6.6 of the present report, 'Requirements placed on the emplacement of further radioactive waste.
[20] Cf. section B 7 of the present report, 'Repository site selection in dialogue with the regions'.

On the other hand, important experience has been gained with the Asse 2 Monitoring Group that should also be used for community participation in future major projects.[21] From a contemporary point of view, the Commission recommends that the whole disposal process be designed as a self-interrogating system, with errors and undesirable developments being avoided if possible by means of continual process monitoring.[22]

The Commission on Storage of High-Level Radioactive Waste recommends that the consequences it highlights be drawn from the experience of disposal projects in Germany. This would mean it was possible to arrive at a new understanding, which would allow a fair, transparent solution that is as safe as possible to be achieved in an open-ended procedure.

2.2 The Commission's mandate and working methods

The task of the Commission on Storage of High-Level Radioactive Waste was to make preparations for the selection of a site that 'guarantees the best possible safety for one million years' for the disposal of, in particular, high-level radioactive waste. To this end, the Commission has carried out a critical examination of the rules laid down in the Site Selection Act for the search to find a disposal site. Having done so, it has drawn up criteria for the selection of a disposal site, and proposals concerning citizens' participation in its selection, the procedure for the disposal site selection process and the organisation of the process. For instance, it has developed a criteria-based selection procedure that could be used to select the disposal site with the best possible safety and, at the same time, would make it possible to correct errors. On the foundation of its proposals concerning these principle tasks and its other functions under the Site Selection Act, the Commission has formulated recommendations for the Bundestag, the Bundesrat and the German Federal Government that are now to be implemented by amending statutory provisions or taking administrative measures.

In its Rules of Procedure, the Commission committed itself, above all, to transparent working methods and granted its members extensive minority rights. To make sure its work was transparent, the Commission itself met in public as a matter of principle, as did the working groups and *ad hoc* groups it set up. The Commission's meetings were broadcast live on Bundestag Parliamentary Television and the Internet, and video recordings of the meetings were subsequently published on the Commission's website. Audio recordings of the working group and *ad hoc* group meetings were also made available for download on the website. Furthermore, all relevant documents consulted and produced during the deliberations were accessible to the public on the Internet site as Commission printed papers (K-Drs.) or Commission materials (K-MAT), except where third party rights stood in the way of this. Not only that, in the spring of 2015 the

[21] The Asse 2 monitoring process is a joint approach under which various state, political and civil society bodies play differentiated roles with the aims of guaranteeing regional and civil society involvement in the statutorily prescribed retrieval of atomic waste from the former Asse II mine (Wolfenbüttel County) and managing the process transparently. The monitoring process has, in particular, been managed by the Asse 2 Monitoring Group (a2b). The monitoring process is financed with funds from the Federal Ministry for the Environment, Conservation, Building and Nuclear Safety.
[22] On this issue, cf. section B 6.4 of the present report, 'Process design as a self-interrogating system'.

Commission established an Internet forum. The Commission involved interested citizens and representatives of societal groups more closely in its work with numerous dialogue events, from the Community Dialogue on the Search for a Disposal site to a discussion event about its draft report.

Taking its lead from the provisions set out in the Site Selection Act on the Commission's work, as well as the decision the German Bundestag passed with a broad majority when the Commission was appointed,[23] it emphasised its determination to reach a consensus. The Commission would make efforts 'to find unanimous solutions to all questions because the success of the Commission's work will ultimately depend on a broad consensus being reached,'[24] as its Rules of Procedure put it. The present Final Report, which the Commission has adopted by an overwhelming majority, achieves this self-defined goal. The fact that the report includes only a few dissenting opinions shows the Commission has indeed reached an extremely far-reaching consensus, and it is delivering its recommendations unanimously.

3. RECOMMENDED OPTION: FINAL DISPOSAL WITH REVERSIBILITY

Having looked comprehensively at a large number of options for the disposal of, in particular, high-level radioactive waste, the Commission has decided to recommend their transfer to an underground facility in a deep geological formation. What is conceptually new is the demand for the reversibility of decisions once they have been taken as an integral part of a learning procedure. This will allow the aim of the best possible safety to be achieved, a demand focussed on future-directed ethical principles and the desire for far-reaching opportunities to correct errors.[25] Reversibility, i.e. the ability to change course during the ongoing procedure, will be required in order to allow the correction of errors and so keep options for action open for future generations, for example to take account of new findings, and may help to build trust in the process. Concepts for the retrievability or recoverability of waste and/or the reversibility of decisions are central to this.

3.1 Foundations for the recommendation

Pursuant to the Commission's vision, the parameters specified in the Site Selection Act and ethical concerns, the pathway to safe final disposal must fulfil the following requirements:

- The search for the disposal pathway, disposal site and disposal concept must beoriented, above all, towards the goal of finding what is, from a contemporary perspective, the safest waste management solution for, in particular, high-level radioactive waste: safety has primacy.

[23] On this issue, cf. the motion tabled by the Christian Democratic Union/Christian Social Union (CDU/CSU), Social Democratic Party of Germany (SPD) and ALLIANCE 90/THE GREENS parliamentary groups on the formation of the Commission on Storage of High-Level Radioactive Waste – taking responsibility for following generations, Bundestag Printed Paper 18/1068.

[24] Cf. Rule 3 of the Commission's Rules of Procedure. On this issue, see section B 12.2.3 of the Annex to the present report.

[25] Cf. section A 1 of the present report.

- Domestically produced radioactive waste must be directed towards safe final disposal in Germany.
- The waste management solution is to be configured in such a way that it does not impose any permanent burden on generations to come, but ensures the safe final status of the structures put in place for the management of all high-level radioactive waste.
- Opportunities to take conscious decisions to change course and deviate from the option recommended here must not be cut off. It must be possible for errors to be corrected. Unnecessarily irreversible steps must be avoided.
- Before decisions are taken that will be irreversible or can only be revised with a great deal of effort, a transparent, scientifically supported evaluation will have to be carried out with the participation of the public and the bodies for which provision will be made.
- The whole process must be transparent, conducted with substantial participation on the part of the public and the regions, and designed as a self-interrogating system.

The basic features of the option recommended by the Commission are presented below. Its implementation by means of concrete procedural steps and the application of decision-making criteria is the topic of the following section.

Some terms briefly explained: stages, phases, steps, BGE and BfE

The present report describes the whole process for the final disposal of high-level radioactive waste. The selection of a disposal site will only be the first ***stage*** *in this process, and will be followed by further stages, such as the construction of the disposal facility, the disposal of the radioactive waste itself and the sealing of the underground facility. The selection of the disposal site is planned in three* ***phases****: the selection of siting regions, surface exploration and underground exploration. Phase 1 of the site selection stage is to be conducted in three* ***steps****. The selection of the disposal site and, subsequently, the final disposal of the waste will be tasks for a still-to-be-founded* ***Agency for the Disposal of Nuclear Waste (Bundes-Gesellschaft für kerntechnische Entsorgung, BGE)****, which will therefore act as the project delivery organisation.* ***BGE*** *will be supervised by the* ***Federal Office for the Regulation of Nuclear Waste Management (BfE)****. The regulatory authority will also organise public participation in the selection of the disposal site.*

3.2 Grounds for the recommendation

In the early days of nuclear energy, little attention was devoted to the problem of managing high-level radioactive waste. The prevailing mood was one of optimism that a solution would be found when the time came. Early contributions to the discussion about waste management options also propagated ideas that, from a contemporary point of view, appear extremely inappropriate given the challenges to be faced. The actors' thinking about the handling of radioactive waste was dominated by notions such as shipping waste to underground caverns and dissolving them so they would be diluted in the water of the oceans, as well as trust in technological progress, which was expected to resolve the problems by technical means. Only in the course of time did it become clear how great the scientific, technical, but also societal challenges of dealing safely, equitably and peacefully with waste would be.

The goal of keeping radioactive waste far away from the inhabited surface of the Earth has also inspired ideas about disposing of them in outer space, in the depths of the Earth's crust – for instance using deep boreholes that would reach depths of 3,000-5,000 m –, in the deep ocean, or in the Antarctic and Greenland ice sheets. Another group of options would rely on time as a factor, i.e. interim storage continuing over several centuries in the expectation that new solutions would be found in the mean time. It is expected to be possible for transmutation, i.e. the conversion of long-lived radionuclides into less long-lived nuclides, to at least simplify the disposal problem. Underground solutions in deep geological strata can be distinguished depending on the degree of reversibility that is envisaged, and range from rapid, practically irreversible sealing to steps that would ensure the retrievability of the waste over longer periods of time and their recoverability following the sealing of the deep repository.

The Commission has studied these options thoroughly. The central arguments for recommending the option termed 'deep repository with reversibility' to the German Bundestag are as follows:

- Final disposal in a deep geological formation is the only option that, in the opinion of the Commission, offers the prospect of permanent, safe disposal of radioactive waste for the reference period of one million years. The long-term reliability of the containment function and the integrity of the geological characteristics that will ensure its safety can be scientifically proven by means of empirical surveys and modelling exercises.
- Unlike surface or near-surface disposal, geology will offer passive safety as of a particular point in time and then require no maintenance.
- It is not possible to build in the same way on societal structures that would be stable over the very long term and capable of safely maintaining radioactive waste stored near to the surface in perpetuity.
- The 'deep repository with reversibility' option will be feasible in Germany in the foreseeable future. The commission believes it will be possible to realise the technical preconditions, such as technologies for the containers, the excavation and operation of the deep repository, the emplacement of waste and the sealing of the repository.
- In contrast to permanent near-surface storage, for example, this option will free future generations from the burdens imposed by radioactive waste as of a particular point in time.
- The 'deep repository with reversibility' option will allow a high degree of flexibility with regard to the utilisation of newly acquired bodies of knowledge. It will remain possible to switch over to other disposal pathways for a long time under this process.
- It will make it possible to learn from previous process steps and correct errors, for instance by means of monitoring.
- Far-reaching scientific information is available about the requisite geological preconditions that make the implementation of this option appear highly promising.

- In the opinion of the Commission, the ‘deep repository with reversibility’ option therefore accords best with its vision and is the most promising pathway for the responsible handling of high-level radioactive waste in Germany.

It is clear to the Commission that the final disposal of high-level radioactive waste will only be possible as part of a long-term process. However, it is also of the opinion that everything has to be done in order to create the disposal facility expeditiously.

3.3 The pathway to safe final disposal

Under the current parameters, different practical versions of the disposal pathway recommended by the Commission, ‘deep repository with reversibility’, are imaginable in detail. As a matter of course, it will remain open to the next few generations to configure the final disposal of radioactive waste in detail.

The Commission associates the ‘deep repository with reversibility’ option with the goal of constructing a repository as an underground facility in a deep geological formation. This facility is to be sealed in the more or less distant future and not impose any burdens on the inhabited environment and future generations. All the steps along the pathway that will lead to this state must be set out plausibly at the beginning of the procedure in order to explain why it is expected to make a sustainable, responsible, safe solution for the handling of high-level radioactive waste possible. The following account is intended to show how the whole pathway can be broken down into stages from the perspective of the present. It serves to illustrate the entire process up to its conclusion in order to examine whether the processes are plausible and the demand for reversibility can be implemented.

Stage 1 – Disposal site selection procedure: The selection procedure will start once a decision has been taken by the German Bundestag. Above all, there will be a need for clearly scientifically defined, democratically legitimated selection criteria and safety requirements, as well as clear rules on procedural steps, public participation, the structure of the relevant authorities and decision-making processes. The disposal site will be selected in several steps, during which the regions or sites that come into question will gradually be narrowed down until the site with the best possible safety is determined. During this process, high-level radioactive waste will continue to be stored at interim storage facilities. Should an unexpectedly long period of time be needed for the selection of a disposal site, or should it be decided to switch over to other pathways, a step that might require considerable technical, economic and institutional effort, safe storage processes would have to be initiated. This stage will be concluded with the specification of a disposal site by a decision of the German Bundestag.

Stage 2 – Geotechnical engineering of the site: The geotechnical engineering of the site for the emplacement of radioactive waste will initially involve the planning and licensing procedures that have to be conducted in advance, as well as the provision of the requisite evidence of the long-term safety of the combination of the geological barriers and the technical disposal concept that is foreseen. It will then be a matter of constructing the disposal facility with all the necessary surface and underground technical installations, including transport routes for the subsequent emplacement of waste. During this stage, it will be possible to discontinue the engineering activities at any time and switch to other disposal pathways.

Stage 3 - Emplacement of radioactive waste in the deep repository: The emplacement of radioactive waste will begin when the first loaded waste package is transferred into the prepared deep repository. The waste packages will be placed in a series of chambers, in galleries or from the galleries into boreholes, depending on the disposal concept in question. As soon as one of these emplacement areas is full, it will be backfilled to ensure waste that have been finally disposed of are isolated behind a seal from the rest of the deep repository, in particular from the people who work there. They will be backfilled in such a way that it will be possible to reopen them and retrieve the waste in accordance with an existing technological concept within an appropriate period time, i.e. within a period similar to that required for the emplacement of the waste in the first place. The packages/containers must also be designed in such a way that retrieval is possible. The deep repository itself will remain in an operational state during this stage. It will be possible for emplacement to be interrupted at any time and continued at a later date. It will even be possible for it to be completely discontinued. For it will be possible to switch over to other disposal pathways because the deep repository will remain functional. The waste that had still not been emplaced would then remain in interim storage facilities subject to appropriate requirements that guaranteed their safety. The end of the emplacement stage will be reached when the last loaded waste package is transferred into the repository.

Stage 4 - Observation prior to the sealing of the deep repository: During this stage, the deep repository will continue to be fully functional and accessible. The observation of the further development of, for instance, its temperature, the stability of the geological formation and gas generation will be ensured by monitoring. The aims for the monitoring will have to be specified as early as possible. The emplaced packages will remain in the deep repository, but it will still be possible for them to be retrieved under certain circumstances. It will still be possible for the procedure to be discontinued at this stage too, and it will be possible to switch to other pathways. In this case, the emplaced waste would have to be retrieved and transferred to a safe, surface location. The sealing of the deep repository will mark the conclusion of this stage.

Stage 5 - Sealed deep repository: Once the deep repository has been sealed and is in its final state, the goal of the safe, zero-maintenance containment of radioactive waste in the deep repository will have been achieved. It will continue to be possible for the sealed deep repository to be observed from outside. The extent to which events within the repository can continue to be observed will depend on the monitoring measures provided for in the course of emplacement or during the phase prior to sealing. Where necessary, it will be possible for the packages to be recovered by excavating new underground access ways and using available documentation. Recovery will be possible as long as the site of the deep repository is known, the documentation can be found and is legible, the waste packages (containers) are themselves in a recoverable state, and the technical and societal preconditions for recovery, i.e. the excavation of parallel underground access ways are in place.

In this way, the goal of safe, zero-maintenance final disposal can be combined with the desired reversibility of decisions, retrievability of waste, steps that allow errors to be corrected and opportunities for learning during the process. Precautions must be taken for the permanent revision of the waste management process from the perspectives of safety, transparency and participation, at least until the final status of the waste management pathway designed in accordance with these requirements has been reached.

If it is actually to be possible for the actors to recognise when there is a need to change course and correct errors, forms of monitoring suitable for this purpose will be required. This will be true, in particular, with regard to decisive steps in the disposal process, but also with regard to decisive societal changes. It is difficult to estimate from a contemporary perspective how long it will take before a disposal site is specified, the emplacement of the waste begins or the deep repository is sealed. The timescales might extend far into the future on account of delays to the process, disputes before the courts, changes of plan or decisions to return to earlier stages.

Very long timescales would, however, place considerable burdens on following generations, make extensive interim storage arrangements necessary, subject to appropriate safety requirements and licensing procedures, entail the danger of paralysis and fatigue, and increase the risk of the whole process not being concluded purposefully. Viewed in the light of the ethical requirements to which the Commission has committed itself, it is necessary to work for the whole process to remain manageable within a justifiable timeframe. Given the trade-off between the best possible safety and substantial public participation, on the one hand, and the desire for the procedure to be conducted as quickly as possible, on the other, the Commission has adopted the following position:

- The expeditious implementation of the final disposal of high-level radioactive waste is important. In this respect, however, safety and participation have priority; nonetheless, the problems of interim storage facilities are also to be taken into account when these issues are being considered.
- As part of the disposal site selection procedure, the project delivery organisation is to develop a framework schedule with key deadlines and milestones at an early stage.
- All the parties involved are called upon to optimise the procedure for the selection of the disposal site and the construction of a disposal facility so it is conducted expeditiously and the delivery of the project is managed as time-efficiently as possible.
- Procedural steps should be followed in parallel where this is possible.
- Research is to be funded in order to develop options that allow time-intensive processes, such as underground exploration, to be shortened.

Under the site selection procedure provided for as of 2017, thought must be given to all aspects relevant for the stages until the deep repository is ready to be sealed. This is true, above all, for the specification of the decision-making criteria and the procedural steps, the outcome of which will be the selection of the site with the best possible safety.

4 THE PATHWAY TO THE SITE WITH THE BEST POSSIBLE SAFETY

The selection of the disposal site with the best possible safety as the outcome of a scientifically based, criteria-led, transparent, participative process will place exacting requirements on the procedure. The selection procedure will be briefly set out below,[26] following which there will be a discussion of public participation[27] and the decision-making criteria,[28] which are central elements in the Commission's recommendations to the legislature.[29]

4.1 The disposal site selection procedure

Once the Bundestag and the Bundesrat have re-enacted the Site Selection Act on the basis of the present report, it will be possible to start the selection procedure to find a disposal site for high-level radioactive waste. The actors, procedural steps and decision-making criteria that are to be provided for in the Site Selection Act on the basis of the Commission's recommendations will be crucial to the procedure.

Following the Site Selection Act, the Commission has broken down the selection procedure into three phases. During each phase, the project delivery organisation will present a report on the results achieved up to that point and how they have been reached. The report will be examined by the Federal Office for the Regulation of Nuclear Waste Management. It will also be discussed and deliberated on during the public participation activities, by scientists, and finally by the German Bundestag and the Bundesrat. Ultimately, the Bundestag and the Bundesrat will decide conclusively on the commencement of the next selection phase on the basis of the results of this process.

Table 1: Phases of the site selection procedure

Phase	Tasks	Conclusion
One	Start with a 'blank map' of Germany. Exclusion of regions in accordance with the agreed exclusion criteria and minimum requirements. Comparative analysis on the basis of available data[30] in accordance with the specified consideration criteria and the representative preliminary safety analyses	Decision of the German Bundestag and the Bundesrat on the surface exploration of possible siting regions
Two	Surface exploration of the possibly suitable siting regions identified in Phase 1. Comparative analysis and consideration in accordance with the agreed exclusion criteria, minimum	Decision of the German Bundestag and the Bundesrat on the underground exploration of possible disposal sites

[26] On this issue, cf. section A 4.1 of the present report.
[27] On this issue, cf. section A 4.2 of the present report.
[28] Cf. section A 4.3 of the present report.
[29] Cf. section A 5 of the present report.
[30] And, under certain circumstances, further data that are acquired.

	requirements and consideration criteria, as well as further developed preliminary safety analyses.	
Three	Underground exploration of the disposal sites selected as the outcome of Phase 2. In-depth study informed by the requirements placed on safe final disposal. Comprehensive preliminary safety analyses. Comparative consideration of possible disposal sites with the aim of identifying the site with the best possible safety.	Specification of the disposal site by the German Bundestag and the Bundesrat

During Phase 1, the project delivery organisation will work on the foundation of the geological data and information that are available to the specialist geological authorities in Germany or can be obtained by the authorities. During the first phase, available information is to be made extensively accessible and interpreted. However, no further geological data will yet be obtained by exploration. It may become necessary to reanalyse data[31] if the immediately available level of knowledge is insufficient for an assessment, and an in-depth evaluation of the raw data that are available throws up additional findings.[32]

Starting with the whole territory of the Federal Republic of Germany and a blank map of the country, the sites that are subsequently to be explored from the surface will be determined in three steps during the first selection phase: The geological exclusion criteria and the minimum requirements will be used in Step 1 to determine the areas where final disposal does not appear to be possible from the very outset.[33] The remaining areas will be narrowed down in Step 2 by the application of the geological consideration criteria to a large number of potential regions or sites. In Step 3, when the in-depth geoscientific consideration is carried out, the geological consideration criteria will be applied again and combined with the results of the representative preliminary safety analyses. After this, spatial planning consideration criteria[34] will be applied. This will narrow down the subareas that might possibly be suitable from safety points of view to those that are also justifiable under planning law.

After Step 2, the project delivery organisation will present an interim report on the subareas that have been identified. This report will be discussed at a subareas conference,[35] while the project delivery organisation continues its work. The project delivery organisation’s report on Phase 1, including the proposal

[31] When data are reanalysed, raw geological data or drilling cores that are available may be evaluated once again or in greater detail. Cf. section B 6.5.8 of the present report.
[32] Cf. section B 6.3.1.1 of the present report.
[33] Cf. section A 4.3 of the present report.
[34] Cf. section B 6.5.9 of the present report.
[35] Cf. section A 4.2 of the present report.

concerning eligible subareas, the associated preliminary safety analyses and the proposal for a selection of siting regions for surface exploration put forward on this basis, will subsequently be forwarded to the Federal Office for the Regulation of Nuclear Waste Management and published. The report is to set out exactly how the results have been arrived at by providing transparent documentation, and explaining the grounds for all the steps and decisions that have been taken. The report is the proposal put forward by the project delivery organisation and not yet the result of the first phase.

The handing-over of the report will mark the beginning of its scientific examination and the public discussion with the public participation methods for which provision has been made.[36] Taking account of the results of the participation procedure, the Bundestag and the Bundesrat will decide which potential sites are to be explored from the surface.

During Phase 2, the potential sites that have been selected will initially be explored from the surface of the Earth. The project delivery organisation will evaluate the results of the surface exploration activities and build on them to further develop the preliminary safety analyses. The exploration work will follow the site-specific exploration programmes specified by the Federal Office for the Regulation of Nuclear Waste Management (BfE).[37] At the same time, the public of the regions where exploration activities are conducted will be involved on a regular basis by means of regional conferences and further formats.[38]

The information gained from the exploration activities and further developed preliminary safety analyses will be assessed by the project delivery organisation with a view to deep disposal facilities' environmental compatibility and their other possible impacts.

On this basis, the project delivery organisation will draw up a report in which it will propose an objectively justified selection of disposal sites to the BfE for the types of host rock that are to be covered by the further exploration activities. The proposal will also include elaborated programmes for the underground exploration work. In the opinion of the Commission, this report must also contain proposals for an in-depth geological exploration programme and site-specific examination criteria, as well as the documents required for the sites to be appraised from the perspective of spatial planning.

The project delivery organisation's report will have to set out precisely how the results have been arrived at by providing transparent documentation, and explaining the grounds for all the steps and decisions taken. With the handing-over of the report to the BfE, its scientific review and public discussion will begin. Ultimately, the Bundestag and the Bundesrat will decide which sites are to be explored underground, taking account of the results of the public participation and the examinations that have been carried out.

During Phase 3, the project delivery organisation itself will conduct the underground exploration of the potential disposal sites. It will draw up a report for the BfE on the results of the exploration activities and its conclusions. This report will have to set out precisely how the results have been arrived at by

[36] Cf. section A 4.2 of the present report.
[37] Cf. section B 6.3.1 of the present report.
[38] Cf. the detailed account given in sections B 7.4 and B 7.5 of the present report.

providing transparent documentation and explaining the grounds for all the steps taken and the assessments that have been carried out. The BfE will consult the public in parallel during the examination of the report, the conclusive comparison of the disposal sites and the elaboration of the disposal site proposal. In contrast to Phases 1 and 2, the project delivery organisation will not present a proposal for a site at this point. Rather, this will be the BfE's task during Phase 3. The last step of Phase 3 will be the decision on a disposal site enshrined in federal legislation. Subsequently, Stage 2 will begin the geotechnical engineering of the disposal site, which will commence with the licencing procedure under Section 9b of the Atomic Energy Act.[39]

The exclusion criteria, minimum requirements and consideration criteria recommended by the Commission, as well as the requirements placed on safety analyseswill remain valid during all three phases of the selection of the disposal site. They will be applied in an ever more detailed manner and with ever more precise data between Phase 1 and Phase 3, from the data already available during Phase 1 to the additional data to be acquired by means of the surface exploration during Phase 2 and the data from the underground exploration during Phase 3. In this fashion, the pathway will gradually be followed from the 'blank map' all the way through to the identification of the disposal site with the best possible safety.

The set of criteria will therefore be used to navigate the selection procedure in the direction of the site with the best possible safety, while the adequate application of the criteria, the consideration criteria in particular, will have to be scrutinised during the procedure itself. The Commission regards this unprecedented procedure as ambitious, but nevertheless feasible.

4.2 Public participation

4.2.1 Challenges and foundations

The participative search procedure that is proposed will break new ground as far as central questions are concerned. It will address a highly complex topic with a previous history marked by numerous conflicts over many decades, and in doing so it will have the aim of finding a solution supported by a broad societal consensus that can ultimately be tolerated by the directly affected parties as well.

This aim can only be achieved if all the parties are not only involved fairly and unreservedly in the whole procedure, but if these parties are also willing to engage in a new culture of openness to societal conflicts that does not ignore past conflicts, addresses any new conflicts that arise, but is always oriented towards the principle of constructive conflict management and does not lose its focus on the shared goal of a largely consensual, societally viable solution.

This will require a genuinely participative search procedure that takes equal account of what have historically been highly charged conflicts, the complexity of the subject matter and the timescale of several decades that is to be anticipated. Comprehensive participation will be the essential foundation for a procedure that uses participation not only to design the process, but also to ensure it reaches a higher-quality, more legitimate, acceptable outcome. It will look on citizens as

[39] Cf. section A 3 of the present report.

emancipated actors who collaborate in designing the procedure, thus taking account of all the dimensions of successful participation.
This task gives rise to the following central basic requirements for the organisation of participation during the search procedure:

- **Transparent information policy characterised by its breadth and depth:** Information and transparency at all steps of the disposal site selection procedure are elementary preconditions for successful participation. Such information must be available in the necessary depth for the specialist public and committed citizens. In parallel, the aspiration will be to provide basic information to the largest possible sections of the population about the problems faced and the process of the search for a disposal site.[40]

- **Shaping the public interest with the participation of affected parties:** The disposal site selection procedure also represents a particular challenge because it aspires to a public interest-oriented outcome and will be reliant on the tolerance of the people affected in the siting region to achieve this. Not forcing this orientation towards the public interest on affected parties, but shaping it as well as possible with their direct participation will require participation formats that go beyond the previous standards for infrastructure projects. In this respect, their orientation towards the public interest will be the focus for the National Societal Commission.[41] Affected parties will be consulted comprehensively, in particular at regional conferences. Additional formats for supraregional participation[42] are to promote dialogue between the regional conferences and encourage changes of perspective among the actors. To this end, the municipalities where the current interim storage facilities are sited will also be involved in the supraregional participation structures.

- **Successful participation through collaboration and re-examination:** Trust in the fairness of the disposal site selection procedure can only be built up if the participants exercise rights to be involved at two levels: Firstly, they must be able to oversee and collaborate in the design of the selection steps. Secondly, they need defined scrutiny rights in order to be better able to interrogate and improve the quality of the process and the decisions that are taken, but without running the risk of endangering the whole procedure by blocking it entirely. The Commission foresees this being done by the regional conferences, which are described in detail in the present report. With their re-examination rights, the regional conferences will be given opportunities to identify defects and request action to eliminate them before any decisions are taken by the Bundestag. We present the practical arrangements for such requests in the section on regional conferences[43] and the section 'Statement procedure and hearings'.[44]

- **Joint development of future prospects for the region affected:** The people ultimately affected by the decision on the disposal site will rightly expect a process that is as transparent as possible and in which the joint evaluation of

[40] Cf. sections B 7.3.4 and B 7.3.5 of the present report.
[41] Cf. section B 7.4.1 of the present report.
[42] Cf. section B 7.4.4 of the present report.
[43] Cf. section B 7.4.3 of the present report.
[44] Cf. section B 7.4.5 of the present report.

their region's future prospects also plays an essential role. In particular, this will mean looking at the question of how the region's potential for development should be structured. This must be done at an early stage, transparently and in dialogue with all the participating actors in order to offer the region where the disposal site is located long-term compensation and ensure it is not disadvantaged. We recommend the participative elaboration of a siting agreement for this purpose.[45]

- **Holding course with an adaptive, self-healing procedure:** The intensity, complexity, scale and duration of the disposal site selection procedure are exceptional in the history of the Federal Republic of Germany. The ambitions for, but also the risks of, the associated participation process will be correspondingly great. Against the background of our current level of knowledge, it is not possible to predict and take account of all the risks involved during planning activities. We therefore recommend the establishment of a robust, adaptive, self-healing participation system in which, just like the roles in the procedure, real opportunities to collaborate are clearly defined and transparent for all participants. We would, in particular, use the National Societal Commission to make this possible[46] with the support of its participation officer, the accompanying scientific evaluation and the iterative development of how the participation is designed in direct dialogue with the citizens who take part in each phase. We present this adaptive participation system[47] once again at the end of the present section in a compact, readily understandable form.

4.2.2 Information and transparency

If successful participation is to be possible, those who are to be involved must be provided with early, comprehensive, low-threshold information. Free access to information and its preparation will play an important role in the quality of the participation.

One essential element in the provision and dissemination of information is the independent information platform previously proposed in the report from the Committee on a Selection Procedure for Repository Sites (AkEnd). Particular emphasis has been placed on the independence of this medium. Although it will be administered by the Federal Office for the Regulation of Nuclear Waste Management (BfE) as the organisation that delivers the public participation, it will simultaneously enable other actors, such as regional bodies and the National Societal Commission, to influence editorial decisions. These actors are to collaborate actively in the compilation, processing and checking of information.

The formats are to be conceived in such a way that conflict-laden situations too are illuminated from different perspectives and by various authors. Minimum academic standards are to be guaranteed.

A balanced, comprehensive information base is to be created by surveying this information in its entirety. The service provided must be prepared and made accessible in such a way that both laypeople and committed citizens with

[45] Cf. section B 7.2.2 of the present report.
[46] Cf. section B 7.4.1 of the present report.
[47] Cf. section A 4.2.8 of the present report.

specialist knowledge, researching journalists, or experts from the scientific and business communities are able to find appropriate levels of information and presentation.

The regional bodies are to take on an active role in the development of the platform and its ongoing administration. The platform and the optional information offices on the ground are to be tools with which to make the results of these bodies' deliberations known to the regional public and receive feedback from the public. The National Societal Commission will also be able to contribute content.

The information work must not merely reach those who already come to the procedure with an interest in it from the beginning. It is far more important that, in the interests of activating broad sections of society, the procedure is accompanied by a supraregional information campaign, so that people who have still not taken any notice of it until then are also informed about the relationships between different issues when it comes to the selection of the disposal site and the opportunities for participation.

Several preconditions have to be fulfilled before transparency can be used in an effective manner: Knowledge about the existence of information, access to that information, and the capacity to analyse the information and put it in its scientific or political context. Access will be made possible with the information platform while, in the regional conferences, new institutions will be created that are to responsibly develop this capacity for analysis and contextualisation.

The Commission therefore recommends that, for this purpose, the experience gained with the Hamburg Transparency Act be drawn on to help compile a public information register of BGE and the BfE's documents.

4.2.3 National Societal Commission

The central functions of the National Societal Commission will be the mediating, independent oversight of the disposal site selection procedure as well as, in particular, the implementation of public participation in the site selection procedure.

The National Societal Commission will be a societal entity independent from the authorities, participating enterprises and expert institutions that stands above the procedure, is characterised by its neutrality and expert knowledge, and is intended to mediate continuity of knowledge and trust. The Group's focus will therefore lie not only on the public interest-oriented oversight of the process, but also on building up and maintaining continuity of trust between the actors who will take part in it.

The National Societal Commission is to be established immediately after the delivery of the Commission's report in order to prevent disruption to societal oversight and not allow the societal dialogue to be interrupted. It will therefore be appointed in two stages:

- The National Societal Commission is to consist of nine members from its creation to the conclusion of the evaluation provided for by the second sentence of Section 4(4) of the Site Selection Act. Six members who will be appointed by the Bundesrat and Bundestag are to be of high societal standing; apart from them, two citizens are to be appointed who will be selected randomly,[48] and one representative of the younger generation.

- Following the evaluation of the Site Selection Act, the National Societal Commission is to consist of 18 members: six randomly selected citizens, of whom two will represent the younger generation of 16-to-27-year-olds, and twelve eminent figures in public life.

The German Bundestag and the Bundesrat will determine the twelve eminent figures in public life. The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) will appoint the randomly selected citizens and the representatives of the younger generation, who will previously have been nominated in a procedure that is suitable for this purpose, for example, as part of the work done by a planning cell. The members will not be able to belong to a legislative body of the German Federation or one of the German Länder, the Federal Government or a Land government; they must not have business interests connected with the selection of the disposal site or the disposal of radioactive waste in its broadest sense. The members will serve for a term of three years. It is to be possible for members to be reappointed twice.

The members will be given the right to consult all files and documents held by the BfE and BGE. Should they consult documents that are not to be disclosed under the Environmental Information Act (UIG), the members are to be to be bound to secrecy as necessary.

The National Societal Commission will help to ensure changes and innovations that are required can be identified. If it comes to the conclusion that parts of the procedure or decisions need to be reassessed, it will be able to recommend appropriate changes to the legislature. On the basis of its recommendations, the legislature will be able to adopt modifications to the procedure that may even return it to earlier stages. To this end, the National Societal Commission will be able to consult the advisory board or experts appointed by it under certain circumstances to reflect on issues, design processes and provide scientific expert opinions.

The National Societal Commission will appoint a participation officer. The participation officer will contribute to the resolution and arbitration of conflicts for the National Societal Commission, and will therefore be responsible for conflict management. The National Societal Commission will also be the ombuds office for the public and point of contact for all participants in the site selection procedure, as well as for parties affected by interim storage facility sites.

The appointment of ordinary people will send out a clear signal about the National Societal Commission’s special role. Numerous examples of praxis from Germany and abroad demonstrate that, thanks to the unconditional, high-quality collaboration of private citizens, the principle of the ‘citizens’ report’ strengthens representative democracy and performs a mediating function in debates with critical stakeholders.

The National Societal Commission will hold the rights to take up issues on its own authority and make complaints, and will therefore be able to put questions to the BfE and BGE at any time, and demand that they be answered. At the same time,

[48] On the procedure to be used, cf. section B 7.4.1.6 of the present report.

in order to prevent overlaps and delays, it will synchronise the scheduling of its activities with the regional conferences' procedural processes and the re-examinations they carry out.

During each phase, the National Societal Commission will forward the results of its deliberations to the German Federal Government and the legislature.

4.2.4 Regional conferences[49]

The central institutions for the participation of affected parties will be the regional conferences. In each region proposed during Phase 1 as a siting region to be explored from the surface, a regional conference will intensively oversee the procedural steps that are taken over the long term. The Federal Office for the Regulation of Nuclear Waste Management will set up the regional conferences, and provide organisational and financial resources for as long as they are active. The regional conferences are to be put in a position to organise their work autonomously with a high degree of independence from the BfE.

Each regional conference will consist of a plenary and a representative panel. The main functions of a regional conference will be to intensively oversee the whole selection process, and review the main proposals and decisions to make sure they are correct and readily understandable. Should it not be possible to remedy such deficiencies in dialogue with the BfE and BGE, it will be the task and right of the regional conferences to formulate re-examination requests before any decisions are taken by the Bundestag.

Furthermore, it will be incumbent upon the individual conferences to inform the public in their own regions about the progress made towards selecting the disposal site and continuously consult the public. The rights to be involved in the information platform are important instruments for this purpose, as are the autonomous forms of public participation to be designed by the regional conferences.

Citizens who are entitled to vote in local elections within a regional authority will be invited to the plenary meeting in writing. The plenary meeting will have the following functions:

- It will elect and/or confirm the members of the representative panel.
- It will be the discussion forum for the members of the representative panel.
- It will be able to submit motions to the representative panel and make proposals to it.

The representative panel will be in charge of operative business and take decisions. Important decisions, for instance about the right to request re-examinations, will be taken after a hearing of the plenary meeting.

The representative panel will be made up of equal numbers of representatives from each of the following groups of institutions and persons:

- representatives of local authorities at the municipal and county levels,
- representatives of societal groups, such as business, environmental and other organisations whose areas of activity are immediately connected with the selection of the disposal site,

[49] On this issue, cf. section B 7.4.3 of the present report.

- individual citizens.

The members of the representative panel will be elected or, in the case of the local authority representatives, confirmed by the plenary meeting. An election procedure is to be applied that will allow three equally large groups to be elected to the representative panel. The BfE will ask the participating county councils and county borough councils for a list of representatives for the ‘local authorities’ segment. The BfE will collaborate with the representatives from the local authorities to specify a procedure for the nomination of candidates for the ‘societal groups’ and ‘individual citizens’ segments. The representatives of both the societal groups and individual citizens will be elected by the plenary meeting of the regional conference.

The members of the representative panel will be elected for three years in each case, and it will be possible for them to be re-elected twice.

The Commission assumes that the delimitation of the regions in question will have to be based equally on geological and socioeconomic points of view. The regional conferences are to represent the perspectives of all people who would regard themselves as being affected by the construction and operation of a disposal facility at the possible site. These effects may be felt beyond the area above the rock formation.

Nor will state borders constitute barriers to participation. It is recommended that, should foreign parties be affected, a state treaty be concluded with the neighbouring countries in question that provides for their involvement.

As a pragmatic basic rule, it is recommended that the local authorities whose territory is located above the possible repository form a joint region together with all the directly adjoining local authorities. This basic rule is to be adapted depending on the geographical specifics.

The main right of each regional conference will be to formulate a re-examination request if it comes across a deficiency in BGE’s reports that, in its estimation, is not consonant with the procedural standards laid down in the Site Selection Act, and it is also unable to remedy this deficiency in cooperation with the BfE and BGE. Re-examination may be demanded prior to any decision being taken by the Bundestag under the Site Selection Act. The BfE and the regional conferences will agree on appropriate time limits. Where unanimous agreement is not reached, a decision will be taken by the National Societal Commission.

The instrument of re-examination will be used to pursue the aim of raising the quality of the disposal site selection procedure by giving the affected parties strong opportunities to have input, resolve conflicts in good time and reduce the risk of the process being discontinued or permanently delayed.

A regional conference’s re-examination request is to relate to a forthcoming decision in the disposal site selection procedure and describe the deficiencies that have been found or alleged as concretely as possible.

The Federal Office for the Regulation of Nuclear Waste Management will deal with the re-examination request and, where necessary, consult BGE. The results of re-examinations will be presented to the legislature together with the comments of the bodies that initiated them.

4.2.5 Supraregional participation

In the course of the public participation, supraregional participation will be accorded a function as an interface between the orientation towards the public interest and the participation of affected parties. It will permit

- open dialogue between the BfE, the project delivery organisation and regional actors who are actually directly affected or may potentially be affected,
- intensive appreciation of others' perspectives,
- opportunities to deal with existing or possible conflicts at a low level of escalation,
- exchanges of experience, in particular between the regions that still find themselves in the procedure.

In this respect, it will be worthwhile to have different structures for supraregional participation and deal with different substantive issues during each of the various phases of the site selection procedure.

4.2.5.1 Subareas conference

Following the conclusion of the Commission's work and at the beginning of the search procedure, it will still not be possible for affected regions and their citizens to participate because no possible siting regions will have been selected. Nonetheless, it will be worthwhile to offer participation formats during this phase in order to oversee the process by which structures are formed for the participative search procedure, as well as the drafting of BGE's interim report during Phase 1 of the selection procedure.

The aim is to defuse the paradox of participation. For experience suggests that potentially extensive opportunities to have input at the beginning of a process usually meet with little or no real willingness to participate. To deal with this, it would seem obvious to continue using the formats developed and successfully put into practice during the Commission's work,[50] and introduce a Subareas Conference.

The Subareas Conference will open up opportunities to shorten the amount of time devoted to merely providing information and initiate well informed deliberations promptly before primarily regional interests become significant. The Subareas Conference will discuss BGE's interim report after Step 2 of Phase 1.[51] It will look at the application of the exclusion criteria, the minimum geological criteria and the geoscientific consideration criteria that have led to the identification of subareas by BGE during Phase 1, and will present a report on these topics.

4.2.5.2 Council of the Regions Conference

Following the formation of the regional conferences, we recommend the establishment of a Council of the Regions Conference. At the Council of the Regions Conference, representatives from the regional conferences will discuss with one another their experiences of the processes that have been taking place in their home regions and develop a supraregional perspective on the search for a

[50] On this issue, cf. section B 7.7 of the present report, 'Participation in the Commission's work'.
[51] Cf. section B 6.3.1 of the present report.

disposal site. Representatives from the sites of interim storage facilities will also be involved in the Conference. This will make it possible to recognise the potential for possible problems, but also areas for optimisation, and deal with them more efficiently. The representatives of the regions are to engage together with the processes that are taking place and, as the procedure continues, the proposed decisions concerning the identification of the disposal site with the best possible safety as well. The aim will be, in particular, to help reconcile the regions' conflicting and contrary interests. The Council of the Regions Conference and the regional conferences will work in parallel both in substantive terms and as far as their scheduling is concerned.

It is certainly possible that, in the course of the process, it will also become evident the regions have contrary interests that are not easily to be reconciled at the regional level. As described in the section 'Handling of conflicts',[52] these differences must be circumscribed in good time and dealt with as foreseen under the conflict stages model.

4.2.6 Comments procedure and hearings

Following the discussion of the relevant proposal by the regional bodies and any potential re-examination and revision, it will be presented to the general public and public agencies for discussion at the end of each phase. This step will ensure public participation with procedural elements that are strongly defined in legal terms.

Pursuant to Section 9(3) of the Site Selection Act, the public is to be given the opportunity to comment on the substantive issues that are described in section 7.2.1. The BfE will have to prepare the information to be provided appropriately, and present it on the information platform and in other suitable media in forms that allow different target groups to readily understand it.

The BfE will forward the comments to BGE as the project delivery organisation. Within BGE, the first step will be to evaluate them quantitatively and qualitatively so that substantive priorities become apparent. The second step will be to look at each comment and consider it individually. BGE will draw up an evaluation report that summarises all its results. On the basis of this evaluation, the Federal Office for the Regulation of Nuclear Waste Management will publish its conclusions, which it will plan to take account of in the further procedural steps. The evaluation and the conclusions will form the basis for the subsequent hearing, to which the BfE will issue invitations.

A hearing will be arranged by the BfE at the end of each phase. Opportunities to comment and attend the hearing will be open to all interested citizens. These events are to be conducted in the area around the project. They must be announced in good time through suitable channels. In addition to this, representatives of the project delivery organisation, regional bodies, affected local and regional authorities, and public agencies will have to be present.

The results will be incorporated into the BfE's report on the public participation, as well as the reports of the regional conferences and the National Societal Commission.

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[52] Cf. section B 2.4 of the present report.

4.2.7 Siting agreement

The Commission's recommendations concerning public participation are based on the thesis that two essential conditions have to be fulfilled in order for a region's citizens to be able to tolerate the construction and operation of the disposal facility: Firstly, convincing scrutiny will have to be exercised to ensure the selection of the disposal site and construction of the disposal facility are consonant with the concept of the best possible safety. Secondly, the region will have to be in a position to compensate effectively and permanently for the burdens imposed by the construction of the disposal facility and the transportation of the containers. Action must also be taken to counter any negative labelling of the region by developing a compensation concept.

The strategies for action to provide this compensation are to be developed individually in each region. The economic, historic and social potential of the regions is to be studied closely for this purpose, and fitting long-term strategies are to be both elaborated and validated. The aim cannot merely be to provide compensation in the form of short-term financial payments; rather, long-term potential lines of development for the regions in question are to be elaborated that will constitute a highly sophisticated response to the construction of the disposal facility. When this is being done, it will be necessary to both look at the concerns of the current population and, at the same time, factor in expert knowledge and predictions about future developments.

The parties to such an agreement should, on the one hand, be the Federal Republic of Germany and, on the other hand, the local authorities of the region where the selected disposal site is located. It will only be possible to conclusively define how such a region should be delimited during Phase 3.

The subject matter covered by an agreement could be:

- the configurable key elements of the installations, such as transport links, surface installations, emissions control, parameters for the emplacement process, waste capacity,
- long-term obligations during the operational and post-operational phases,
- compensation measures with intergenerational effects that would strengthen the regions' potential for development and compensate for possible negative side effects of the disposal facility.

The options to gain legal redress will not be negatively affected by any such agreement.

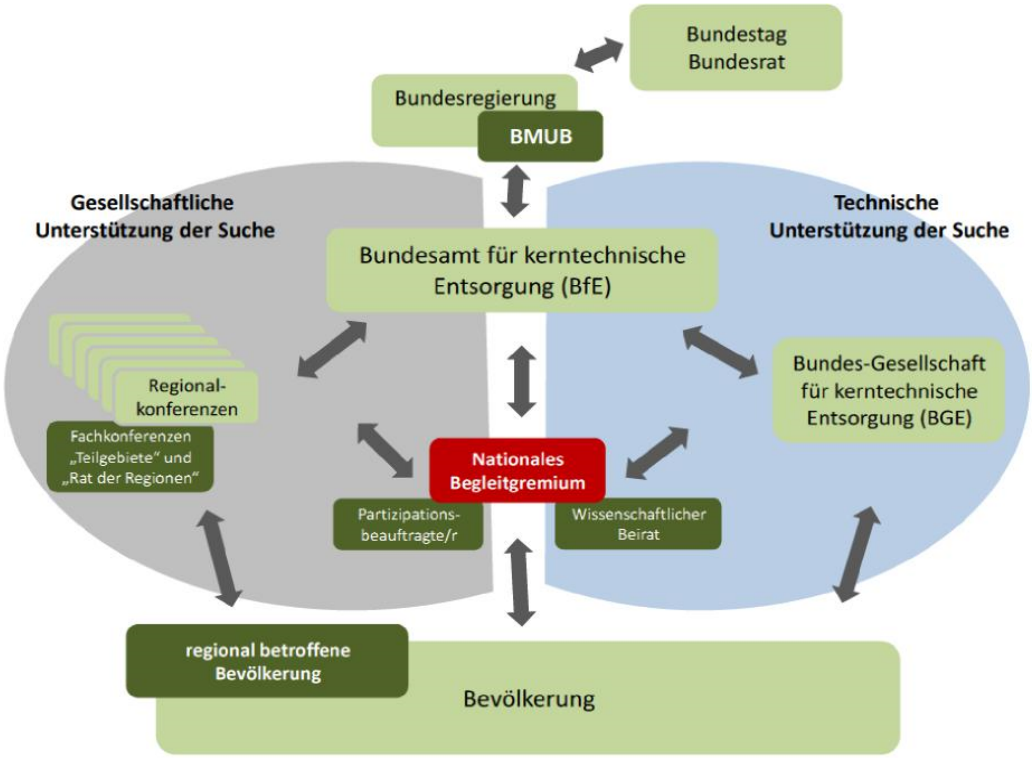
4.2.8 Adaptive participation system

The essential precondition for successful participation over the long timescale of the process and in the context of such a complex topic is a robust participation system. This will be based on a clear definition of the participating actors' roles and their individual opportunities for involvement.

At the same time, such a system must be capable of responding flexibly to the changes and conflicts that will inevitably occur in the course of the disposal site selection procedure. Errors and shortcomings may become apparent during this procedure. They are even to be expected. The cooperation between the BfE, BGE, the National Societal Commission and the regional conferences, supported by scientific evaluation activities and the participation officer, who will work to deescalate conflicts, is to ensure that the participation – and with it the whole procedure – is not halted by the occurrence of unexpected events at a particular point.

The handling of conflicts, errors and things we do not know will be of enormous importance in this respect. The aim of this adaptive participation system, which will be given the capacity to repair itself, will not be to seek to avoid all conflicts from the outset, but to integrate them and grasp them as drivers of participation. The participation system will therefore not be a corset whose every detail has been determined in advance, but a robust, living, adaptive organism in which each actor is able to contribute to its success:

Graphic 1: Community participation in the selection procedure



Bundestag = Bundestag

Bundesrat = Bundesrat

Bundesregierung = German Federal Government

BMUB = Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

Gesellschaftliche Unterstützung der Suche = Societal support for the search

Technische Unterstützung der Suche = Technical support for the search

Bundesamt für Kerntechnische Entsorgung (BfE) = Federal Office for the Regulation of Nuclear Waste Management (BfE)

Regionalkonferenzen = Regional conferences

Bundes-Gesellschaft für kerntechnische Entsorgung (BGE) = Agency for the Disposal of Nuclear Waste

Fachkonferenzen „Teilgebiete“ und „Rat der Regionen“ = Subareas and Council of the Regions conferences

Nationales Begleitgremium = National Societal Commission

Partizipationsbeauftragte/r = Participation officer

Wissenschaftlicher Beirat = Scientific advisory board

regional betroffene Bevölkerung = Affected regional population

Bevölkerung = Population

4.3 Decision-making criteria and their function in the selection procedure

The selection procedure for the site of an installation for the final disposal of, in particular, high-level radioactive waste with the best possible safety will be conducted in stages and criteria-led. The Commission proposes the use of the following types of criteria:

- geoscientific exclusion criteria,
- geoscientific minimum requirements,
- geoscientific consideration criteria,
- safety requirements and requirements placed on safety analyses,
- spatial planning criteria.

The exclusion criteria, minimum requirements and consideration criteria to be applied, the safety requirements and the requirements placed on safety analyseswill remain valid throughout all three phases of the selection process. As they develop further, the safety requirements are to be issued in versions that reflect the latest advances in science and technology. The criteria will be applied in an ever more detailed fashion and with ever more precise data from Phase 1 to Phase 3 of the disposal site selection procedure. In this way, beginning with a blank map of Germany, the site with the best possible safety will gradually be determined.

4.3.1 Geoscientific exclusion criteria and minimum requirements

These two types of criteria will be applied for the first time at the beginning of the disposal site selection procedure, in Step 1 of Phase 1. The geoscientific exclusion criteria will be used to permanently exclude all areas from the further procedure that are unsuitable for disposal from the outset on account of circumstances of the kinds defined by the criteria. Analogously, the application of the geoscientific minimum requirements will mean any areas that do not fulfil these minimum requirements will be permanently excluded from the procedure.

Table 2: Geoscientific exclusion criteria

An exclusion criterion is a criterion whose fulfilment indicates a siting region or a site is unsuitable for disposal and will therefore be excluded from the further procedure.

Exclusion criterion	Exclusion characteristic
Large-scale vertical movements[53]	Mean large-scale geogenic uplift of more than 1 mm per year during the reference period.
Active fault zones[54]	Faults along which it is demonstrable or highly probable movements have taken place during the period from the Rupelian to the present day. Atectonic and/or aseismic events that may lead to safety consequences similar to those of tectonic faults are to be treated as tectonic faults.
Influences of current or previous mining activities[55]	Damage caused by current or previous mining activities from which negative influences on the barrier, and the permeability of the rock in the area of the repository and, in particular, the isolating rock zone are to be feared.
Seismic activity[56]	Seismic activity levels higher than in Earthquake Zone 1 according to standard DIN EN 1998-1/NA 2011-01.
Volcanic activity[57]	Quaternary or anticipated future volcanism.
Age of groundwater[58]	Concentrations of tritium and carbon-14 in the isolating rock zone above the natural background level are indicative of younger groundwater.

In addition to this, data will be obtained on the sites investigated in greater detail during the further phases of the selection procedure: by means of surface exploration during Phase 2 and by means of underground exploration during Phase 3. If these additional data show that a possible disposal site included hitherto in the procedure either fulfils a geoscientific exclusion criterion or fails to comply with a geoscientific minimum requirement, the site in question will have to be finally excluded from the procedure at this point in time.

The geoscientific exclusion criteria and minimum requirements are elaborated in Part B of the present report, in sections B 6.5.4 and B 6.5.5. They are to be stipulated by legislation under the Site Selection Act prior to the start of the selection process because, for reasons relating to the transparency of the procedure, following the principle of procedural clarity, they will have to be defined before they are applied for the first time.

[53] Cf. section B 6.5.4.1 of the present report.
[54] Cf. section B 6.5.4.2 of the present report.
[55] Cf. section B 6.5.4.3 of the present report.
[56] Cf. section B 6.5.4.4 of the present report.
[57] Cf. section B 6.5.4.5 of the present report.
[58] Cf. section B 6.5.4.6 of the present report.

Table 3: Minimum geoscientific requirements

Minimum requirement	Characteristic
Rock permeability[59]	Rock permeability kf must be less than 10-10 m/s in the isolating rock zone. Overlying strata may also take on the function of the isolating rock zone.
Thickness of the isolating rock zone[60]	The isolating rock zone must be at least 100 m thick. In less thick crystalline host rock bodies, the evidence of the long-term isolation of the containment zone where the rock permeability is low may also be provided by the safety performance of the interaction between the host rock and the geotechnical and technological barriers. The subdivision of a disposal system into several such containment zones is permissible.
Depth of the isolating rock zone[61]	The surface of the isolating rock zone must lie at least 300 m below the surface of the ground. It must lie deeper than the greatest anticipated depth of the impacts of exogenic processes. In rock salt, it must lie at a sufficient depth for evidence to be provided of a salt overburden of at least 300 m above the isolating rock zone. In claystone, it must lie deep enough to be able to rule out any impairment of the isolating rock zone's integrity due to decompaction, with account also being taken of exogenic processes.
Area of disposal facility[62]	The isolating rock zone must occupy an area sufficient to permit the construction of the disposal facility.
Information concerning the isolating rock zone over the reference period[63]	There must be no information or data available that make the integrity of the isolating rock zone over a period of one million years appear doubtful.

A minimum requirement for the selection of a siting region or disposal site is a requirement that has to be complied with in any event. Should it not be complied with, the site is unsuitable and will be excluded from the further procedure.

4.3.2 Geoscientific consideration criteria

Siting regions and/or sites that have remained in the procedure after the application of the exclusion criteria and minimum requirements are to be compared with one another using consideration criteria. When this is done,

[59] Cf. section B 6.5.5.1 of the present report.
[60] Cf. section B 6.5.5.2 of the present report.
[61] Cf. section B 6.5.5.3 of the present report.
[62] Cf. section B 6.5.5.5 of the present report.
[63] Cf. section B 6.5.5.6 of the present report.

preliminary safety analyseswill be used together with the geoscientific consideration criteria to appraise geological circumstances as better or less well suited. Their application will consequently not lead to areas being excluded, but ordered in a ranking of relative suitability. They are to be used to appraise whether a favourable overall geological situation is found in a subarea or siting region. In this respect, it is accepted as a matter of principle that one individual consideration criterion is not enough to provide evidence of, or rule out, a favourable overall geological situation. Such a favourable overall geological situation will not therefore depend on the particularly good fulfilment of a single criterion, but on the sum of the requirements fulfilled or the extent to which all the requirements and the associated consideration criteria are fulfilled. Geoscientific consideration criteria are the central element in a comparative selection procedure under which the site with the best possible safety is ultimately to be determined from among a large number of possible sites. For reasons connected with the transparency of the procedure and adhering to the principle of procedural clarity, such criteria are to be specified by legislation prior to the start of the selection process.

The geoscientific consideration criteria will first come to be applied in Step 2 of Phase 1 of the disposal site selection procedure and will then be valid for the entire further selection process. In Step 2 of Phase 1, they will be used initially to designate subareas with favourable geological preconditions. In Step 3 of Phase 1, they are to be used as part of the in-depth consideration of the subareas together with the representative preliminary safety analysesand the application of spatial planning criteria to designate siting regions for surface exploration.

They will also be applied during Phase 2 and Phase 3 together with the results from the respective safety analysesin order to elaborate and set out the safety aspects of the grounds for the proposal concerning the sites to be explored underground or the proposed site. A reasoned consideration process will be required whenever the siting regions or sites to be analysed are assessed and compared. At each process step, all requirements, with their associated consideration criteria, are to be analysed and checked in accordance with the level of information available for each of the siting regions and sites to be analysed at that point. Formal aggregation rules, in particular rules for the compensatory aggregation of the individual results from the application of the criteria, are not regarded as expedient by the Commission. The steps in the argument must all be transparent and subject to rights of re-examination[64] under the auspices of the public participation.

The geoscientific consideration criteria are divided into three groups of criteria. They are elaborated and explained in the second part of the present report.[65]

Criteria group 1, ‘Quality of isolation capacity and reliability of evidence’, consists of those consideration criteria that will be used during a comparison of siting regions or sites to assess the quality of the isolation of the radioactive materials at the location for their final disposal, and the reliability of the evidence provided for the long-term safety case. Both will be central aspects with a view to the final disposal of radioactive waste. They will indicate that the safe, long-term isolation of radioactive materials is possible at the location where the waste may be emplaced, and that this may also be demonstrated with sufficient certainty

[64] Cf. section A 4.2 of the present report.
[65] Cf. section B 6.5.6 of the present report.

within the framework of an evidence procedure and may be forecast for the reference period.

Whether it is ensured by the designation of one or, in certain circumstances, several isolating rock zones and the provision of evidence of their effectiveness or whether it is ensured by the interaction of technological, geotechnical and geological barriers in a stable long-term environment, the isolation capacity at the location where the waste is to be emplaced will be the central geological property of the whole disposal system and, in so far as this is the case, the primary characteristic of the site that will be sought in the site selection procedure.

Table 4: Geoscientific consideration criteria, criteria group 1
Quality of isolation capacity and reliability of evidence

Requirement	Criteria
No or slow transportation through groundwater in the isolating rock zone[66]	Groundwater flow (displacement velocity) in the isolating rock zone as low as possible; this means less than one millimetre per year Groundwater supply in the isolating rock zone as low as possible Diffusion speed in the isolating rock zone as low as possible
Favourable configuration of rock bodies, in particular host rock and isolating rock zone[67]	Barrier effectiveness (thickness and degree of enclosure of the repository area or the host rock body by the isolating rock zone) Robustness and safety reserves beyond the minimum requirements Extent of the isolating rock zone proportional to the minimum required Claystone: Water-bearing strata in immediate proximity to the isolating rock zone and/or the host rock body connected to a high hydraulic potential
Ease of spatial characterisation[68]	Ease of identification: low range of variation and even distribution of characteristic properties of the isolating rock zone, as little tectonic imprinting as possible Transferability: Composition of the rocks of the isolating rock zone uniform or very similar over large areas
Good predictability of the long-term stability of	Change • in the thickness of the isolating rock zone • in the extent of the isolating rock zone • in the rock permeability of the isolating rock zone

[66] Cf. section B 6.5.6.1.1 of the present report.
[67] Cf. section B 6.5.6.1.2 of the present report.
[68] Cf. section B 6.5.6.1.3 of the present report.

favourable conditions[69]	over time

Criteria group 2, ‘Protection of isolation capacity’, includes consideration criteria that may be used to assess how well the rock will maintain its isolation capacity in the face of the stresses that will be generated during the construction and operation of the facility’s underground cavities.

Favourable properties include a high load-bearing capacity of the rock, i.e. high stability of the cavities to be excavated, as low as possible a tendency to rock loosening, as low as possible a tendency to the formation of new, or reactivation of old, fossil water flowpaths in the isolating rock zone and the capacity to respond to crack formation with self-healing processes.

Table 5: Geoscientific consideration criteria, criteria group 2
Protection of isolation capacity

Requirement	Criteria
Favourable rock-mechanical preconditions[70]	Low tendency to the formation of mechanically induced secondary permeabilities in the host rock and the isolating rock zone outside a excavation-damaged zone close to the walls of the disposal cavities
Low tendency to the formation of water flowpaths in the host rock body and the isolating rock zone[71]	Likelihood of change in rock permeability Reversibility of cracks and/or secondary permeabilities by means of the closure and/or healing of cracks

Criteria group 3 includes consideration criteria that will be used to assess the robustness of the disposal system. They relate to the fact that the function of the disposal facility will not end with the reference period but, as far as it is humanly possible to tell, the waste is to remain isolated for an infinite period, and properties that will support this are to be rated positively when otherwise equivalent sites are being considered.

Favourable properties in this criteria group strengthen and raise the safety of the overall system beyond the isolation capacity assessed in criteria groups 1 and 2, for example because a favourable environment for the minimisation of corrosion and gas generation prevails in the immediate vicinity of the waste, or the heat from the waste is dissipated into the rock rapidly or without mineral metamorphosis, countering any build-up of critical gas pressure levels. The capacity to retain radionuclides in the rock of the isolating rock zone limits or

[69] Cf. section B 6.5.6.1.4 of the present report.
[70] Cf. section B 6.5.6.2.1 of the present report.
[71] Cf. section B 6.5.6.2.2 of the present report.

hinders the transportation of radionuclides into the biosphere if there is a release from the waste.

Cap rock that additionally shields the isolating rock zone against unfavourable impacts, for instance erosion, subrosion or glacial channels, and/or is able to retain radionuclides, increases the robustness of the disposal system as well.

Table 6: Geoscientific consideration criteria, criteria group 3

Further safety-relevant properties

Requirement	Criteria
Protective structure of the cap rock[72]	Protection of the isolating rock zone by: Coverage of the isolating rock zone with groundwater-resistant rocks Distribution and thickness of groundwater-resistant rocks in the cap rock Distribution and thickness of erosion-resistant rocks in the cap rock No structural complications in the cap rock
Good conditions for the prevention and/or minimisation of gas generation[73]	Gas generation from the waste should be as low as possible under disposal conditions.
Good temperature compatibility[74]	For precautionary reasons, the Commission recommends a threshold temperature of 100 degrees at the outer surface of the container, unless the physically possible maximum temperatures in the host rocks in question have been reliably specified on the basis of research studies.
High radionuclide retention capacity of the isolating rock zone[75]	As great as possible sorption capacity of the rocks in the isolating rock zone As high as possible proportions of mineral phases with large reactive surfaces in the rocks of the isolating rock zone As high as possible ionic strength of the groundwater in the isolating rock zone Widths of the rock pores in the isolating rock zone in the nanometre range

[72] Cf. section B 6.5.6.3.5 of the present report.
[73] Cf. section B 6.5.6.3.1 of the present report.
[74] Cf. section B 6.5.6.3.2 of the present report.
[75] Cf. section B 6.5.6.3.3 of the present report.

Favourable hydrochemical conditions[76]	The deep groundwater in the host rock/isolating rock zone is to • be in chemical equilibrium with the rocks • have a pH of 7-8, • display favourable redox conditions (anoxic-reducing environment), • display as low as possible a content of colloids and complexing agents, • display as low as possible a carbonate concentration.

4.3.3 Requirements placed on safety analyses

The Site Selection Act posits the methodology for the preliminary safety analysesthat are to be conducted as an essential foundation for decision-making when the areas to be searched are narrowed down and the disposal site is selected. According to the explanatory memorandum to the Act, a safety analysiswill be used to analyse the behaviour of the disposal system under stress situations of all kinds, with data uncertainties, malfunctions and possible future developments in relation to the performance of safety functions being taken into account. Furthermore, it will include an appraisal of the reliability with which the safety functions will be performed and therefore the robustness of this system as well.

The preliminary safety analysesmust include assessments of which geological properties of the siting regions and/or the site could have particularly positive or negative impacts on the disposal system.

To ensure the credibility of the results of the preliminary safety analyses, and the comparisons of different sites and host rock formations, it will be necessary to determine the methodology for the preliminary safety analyses that are to be carried out, as well as the data and information they will require prior to the beginning of the comparative study.

The level of detail included in the preliminary safety analyses and the evidential value of their results will rise from phase to phase of the selection procedure as more information is obtained from the exploration of the siting regions or sites. Accordingly, the safety concept and the disposal concept are to be reviewed and further developed as the level of knowledge available goes up further. During the final phase of the selection procedure, the project delivery organisation will have to compare the remaining sites on the basis of the examination criteria intended for the appraisal of the results from the underground exploration, as well as the results from the comprehensive preliminary safety analyses for the operational and post-sealing phases, and then present a proposal for a site.

The conclusive safety case[77] for the site that is ultimately selected will build on a comprehensive safety analysis, which will require comprehensive data and information about the disposal system, the isolating rock zone and the geological environment.

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[76] Cf. section B 6.5.6.3.4 of the present report.

[77] The documented evidence that a facility or a product exhibits the safety characteristics that are to be demanded of it is referred to as a 'safety case'.

4.3.4 Examination criteria

It will only be possible to define examination criteria in the course of the procedure because the results of previous studies will have to be available in order for the definition of such criteria to be possible. If the requirements of the transparency of the procedure and the principle of procedural clarity are to be satisfied, examination criteria will have to be specified in good time prior to the conduct of the in-depth underground exploration and have been examined when the re-examination rights for which provision is made are exercised.

The Commission has therefore not itself proposed the examination criteria in section B 6.5.7, but the procedure by which, and the point in time when, these examination criteria are to be specified.

4.3.5 Spatial planning criteria

The Commission is of the opinion that spatial planning criteria are always to be consideration criteria. This is the implication of the primacy of safety. Pursuant to Section 1(1) of the Site Selection Act, a ‘site for an installation for the final disposal of […] radioactive waste [is to be found] that guarantees the best possible safety for a period of one million years.’ The Commission has confirmed this objective and specified that long-term safety will have priority over other considerations that might also be factored in when the sites are being narrowed down.

This means the spatial planning consideration criteria for the disposal site selection process will only ever be applied after the geoscientific criteria once the safety assessment of the areas to be surveyed is available. The spatial planning criteria will come to be applied for the first time in Step 3 of Phase 1 in order to further narrow down the selection of subareas that are potentially suitable from safety points of view. Analogous measures will also have to be taken during Phases 2 and 3 of the selection process.

The spatial planning consideration criteria are split into three weighting groups. They are elaborated in Part B of the present report, in section B 6.5.9, and will have to be specified by legislation prior to the start of the selection process in order to ensure the transparency of the procedure and procedural clarity. In this respect, the Commission distinguishes between surface and underground spatial planning consideration criteria.

Table 7: Spatial planning consideration criteria

Weighting group	Criteria
Weighting group 1: Protection of	Distance from existing built-up land in residential and mixed-use neighbourhoods Emissions (noise, radiological and conventional pollutants)

humans and human health[78]	Near-surface groundwater reserves for the extraction of drinking water Flood plains
Weighting group 2: Protection of unique natural and cultural assets from irreversible degradation[79]	Nature conservation areas and Natura 2000 sites Significant cultural assets (for example, UNESCO World Heritage Sites) Deep groundwater reserves for the extraction of drinking water
Weighting group 3: Other competing uses and infrastructure[80]	Installations subject to the Major Accidents Ordinance Extraction of mineral resources, including fracking Geothermal use of underground rock Use of geological formations as underground storage facilities (compressed air, CO_2 compression, gas)

5 POLITICAL AND SOCIETAL RECOMMENDATIONS

With a view to the political implementation of its proposals for a fair, transparent selection procedure, the Commission has drawn up a series of practical proposals for changes to the site selection procedure and other statutory provisions, some of which have been elaborated in detail. Among other things, it recommends that the authorities and state or semi-state enterprises engaged in the search for a disposal site be reorganised and organised more simply. Its recommendations also relate to disposal research, and measures to secure the data and knowledge that will be needed for the final disposal of waste. It has formulated general conclusions concerning the assessment of the technological impacts caused by the problematic legacy of nuclear energy.

5.1 New organisational structure

The Commission has arrived at the opinion that the organisational structure established in the Site Selection Act is in need of modification. In particular, the structure of the authorities provided for in the Act is unsuitable for appropriate, expeditious action to deal with the diverse tasks relating to the disposal facility, including the public participation procedure that is to be restructured.

The Commission has proposed that all licensing, monitoring and supervisory functions connected with the safety of the management of spent fuel elements and radioactive waste be concentrated within the jurisdiction of a single higher federal authority – except where they are performed by the Länder. The Commission has argued, in particular, for the operator's responsibilities to be taken away from the Federal Office for Radiation Protection (BfS) and bundled

[78] Cf. section B 6.5.9.7 of the present report.
[79] Cf. section B 6.5.9.8 of the present report.
[80] Cf. section B 6.5.9.9 of the present report.

in a new, federally owned enterprise together with the functions performed by the operating companies, Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe mbH (DBE) and the federally owned Asse GmbH. The search for a disposal site, and the construction, operation and decommissioning of disposal facilities are to be concentrated in the hands of the new company that is to be established as the future project delivery organisation. In the opinion of the Commission, this company is to belong 100 per cent to the public sector, have commercial freedom of action and not be directly integrated into the federal budget.

These proposals have already been accepted by the Bundestag; they were the subject of an ongoing legislative procedure while the present report was being drafted.

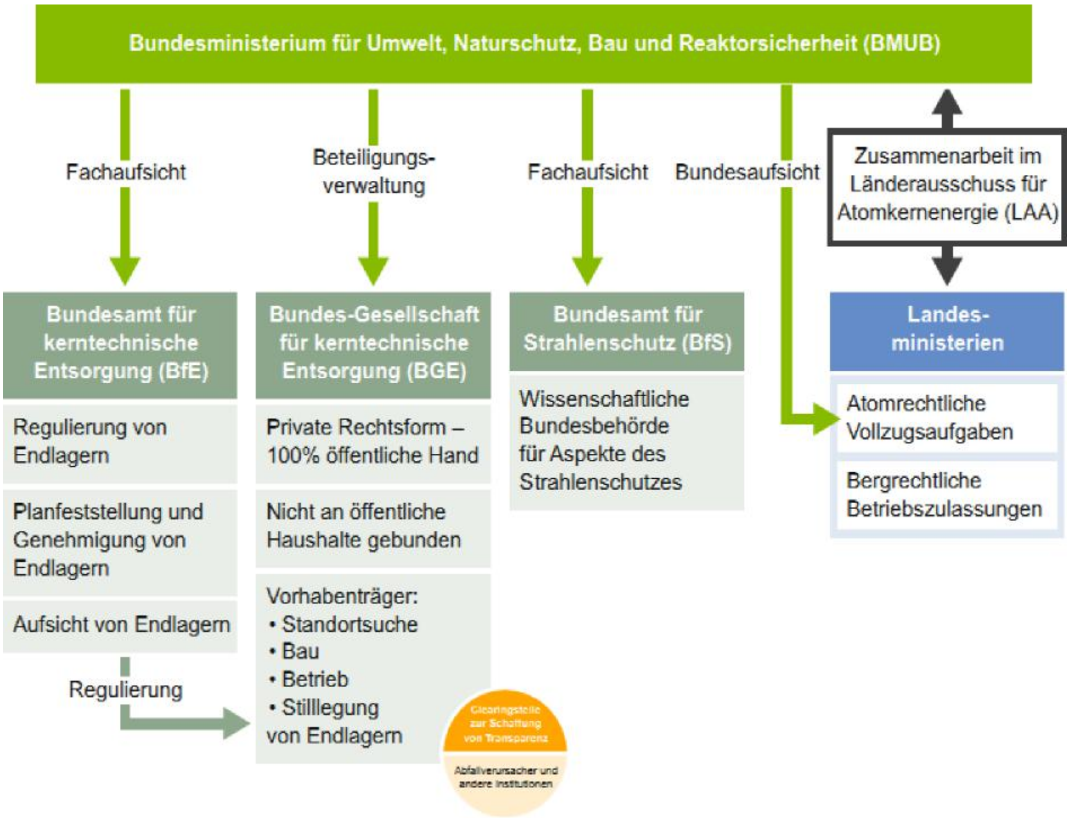
Recommendation:

- The functions of the BfS, DBE mbH and Asse GmbH as operators should be brought together in a Agency for the Disposal of Nuclear Waste (BGE). This new enterprise is to be 100-per-cent publicly owned.
- As far as possible, this new state enterprise should be established in unanimous agreement with, in particular, DBE's current owners. Any future privatisation is to be ruled out.
- With the goal of transparency in mind, waste producers and, under certain circumstances, other institutions should be involved before decisions are taken by the federally owned company. This could be made possible in a suitable way, for instance by a clearing agency.[81]
- All the functions performed and resources deployed by the BfS as the disposal facility operator, DBE and Asse GmbH in providing administrative assistance for the planning, construction, operation and decommissioning of disposal facilities, and the BfS as the project delivery organisation under the Site Selection Act should be transferred to the new company without delay.
- BGE should be administered in a private legal form. Its main function should be the search for a disposal site, as well as the construction, operation and decommissioning of disposal facilities for radioactive waste. It should not be directly integrated into the administration of the public budget.
- The state regulatory, licensing and supervisory functions connected with the safety of the management of spent fuel elements and radioactive waste should be concentrated in a federal office – except where they are performed by the Länder. Appropriate staffing and financial resources are to be secured. This does not mean the division of responsibilities between the German Federation and the Länder laid down in the Site Selection Act and the Atomic Energy Act would consequently have to be modified.
- It is to be guaranteed that the independence of the regulatory authorities from the national government will be ensured in accordance with the requirements of the Euratom Directive 2011/70.

The following graphic shows the organisational structure that would result from the implementation of the Commission's recommendations:

[81] This recommendation does not yet take account of the recommendations made by the Commission to Review the Financing for the Phase-out of Nuclear Energy (KFK), which also envisages changes in the distribution of responsibilities for the management of radioactive waste.

Graphic 2: Recommended new organisational structure



Bundesamt für Strahlenschutz (BfS) = Federal Office for Radiation Protection (BfS)

Landesministerien = Land ministries

Regulierung von Endlagern = Regulation of disposal facilities

Private Rechtsform – 100% öffentliche Hand = Private legal form – 100% publicly owned

Wissenschaftliche Bundesbehörde für Aspekte des Strahlenschutzes = Scientific federal authority responsible for radiation protection aspects

Atomrechtliche Vollzugsaufgaben = Functions implementing nuclear law

Bergrechtliche Betriebszulassungen = Operating approvals under mining law

Planfeststellung und Genehmigung von Endlagern = Plan approval and licensing of disposal facilitiesdisposal facilities

Nicht an öffentliche Haushalte gebunden = Not integrated into public budgets

Aufsicht von Endlagern = Supervision of disposal facilities

Regulierung = Regulation

Vorhabenträger: = Project delivery organisation:

Standortsuche = siting

Bau = construction

Betrieb = operation

Stilllegung = decommissioning

von Endlagern = of disposal facilities

Clearingstelle für Schaffung von Transparenz = Clearing agency to create transparency

Abfallverursacher und andere Institutionen = Waste producers and other institutions

These proposals have already been adopted by the Bundestag with the exception of the clearing agency; they have recently been the subject of an ongoing legislative procedure.

5.2 Recommendations to the legislature

5.2.1 Legal redress

The topic of appropriate legal redress during the selection procedure under the Site Selection Act and subsequent licensing procedures under the Atomic Energy Act was dealt with separately in the discussions about the ‘compatibility of existing legislative provisions with the standards laid down in Community law’ and the ‘options for legal redress under national law’.

Implementation of standards under Community law: The Commission has found that the form of legal redress currently granted in the Site Selection Act does not satisfy the standards of Community law laid down in the EIA Directive and Article 9(2) of the Aarhus Convention. The standards for legal redress adopted in the EIA Directive to implement Article 9(2) of the Aarhus Convention prescribe that, when it comes to the licensing of projects for which an environmental impact assessment is required, non-governmental organisations are able to have the legality of the final act of a licensing procedure reviewed under both substantive and procedural law. Against this background, the Commission proposes comprehensive amendments to Sections 19 and 20 of the Site Selection Act that would implement a new option to obtain legal redress modelled on Section 17(4) of the Site Selection Act. This would take account of the requirements of Community Law.

Options to obtain legal redress under domestic law: The question of whether the options to obtain legal redress provided for to date in Section 17(4) of the Site Selection Act should remain preserved in addition to the option to obtain legal redress proposed by the Commission for Section 19(2) or whether they should be replaced by the new provision was discussed intensively within the Commission. Good grounds were cited for both courses of action. In the course of this discussion, it was also pointed out that the disposal site selection and licensing procedures offer the citizen numerous opportunities to lodge appeals, for example when operational plan approvals, permits under water law for exploration activities and orders to tolerate preliminary work on plots of land are issued.[82]

In addition to this, the question of legal redress was also raised in the context of Section 14 of the Site Selection Act.

[82] A detailed overview of possible legal remedies is given by Commission Printed Paper K-Drs./AG2-27.

Having considered all the arguments, and taking account of the legal pros and cons, the Commission sees this as a question that should ultimately be answered in accordance with political criteria. Against this background, it argues for the legal redress granted up until now under Section 17(4) of the Site Selection Act to continue to be retained unmodified.

The question of the necessity of options for legal redress during the site selection procedure that go beyond what is compulsorily required under Community law was viewed in various ways by the experts in attendance at the expert hearing conducted by the Commission on 3 November 2014:[83] Firstly, it was argued that, instead of further options to obtain legal redress, there should be reliance on mediation and consensus.[84] Secondly, further forms of legal redress were regarded as necessary to achieve the aim of comprehensive community participation and the increased acceptance for the procedure it would entail.[85]

If the recommendations on Section 19 of the Site Selection Act were implemented, the legal redress granted to date under Section 17(4) of the Site Selection Act would, as a matter of principle, be superfluous from the point of view of Community law. However, retaining this form of legal redress would make early legal review possible and could so minimise the risk of the procedure being returned to a very early phase if recourse were to be had to legal redress under Section 19 of the Site Selection Act.[86] At the same time, an additional option for legal redress might strengthen trust in the procedure and therefore bolster its acceptance.[87]

In its recommendation, the Commission has acknowledged that in both cases there could be delays to, and impacts on, the use of the public participation formats. Following intensive discussion, it has argued along the lines of the general grounds put forward for the retention of legal redress under Section 17 of the Site Selection Act.

5.2.2 Temporary moratorium on development at Gorleben –securing potential disposal sites

One central point of discussion within the Commission was how it will be possible to deal with the Gorleben site in the interests of an open-ended, Germany-wide selection procedure under the Site Selection Act. As far as this issue was concerned, the Commission was guided by how the earliest possible action to secure all potential sites could be guaranteed given the tension between the necessary legal security, on the one hand, and the principle of equal treatment, to be precise the premise of the ‘blank map’ when the disposal site was chosen, on the other hand. There was great unanimity that legal alternatives to the unilateral

[83] Cf. Repository Commission, ‘Auswertung der Anhörung „Evaluierung des Standortauswahlgesetzes“ / Zusammenstellung von Auffassungen und Ergebnisse’, K-Drs./AG2-4a, pp. 24 ff.
[84] Cf. Repository Commission, ‘Auswertung der Anhörung „Evaluierung des Standortauswahlgesetzes“ / Zusammenstellung von Auffassungen und Ergebnisse’, K-Drs./AG2-4a, p. 15.
[85] Cf. Repository Commission, ‘Auswertung der Anhörung „Evaluierung des Standortauswahlgesetzes“ / Zusammenstellung von Auffassungen und Ergebnisse’, K-Drs./AG2-4a, pp. 5 and 7.
[86] Cf. the 12th meeting of the Evaluation Working Group on 2 November 2015, minutes (draft), pp. 33, 36 and 39.
[87] Cf. the 8th meeting of the Evaluation Working Group on 22 June 2015, minutes, p. 13; cf. the 9th meeting of the Evaluation Working Group on 7 September 2015, minutes, p. 40.

temporary moratorium on development at Gorleben were to be drawn up and put into force as quickly as possible.

As far as the Gorleben site was concerned, in the spring of 2015 it was necessary, above all, to think fundamentally about the issues and to decide whether the existing temporary moratorium on development was to be extended and, if not, how action to secure the site in another way could be guaranteed in a legally secure manner. At that time, partly at the instigation of the Commission, the Bundesrat and the German Federal Government agreed to extend the temporary moratorium on development at Gorleben for a merely limited period until the end of March 2017. After this, general provisions are to be aspired to concerning all potential siting regions and sites.

Recommendation: The Commission requests that the German Federal Government act without delay to draw up statutory provisions that make it possible for early action to be taken to secure siting regions and planning zones for potential disposal sites.

5.2.3 Export prohibition

The second sentence of Section 1(1) of the Site Selection Act in conjunction with the duty to deliver radioactive waste to a federal facility imposed by Section 76 of the Radiation Protection Ordinance established a statutory obligation as a general norm which stipulates that, in particular, irradiated fuel elements from nuclear installations that are operated as power reactors, i.e. for the generation of energy, are exclusively to be disposed of in Germany. This principle of domestic disposal does not extend to irradiated fuel elements from research reactors.

The export of irradiated nuclear fuels was initially addressed by the Commission on account of a forthcoming transfer of irradiated fuel elements from the Experimental Nuclear Power Plant (AVR) at Jülich. The interim storage facility there has to be cleared because, for safety reasons, it does not have a licence to continue in operation. Apart from the construction of a new interim storage facility at the Jülich site and interim storage at Ahaus, return to the USA has also been considered because the fuel elements were originally procured from the USA. The Commission has decided to recommend a statutory extension of the export prohibition to irradiated nuclear fuels from research reactors in the future.

The Commission sees the extension of the export ban as an important signal that would underline the aim of the comprehensive final disposal of irradiated fuel elements in Germany. However, the Commission feels it is indispensable to extend the ban in such a way that science and top-level research in Germany will not be restricted as a result of this move, and account will also be taken of mandatory aspects of non-proliferation.

Recommendation: The Commission advocates the statutory introduction of a general prohibition on the export of high-level radioactive waste.

The Commission calls upon the German Federal Government to draw up new provisions concerning a prohibition on the export of irradiated fuel elements from research reactors as well that take account of mandatory aspects of non-proliferation and the need to ensure top-level research is possible, in particular at the Munich II research reactor.

5.2.4 Statutory provisions concerning public participation

The participative search procedure that is proposed will require amendments and adjustments to the Site Selection Act, in particular in the field of public participation. To this end, the Commission recommends the following amendments or additions to the Act, in particular:

- In Chapter 2 ('Participation of authorities and the public'), the participation system that is described in section B 7.3 below is to be implemented with the following elements:
  - the National Societal Commission, its participation officer and the option of a scientific advisory board,
  - the Subareas Conference and, following on from it, the Council of the Regions Conference and
  - regional conferences with re-examination rights.
- Furthermore, further developments of the imperative of transparency are to be incorporated into the Act as they are manifested in the proposals concerning both the information platform and information offices (7.3.4), and transparency and rights to information (7.3.5).
- In Section 10(4), the requirement that the degree of acceptance for proposed procedural steps be recorded in the minutes of community meetings that has been provided for to date is to be deleted.
- In Chapter 3 ('Site selection procedure'), the procedural steps that have been provided for hitherto by Sections 15 and 18 of the Site Selection Act are to be integrated into the preliminary procedural proposals (reports) provided for by Sections 14 and 17. Apart from this, Section 13 is to be supplemented to the effect that the subareas identified are published by the BGE in an interim report.
- In Chapter 2 and Chapter 3, the process for public participation is to be organised as described in section 7.5 of the present report.

5.2.5 Public agencies' access to information during the site selection procedure

With a view to the particular public interest in a long-term safe disposal facility, the competent public agencies are to be assured comprehensive access to information during the search for a disposal site. In consequence, the particular public interest in safe, long-term final disposal would usually have to outweigh the private interest in confidentiality under current law and therefore make the disclosure of the required data possible even when the data holder has not given their consent for this. However, in view of the current administrative practice, which is not always clear, statutory provisions that clarify the matter are to be recommended.

For the performance of their functions, the public agencies mandated with the search for a disposal site are also to be granted access to geological data gathered by private parties. Here, with its planned re-enactment of the Mineral Deposit Act, the Federal Ministry of Economic Affairs and Energy has mapped out a good pathway for the implementation of this recommendation that is supported by the Commission. Alternatively, appropriate access rights based on the Act on Access to Digital Spatial Data could also be provided for directly in the Site Selection Act specifically for the purposes of the search for a disposal site.

5.2.6 Right of future generations to long-term safety

The third sentence of Section 17(4) of the Site Selection Act expressly provides for the municipalities in whose municipal areas a site proposed for underground exploration is located and the residents of those municipalities to also be entitled to take legal action just like recognised environmental associations. The decision of the Federal Office for the Regulation of Nuclear Waste Management provided for in the current first sentence of Section 17(4) of the Site Selection Act could therefore be attacked by those municipalities and their residents without these parties having to claim their own rights have been violated. Substantively, recognised environmental associations are entitled under the Environmental Appeals Act to request comprehensive examination by the courts. This also includes scrutiny of the long-term safety aspects to be analysed as part of the safety analyses, depending on the progress made in the procedure, which are to be examined as an element of the precautionary action against damage that will be taken during the selection procedure. Pursuant to the third sentence of Section 17(4) of the Site Selection Act, this entitlement also extends to municipalities in whose municipal areas a site proposed for underground exploration is located, as well as to the residents of those municipalities.

Recommendation: Against this background, from the point of view of the Commission, there is currently no need to amend the Site Selection Act; the option for legal redress proposed for Section 19(2) of the Site Selection Act is to be formulated in emulation of the current third sentence of Section 17(4) of the Site Selection Act. Apart from this, a provision concerning the licensing of the disposal facility modelled on the third sentence of Section 17(4) of the Site Selection Act could be incorporated into the Atomic Energy Act.

5.2.7 Environmental assessments during the selection procedure

Two strategic environmental assessments and an environmental impact assessment are to be conducted during the site selection procedure under the Site Selection Act. A strategic environmental assessment is provided for both prior to the decision on surface exploration under Section 14(2) of the Site Selection Act and prior to the decision on underground exploration under Section 17(2) of the Site Selection Act. The environmental impact assessment must be carried out before the decision on the site is taken under Section 20(2) of the Site Selection Act.

In the estimation of the expert opinions drawn up for the Commission, these standards comply with the requirements of Community law.

However, the wording used in Section 11(3) of the Site Selection Act might result in a lack of clarity with regard to the application of provisions set out in the Act on the Assessment of Environmental Impacts (UVPG) to the cross-border participation procedure. The references to the Act on the Assessment of Environmental Impacts made in Section 11(3) of the Site Selection Act are purely declaratory in nature. Even without these express references, the application of the relevant provisions would already be implied by Sections 4 and 14e of the Act on the Assessment of Environmental Impacts.

Recommendation: The Commission advocates that Section 11(3) of the Site Selection Act be deleted without replacement.

5.2.8 Selection of the disposal site and spatial planning

During the disposal site selection procedure, questions of compatibility with spatial planning objectives are to be examined conclusively with the involvement of the Länder and local authorities. Certainly, no autonomous spatial planning procedure is to be conducted alongside the procedure under the Site Selection Act. During this procedure, the selection of the disposal site will primarily have to be oriented towards the yardstick of safety.

In the Site Selection Act, it is to be ensured that the German Federation is not hindered or restricted by the standards for regional planning at Land level or area development planning when it comes to the specification of the site, a decision that is to be primarily safety-oriented.

Recommendation: The Commission proposes the addition of a provision to the Site Selection Act that is based on the first sentence of Section 28 of the Grid Expansion Acceleration Act (NABEG). This provision should be formulated in such a way that, apart from spatial planning, it also covers other planning law standards, in particular those for area development planning.

5.2.9 Comparative procedure for the selection of the disposal site

In the opinion of some members of the Commission, different explanations and interpretations of the phrase ‘site with the best possible safety’, which is introduced in Section 1 of the Site Selection Act as an objective of the Act, but not defined in any greater detail, might have consequences for the development of comparative criteria, as well as the configuration and conduct of the search procedure. With regard to the aspect of the apportionment of costs for a comparative search procedure, which has also been raised in this connection, after detailed discussion, the Commission arrived unanimously at the conclusion that this aspect was of no relevance as far as a comparative search procedure was concerned. In the course of the discussion, it was made clear several times by the Federal Environment Ministry, Land ministers and Members of the German Bundestag that there had been agreement during the legislative procedure that a site selection procedure aimed at finding the ‘site with the best possible safety’ had to be comparative in nature. Accordingly, the aim pursued with the Site Selection Act is to use a comparative procedure to find the best site from safety points of view for an installation for the final disposal of radioactive waste under the first sentence of Section 9a(3) of the Atomic Energy Act that guarantees the best possible safety for a period of one million years.

In the opinion of some members of the Commission, however, the phrase is not adequately defined in the Site Selection Act; furthermore, from this perspective, Section 17 and, in particular, Section 19 of the Site Selection Act are not formulated so unambiguously that the will of the legislature is clearly expressed.

Against this background, following intensive deliberation, the Commission has adopted a definition[88] for uniform use in the present report.

While some members felt a more precise statutory definition of the phrase ‘site with the best possible safety’ and therefore an amendment of the Site Selection Act to be required, other members articulated the opinion that the current Site

[88] Cf. the Preamble to the present report, p. 23 [p. 9 of this translation].

Selection Act already clearly favoured a comparative site selection procedure, and an amendment to the Act was therefore dispensable.

Recommendation: In order to clarify the matter by providing a more precise definition, the Commission proposes that Sections 1 and 19 of the Site Selection Act be amended as formulated in section B 8.7.5 of the present report.

5.2.10 Safeguarding of data for the purposes of documentation

The Commission on Storage of High-Level Radioactive Wastebelieves it will be necessary for the data and documentation materials identified as being required for the final disposal of radioactive materials[89] to be archived permanently. The starting point for this is the realisation that the documentation of these data constitutes a central safety measure for the whole nuclear disposal chain and, in particular, for a disposal facility.

There is a need for appropriate statutory foundations if this is to be guaranteed. Apart from the norms of atomic and radiation protection law that are already in place, the Commission sees a need for further provisions in this field. In particular, the current legislative and sublegislative provisions are not sufficient to justify a duty on the part of installation operators to promptly and regularly supply the data and documents that are to be safeguarded.

Recommendation: The Commission recommends the establishment of a central state agency that, as the organisation devoted to their documentation as its primary function, permanently preserves these data and documents, and has an institutional ‘awareness’ of their safety-related significance.

The Atomic Energy Act or even the planned Radiation Protection Act are to be supplemented with binding provisions that take account of the requirements set out in Part B[90] while, under certain circumstances, transitional provisions are also to be put in place. An authorisation to regulate the matter in an ordinance is to be incorporated into the core legislation to regulate, in particular, the data and information specifically to be gathered by the central state agency, as well as to formulate the obligations to supply data in greater detail so as to permit the flexible adaptation of these elements to ongoing developments.

5.2.11 Anchoring of safety requirements in the Site Selection Act

Under the second point of Section 4(2) in conjunction with Section 4(5) of the Site Selection Act, the Commission has the task of examining whether, and how, general safety requirements are to be anchored in legislation. Some of these requirements are also implied by the Commission’s proposal concerning the foundations for decision-making;[91] some of them are already included in the safety requirements specified by the Federal Environment Ministry in 2010.

They should therefore be anchored directly in the Site Selection Act. To supplement them, the Commission recommends a new authorisation to issue an ordinance also be added to the Act specifically to regulate the relevant safety

[89] On this issue, see section B 6.7.1 of the present report.
[90] On this issue, cf. section B 8.7.6.
[91] Cf. the minutes of the 18th meeting of Working Group 2 of 6 June 2016.

requirements for the final disposal of heat-generating radioactive waste during the disposal site selection procedure or to modify the pertinent authorisation to issue ordinances for these purposes that is already included in the Atomic Energy Act. The ordinance is to be drafted with the participation of the Länder and the public, and will have to be on the statute book by the beginning of Step 3 of Phase 1 of the disposal site selection procedure, at the latest. It should be reviewed every ten years, at least, and adapted to reflect the latest advances in science and technology as necessary.

5.2.12 Anchoring of the phasing-out of nuclear power in the German Basic Law

The question of whether the phasing-out of nuclear power should be anchored in Germany's constitution, the Basic Law, was raised by the Commission early on and discussed comprehensively. In conclusion, the Commission sees the legal anchoring of the phasing-out of nuclear power in the Basic Law as something that is possible in principle. Different opinions have been articulated on the question of whether this should be done. Its anchoring in the Basic Law would not make the phasing-out of nuclear power irreversible, but create a strong *de facto* binding effect. Ultimately, it will be crucial to weigh up the usefulness of the symbolic effect of an amendment to the constitution as a means of calming social conflicts against the constitutional reservations prompted by a depoliticisation of the topic, an eminently political decision that – partly in view of its statutory mandate – the Commission neither should nor would wish to prejudice. The Commission therefore recommends to the legislature that it thoroughly examine the ideas explored in the two expert opinions obtained on this topic[92] and factor them into its decision with regard to any action that is needed.

5.2.13 New directions in disposal research

In future, disposal research in Germany must, in particular, contribute to the resolution of issues for the site selection procedure that have not yet been sufficiently clarified. In this respect, it should, in particular, provide answers to questions

- concerning the characterisation and non-destructive or minimally invasive investigation of host rock deposits, as well as the development of host rock-specific safety and evidence concepts,
- concerning the development of reference disposal concepts for the selection of the disposal site, with precautions for the correction of errors, including the retrievability and recoverability of waste containers.

The Commission views work in the social sciences and on socio-technological aspects of the matter as another research priority that is to be expanded further, for instance in projects such as

- accompanying research on participation in a democratic rule-of-law state,
- research on knowledge management and data storage issues, how to pass on the knowledge about the disposal facility that will be important for later

[92] Cf. Gärditz, Klaus (2016), 'Verankerung des Atomausstiegs im Grundgesetz?', K-MAT 61; and: Roßnagel, Alexander (2016), 'Kurzgutachten zur Verankerung des Atomausstiegs im Grundgesetz', K-MAT 62.

generations over long periods of time, and action to ensure the comprehensibility of data and knowledge,

- the recording and scientific assimilation of experience gained in the debates about nuclear energy. This experience is to be documented, for example by the Federal Agency for Civic Education, and used for the handling of other major conflicts. Citizens from the affected regions should be involved in these activities.

6 CONCLUSION OF THE SUMMARY

The Commission was established in order to find a satisfactory, democratic, sustainable solution for one of the most difficult conflicts experienced over the last few decades in Germany. It is aware of the diverse conflicts about the final disposal of radioactive waste and sees these conflicts, especially, as imposing an obligation to arrive at a new understanding. In this respect, it feels committed to the guiding principle of sustainability.

The Commission regards the safe management of high-level radioactive waste as more than merely a technical task. The best possible disposal of such waste must also take account of the social and cultural dimensions of the matter if the criteria and proposals put forward are to enjoy broad approval in society and be capable of meeting the challenges of the future in the spirit of the imperative of responsibility. This is why the scientifically based selection process recommended by the Commission pays attention to the two aspects that are necessary for a stable consensus in society and the best possible management of radioactive waste: the quality of the scientific-technical criteria and societal modernisation. Both must be seen in a single context.

The Commission has also drawn lessons from the history of the four German disposal projects. In its work, it has assumed ten principles that outline its own understanding of its work. On this basis, it has made recommendations that range from the specification of a scientifically based, open-ended selection procedure to comprehensive transparency and community participation. These proposals have been put forward to ensure the best possible disposal of high-level radioactive waste, but they may also be taken as exemplars for the assessment and handling of complex projects. The most important finding is that it will only be possible for a procedure to meet with approval if it is transparent, fair and open-ended. Such a procedure must aspire to the fairest possible distribution of burdens and duties, and must not give the impression of arbitrariness. The goal is a genuine new start that makes agreement and trust possible.

The results of our work are presented here in order to make this new start possible, and have been formulated to the best of our knowledge and belief in innumerable discussions, and by means of many debates and attempts to clarify the issues. We are presenting our results to the German Bundestag, the Bundesrat, the German Federal Government and German society in the hope that this new start will lead to the safe final disposal of radioactive waste in perpetuity.

PART B: REPORT BY THE COMMISSION ON THE STORAGE OF HIGH-LEVEL RADIOACTIVE WASTE

1 THE COMMISSION'S MANDATE AND WORKING METHODS

On 11 March 2011, the Tōhoku earthquake triggered a tsunami off the coast of Japan that led to a catastrophic series of accidents in four reactor units at the Fukushima Daiichi nuclear power plant. The cooling systems collapsed, which led to core meltdowns in reactor units one to three. As a result of the events, Germany declared a three-month nuclear moratorium, during which time safety inspections were carried out at the 17 nuclear power plants present at that time. This led to broad political consensus in favour of irreversibly withdrawing from nuclear power generation.[93]

German Chancellor Angela Merkel justified this energy transition during a statement she gave on behalf of the government at the German Bundestag on 9 June 2011: 'Fukushima has forced us to acknowledge that the risks of nuclear energy cannot be mastered safely, not even in a high-tech country such as Japan. Anyone who acknowledges this situation needs to draw the necessary conclusions. Anyone who acknowledges this situation needs to reassess it.[94] She continued by saying: 'And that is precisely what this is about - it is not about whether Germany will ever be afflicted by such a devastating earthquake or catastrophic tsunami like those seen in Japan. Everyone knows that that is not going to happen in Germany. No, Fukushima has shown us that this is about the reliability of risk assumptions and the reliability of probability analyses.[95]

On 30 June 2011, the German Bundestag voted by a substantial majority to pass the Thirteenth Act to Amend the Atomic Energy Act. This act included the immediate shutdown of the seven oldest nuclear power plants along with Krümmel nuclear power plant, with the remaining nine nuclear power plants scheduled to shut down until 2022.[96] The Bundesrat ratified this Act on 8 July 2011. Following the decommissioning of Grafenrheinfeld nuclear power plant on 27 June 2015, there are still eight nuclear power plants currently online in Germany that provide a total gross output of 11,357 megawatts.

The Nuclear Phase-out Act imposed a limit on nuclear power generation and the production of high-level radioactive waste. However, the best-possible way to store radioactive waste remained an open issue. As a result, the German Federation and Länder agreed to promptly clarify the issue.

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[93] The German Bundestag is committed to phasing out nuclear power irreversibly', the German parliament declared on 10 April 2014 when forming the Commission on the Storage of High-Level Radioactive Waste. Cf. German Bundestag (2014), motion tabled by the parliamentary groups of the Christian Democratic Union/Christian Social Union (CDU/CSU), Social Democratic Party of Germany (SPD) and Alliance 90/The Greens, Formation of the 'Commission on the Storage of High-Level Radioactive Waste'. Bundestag Printed Paper 18/1068, 7 April, p. 1.

[94] Cf. German Bundestag (2011). Federal Chancellor A. Merkel: Government declaration 'Der Weg zur Energie der Zukunft'. Minutes of plenary proceedings 17/114.

[95] Cf. German Bundestag (2011). Federal Chancellor A. Merkel: Government declaration 'Der Weg zur Energie der Zukunft'. Minutes of plenary proceedings 17/114.

[96] Cf. Thirteenth Act to Amend the Atomic Energy Act of 31 July 2011, Federal Law Gazette I, p. 1704, Article 1.

1.1 History of the Site Selection Act

The German Bundestag passed the Site Selection Act (StandAG) on 23 July 2013 and, with it, the first detailed provisions for searching for and exploring a site where, in particular, high-level radioactive waste can be permanently stored with the best-possible safety. This Act requires a search be performed throughout Germany in order to determine a site that guarantees the best-possible safety for one million years. Before deciding on a site, several potential sites should undergo surface and underground exploration.

A comparative geological investigation of several sites earmarked for the permanent storage of high-level radioactive waste in salt as a host rock was last initiated in Germany back in the 1970s. At that time, the Federal Ministry of Research and Technology commissioned the Kernbrennstoff-Wiederaufarbeitungs-Gesellschaft mbH (KEWA) to identify several alternative sites for a nuclear waste management centre consisting of an industrial nuclear fuel reprocessing plant and a disposal facility.[97] However, the geological investigations underway at three sites were discontinued in 1976. Instead, the Federal Government opted to accept the proposal put forward by the Lower Saxony government in 1977 to use an area above the Gorleben salt dome as a site for a nuclear waste management centre. Geological exploration of the Gorleben salt dome commenced after the Federal Government ratified this decision.[98]

During the exploration phase, which ended with the passing of the Site Selection Act, a number of different political groups and other groups within society repeatedly called for a new comparative search for a disposal site, largely based on the argument that it is simply not enough to investigate the suitability of a single site if comparatively better-suited disposal sites are conceivable.[99] Subsequent attempts to enforce an alternative search procedure on a political level initially failed on account of resistance from political and business groups who – for various reasons – wanted to continue with Gorleben as the disposal site to undergo exploration.[100]

In 1999, the Federal Environment invoked a Committee on a Site Selection Procedure for Repository Sites (AkEnd) tasked with investigating the question of disposal of high-level radioactive waste and with finding a site that is suitable from a scientific perspective. The AkEnd then compiled a list of scientific exclusion and selection criteria to be used for the selection of disposal sites. It also prepared suggestions for effective public participation in the planned search procedure. The AkEnd considered involvement of the regional population and promotion of regional development in siting regions to be key to ensuring acceptance of a disposal site selection procedure.[101]The AkEnd submitted its final

[97] Cf. German Bundestag; First committee of inquiry pursuant to Article 44 of the German Basic Law (2013), recommendation and report. Bundestag Printed Paper 17/13700, 23 May 2013, p. 68.
[98] On this issue, see section B 4.1.4 of the present report 'Gorleben exploratory mine.
[99] Cf. Däuper, Olaf; Bosch, Klaas; Ringwald, Roman (2013): 'Zur Finanzierung des Standortauswahlverfahrens für ein atomares Endlager durch Beiträge der Abfallverursacher', Zeitschrift für Umweltrecht 2013, issue 6, p. 329.
[100] Däuper, Olaf; von Bernstorff, Adrian (2014): Site Selection Act – in tandem with a proposal for the agenda of the 'Commission on the Storage of High-Level Radioactive Waste'. Zeitschrift für Umweltrecht 2014, issue 1, p. 24.
[101] Committee on a Site Selection Procedure for Repository Sites (2002), 'Site Selection Procedure for Repository Sites', Commission Material K-MAT 1, p. 219 ff.

report[102] to the former Federal Minister for the Environment, Jürgen Trittin, on 17 December 2002.

1.2 Origin of the Site Selection Act

A precursor to the Site Selection Act currently in place was the draft 'Act to create an association and to define a disposal site selection procedure for the disposal of radioactive waste – VStG)' which was put forward in 2004. However, the 15th legislative period was abridged as a result of bringing elections forward, in turn meaning that this draft had no chance of being adopted. During the 16th legislative period, Federal Minister for the Environment Sigmar Gabriel proposed a concept to search for a new site titled 'taking responsibility, achieving consensus on a disposal facility'. However, this never ended up becoming a draft act.[103]

In the wake of the Fukushima Daiichi reactor accident in March 2011, the vast majority of the German Bundestag reassessed the risks of nuclear energy and agreed to completely phase out the use of nuclear power for electricity generation by the year 2022. Following on from that, Winfried Kretschmann, the Minister President of the state of Baden-Württemberg, suggested arriving at a broad consensus regarding the unsolved issue of nuclear waste disposal. A site for disposal of high-level radioactive waste should be unbiased and sought only on the basis of scientific criteria. Kretschmann explicitly included the German Land of Baden-Württemberg in the 'blank map' of Germany to be used as a basis for the search.

On 1 November 2011, Franz Untersteller, the Minister for the Environment in Baden Württemberg, submitted a paper outlining the key issues involved in a site selection procedure. On 15 December 2011, the Federal Minister for the Environment at that time, Norbert Röttgen, worked with the heads of the Länder governments to put together a concept that involved a blank map of Germany to be used as a basis for the site selection procedure. Agreement on this concept was in fact reached for two reasons: firstly, the decision to use Gorleben was rescinded; secondly, Gorleben was not excluded from the blank map of Germany. At the initiative of the Land of Baden-Württemberg, a Federal and Länder working group was created under the leadership of the Federal Ministry for the Environment to prepare a draft Site Selection Act. During the course of the negotiations, further exploration in Gorleben was halted in November 2012, in turn meaning that the preliminary safety analysis could not be completed.

At the same time as adopting the Site Search Act, on 24 March 2013, Federal Minister for the Environment, Peter Altmaier, and the Minister President for Lower Saxony, Stephan Weil, agreed to stop transporting reprocessed radioactive waste to Gorleben, and to form a commission made up of representatives from society and science.

[102] Committee on a Site Selection Procedure for Repository Sites (2002), 'Site Selection Procedure for Repository Sites', Recommendations of the Committee on a Selection Procedure for Repository Sites (AkEnd). K-MAT 1.
[103] Smeddinck, Ulrich (2014): 'Das Recht der Atomentsorgung', p. 19.

In contrast to the regulatory authority previously also earmarked for this task, this commission was charged with developing the disposal site search criteria and with evaluating the Act itself. A new draft act was then submitted on the basis of this understanding on 3 April 2013. This draft Site Selection Act from the Federal Ministry for the Environment formed the basis of the agreement reached between the Federal Government and the Länder on 9 April 2013 with regard to the legal framework to be put in place for the site selection procedure. On 24 April 2013, the Federal Cabinet adopted the draft act on the basis of a proposal put forward by the Federal Minister for the Environment at that time, Peter Altmaier.[104]

From 31 May to 2 June 2013, the Federal Ministry for the Environment and most of the Bundestag parliamentary groups organised a public Site Selection Act forum on the subject of a disposal facicity for high-level radioactive waste which was held at the Church of the Resurrection in Berlin. This citizens' forum provided environmental associations, interested citizens and scientists with the opportunity (for a limited time, unfortunately) to voice their opinions and give their feedback prior to the German Bundestag's final debate on the draft act.[105] This event was also streamed live on the internet. Citizens were also able to add comments on the Federal Ministry for the Environment's website.

On 28 June 2013, the German Bundestag approved the version of the 'Draft Site Selection Act' that was amended by the environmental committee.[106] The Christian Democratic Union/Christian Social Union (CDU/CSU), Social Democratic Party of Germany (SPD), Free Democratic Party (FDP) and Alliance 90/The Greens parliamentary groups all approved the draft act, while The Left (die Linke) voted against it and there was one abstention within the FDP. The German Bundestag also rejected a motion for a resolution[107] submitted by The Left to conduct additional preparatory work before enacting site selection procedure legislation, and to work through errors made in the past when looking for a disposal site before preparing a draft act.

The Bundestag's environmental committee had already changed the number of Commission members again in favour of representatives of industry and societal groups. This was a reaction to public criticism which initially saw both a lack of representation on the part of civil society as well as excessive political representation. The adopted version meant that the Commission members from the Bundestag and Land governments also no longer had any voting rights for the Commission's decision on its report.

The German Bundesrat adopted the draft act on 5 July 2013. The Act itself was announced in the Federal Law Gazette on 26 July 2013 and enacted the following day. Nevertheless, Sections 1 and 2 and 6 to 20 did not come into force until 1 January 2014. The German Bundestag and Bundesrat appointed the members of the Commission on the Storage of High-Level Radioactive Waste as of 10 April 2014. In doing so, the Bundestag parliamentary groups of the Christian

[104] Bundestag parliamentary groups of the Christian Democratic Union/Christian Social Union (CDU/CSU), Social Democratic Party of Germany (SPD) and Alliance 90/The Greens (2013),

[105] Friends of the Earth Germany (BUND) and other environmental organisations were not involved in this forum because they rejected the draft act that formed the basis for discussion.

[106] Cf. German Bundestag; Committee on the Environment, Nature Conservation, and Nuclear Safety (2013), recommendation and report. Bundestag Printed Paper 17/14181, 26 June 2013.

[107] Cf. The Left (Die Linke) parliamentary group (2013), motion for a resolution. Bundestag Printed Paper 17/14213, 26 June 2013.

Democratic Union/Christian Social Union (CDU/CSU), Social Democratic Party of Germany (SPD) and Alliance 90/The Greens outvoted The Left (Die Linke) to approve a decision[108] that again detailed the duties of the Commission and highlighted the importance of consensus for the Commission's work. The decision also called on environmental associations and initiatives to take up their allocated seats within the Commission. Their involvement is essential to ensuring general consensus throughout society.[109]

On 14 April 2014, Friends of the Earth Germany (BUND) decided to appoint a representative for the Commission. The German Environment Foundation (Umweltstiftung) also nominated a delegate for the Commission. The members of the Commission were confirmed by the German Bundestag and Bundesrat before the Commission's inaugural meeting held on 22 May 2014.

1.3 The Commission's mandate

The aim of the site selection procedure is to find a disposal site for the disposal of, in particular, high-level radioactive waste produced in the Federal Republic of Germany while also guaranteeing the best-possible safety for a period of one million years.[110]

The 'Commission on the Storage of High-Level Radioactive Waste', which was recently created as a result of the Site Selection Act, has a number of duties including, in particular, the submission of a report[111] containing an analysis and evaluation of all the fundamental questions pertaining to radioactive waste disposal that arise in connection with the site selection procedure.[112] The Site Selection Act required that this report be adopted by consensus or, at the very least, with a majority of two thirds of Commission members who are eligible to vote.[113] The report is designed to provide the German Bundestag, Bundesrat and Federal Government with a basis for the actual site selection procedure and for evaluating the Site Selection Act itself.[114]

The Site Selection Act also tasked the Commission with discussing in detail all of the questions that are material to making decisions about the site selection procedure.[115] The Act does not provide an exhaustive list of the questions material to making decisions. The only limit here came about due to the statutory aim of the Site Selection Act.[116] With a view to the National Programme[117]

[108] Cf. Bundestag parliamentary groups of the Christian Democratic Union/Christian Social Union (CDU/CSU), Social Democratic Party of Germany (SPD) and Alliance 90/The Greens (2014), motion to form the 'Commission on the Storage of High-Level Radioactive Waste' – assume responsibility for future generations. Bundestag Printed Paper 18/1068, 7 April 2014.
[109] Cf. Bundestag parliamentary groups of the Christian Democratic Union/Christian Social Union (CDU/CSU), Social Democratic Party of Germany (SPD) and Alliance 90/The Greens (2014), motion to form the 'Commission on the Storage of High-Level Radioactive Waste' – assume responsibility for future generations. Bundestag Printed Paper 18/1068, 7 April 2014, p. 2.
[110] Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553, first sentence of Section 1(1).
[111] Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553, first sentence of Section 4(1).
[112] Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553, Section 3(2).
[113] Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553, first sentence of Section 3(5).
[114] Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553, Section 4(4).
[115] Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553, second sentence of Section 4(1).
[116] Cf. Commission on the Storage of High-Level Radioactive Waste; secretariat (2015), draft interpretation aid for the Commission pertaining to terms set out in the Site Selection Act. K-Drs. 113, p. 2.

adopted by the Federal Government on 12 August 2015, the Commission also agreed to provide the necessary general requirements for the storage of low, intermediate and high-level radioactive waste at a uniform disposal site.[118]

The Site Selection Act also explicitly tasked the Commission to provide recommendations for exclusion criteria, minimum requirements, consideration criteria and other foundations for decision-making in preparation for the search for a site offering the best-possible safety.[119]

Following the Site Selection Act, these decision-making foundations also include general safety requirements governing storage, geoscientific, water management and spatial planning exclusion criteria along with minimum requirements for host rocks.[120] The salt, clay and crystalline[121] stated specifically in the Act were not the only possible host rocks to be considered. However, the Act only states which host rocks could be included, purely by way of example. Further consideration of these questions is available in section B 6.

A list of consideration criteria both dependent and independent of the host rock was also needed to be able to compare the suitability of the various host rocks. The Commission had to take pertinent opinions and studies into consideration when preparing suggestions for the decision-making foundations.[122]

Proposals for potential error correction also had to be made.[123] These include storage design requirements in terms of retrievability and recovery of radioactive waste both during operation and after sealing the site. As recoverability and retrievability are highly contingent upon the host rock, these requirements had to be defined in line with the host rock.[124] In accordance with its mandate and as a precautionary measure, the Commission also investigated potential returns to earlier stages within the selection procedure that may be required if, following several selection steps, all of the sites investigated hitherto are deemed unsuitable. Statements about this are also available in section B 6 of the present report.

The proposals for the method used to perform preliminary safety analysis which the Commission had to develop are also crucial to the selection procedure. The proposals include the behaviour of the disposal systems under certain load factors and account for any malfunctions.

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[117] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2015): National Programme. http://www.bmub.bund.de/fileadmin/Daten_BMU/Download_PDF/Nukleare_Sicherheit/nationales_entsorgungsprogramm_aug_en_bf.pdf [Last accessed 24 February 2016].
[118] Cf. Commission on the Storage of High-Level Radioactive Waste (2015), decision of 19 November 2015. K-Drs. 145.
[119] Cf. Bundestag parliamentary groups of the Christian Democratic Union/Christian Social Union (CDU/CSU), Social Democratic Party of Germany (SPD) and Alliance 90/The Greens (2013), Draft Site Selection Act (StandAG). Bundestag Printed Paper 17/13471, 14 May 2013, p. 22.
[120] Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553, Section 4(2)(2).
[121] Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553, Section 4(2)(2).
[122] Cf. Bundestag parliamentary groups of the Christian Democratic Union/Christian Social Union (CDU/CSU), Social Democratic Party of Germany (SPD) and Alliance 90/The Greens (2013), Draft Site Selection Act (StandAG). Bundestag Printed Paper 17/13471, 14 May 2013, p. 20 f.
[123] Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553, Section 4(2)(3).
[124] Cf. Bundestag parliamentary groups of the Christian Democratic Union/Christian Social Union (CDU/CSU), Social Democratic Party of Germany (SPD) and Alliance 90/The Greens (2013), Draft Site Selection Act (StandAG). Bundestag Printed Paper 17/13471, 14 May 2013, p. 21.

However, the Commission was not tasked with investigating safety requirements in terms of the interim storage of radioactive waste as part of the decision-making foundations for the site selection procedure.[125]

In contrast to this, the Commission was required to answer the question of whether options were available to dispose of radioactive waste by means other than disposal in deep geological formations as this was deemed material to making decisions about a disposal site.[126] Section B 5 of the present report considers this question in more detail. In line with its mandate and in order to answer this question, the Commission commissioned scientific investigations to assess other disposal options and compared the statements made about the various disposal methods.

Another of the Commission's tasks was to assess the Site Selection Act in terms of its appropriateness, and to provide alternative suggestions.[127] The justification in the Site Selection Act draft states that the Commission should perform a detailed analysis of the Act itself and provide recommendations for action in the event of any need for improvement. This review duty pertains to 'all aspects of the Act'.[128] In doing so, the Commission was tasked with considering questions of a techno-scientific and 73ocio-political nature, in particular the question of appropriate public participation during the site selection procedure in order to foster acceptance. Within this context, the Commission put together proposals 'for requirements placed on public participation and information, as well as on ensuring transparency.'[129] These proposals are available in section B 7 of the present report.

The Commission was also given the legal mandate to prepare proposals for 'requirements placed on the selection procedure organisation and method, and on an assessment of alternatives.[130] This also involved the Commission performing a review of the method and organisational structure of the selection procedure method described in Sections 13 to 20 of the Site Selection Act. The results of this review are available in section B 8 of the present report which covers the Commission's evaluation of the Site Selection Act.

Against this background, the Commission primarily prepared recommendations and proposals for criteria and the approach to be used for the site selection procedure. It reviewed the various disposal options, and eventually recommended disposal in a deep repository under the proviso that retrievability of the waste can be guaranteed. It also recommended a number of changes to the Site Selection Act.

In line with its legal mandate, the Commission also issued a statement in this report about the decisions and stipulations made in Germany to date with regard to the disposal facility question.[131] The report also includes, as required by law,[132]

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[125] Cf. Bundestag parliamentary groups of the Christian Democratic Union/Christian Social Union (CDU/CSU), Social Democratic Party of Germany (SPD) and Alliance 90/The Greens (2013), Draft Site Selection Act (StandAG). Bundestag Printed Paper 17/13471, 14 May 2013, p. 20.
[126] Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553, Section 4(2)(1).
[127] Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553, Section 3(3).
[128] Cf. Bundestag parliamentary groups of the Christian Democratic Union/Christian Social Union (CDU/CSU), Social Democratic Party of Germany (SPD) and Alliance 90/The Greens (2013), Draft Site Selection Act (StandAG). Bundestag Printed Paper 17/13471, 14 May 2013, p. 21.
[129] Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553, Section 4(2)(5).
[130] Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553, Section 4(2)(4).
[131] Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553, Section 3(4).

international experience of searching for disposal sites. The main findings of the Commission on this topic are summarised in sections B 4.1 and B 4.2.

1.4 The Commission's working methods

The task of the Commission on the Storage of High-Level Radioactive Waste was to make preparations for the selection of a site that 'guarantees the best-possible safety for one million years' for the storage of, in particular, high-level radioactive waste. To this end, the Commission performed a critical examination of the rules laid down in the Site Selection Act for the search to find a disposal site and, above all, developed the provisions for public participation in the site selection procedure. It has devised a way to permanently store radioactive waste with the best-possible safety while also being able to correct errors. It has also agreed on criteria which can be applied to select the site offering the best-possible safety. Based on its proposals concerning these principle tasks and its other functions under the Site Selection Act, the Commission has formulated recommendations for the Bundestag, the Bundesrat and the Federal Government that are now to be implemented by amending statutory provisions or taking administrative measures.

Permanent safe storage of radioactive waste is the state's responsibility. However, in order to ensure that the search for a site providing the best-possible safety is successful, the state needs assistance from the sciences and society. The complexity of the disposal site selection procedure was already reflected in the composition of the Commission on the Storage of High-Level Radioactive Waste. The site for permanent storage with best-possible safety should be determined by means of a scientifically based procedure. A quarter (8 out of 32) of the members were appointed to the Commission as scientists: five from the natural sciences or engineers, two lawyers and one philosopher of technology. Eight additional members were appointed to the Commission as representatives of societal groups, trade unions, industry, religious congregations and environmental associations. Eight representatives of Bundestag parliamentary groups and eight Länder representatives were appointed to the Commission to represent the various political levels. Permanent best-possible safe storage of radioactive waste requires constructive collaboration between several different levels within government. This was already observed during the course of previous disposal plans in Germany which the Commission worked on with the aim of learning from the experience.

Ursula Heinen-Esser and Michael Müller, both of whom are former parliamentary state secretaries and former long-standing members of the Bundestag, were appointed equal chairpersons of the Commission on the Storage of High-Level Radioactive Waste and each took turns in chairing Commission meetings. To the extent permitted by the Site Selection Act, the Commission implemented Rules of Procedure governing the steps it was going to take as well as its own applicable structure and rules. The Site Selection Act placed the Commission with the environmental committee of the German Bundestag, but accorded the Commission its own legal status. The Commission should bundle

[132] Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553, Section 4(2).

scientific expertise, represent societal groups and prepare recommendations for legislation and executive bodies.

Shortly after the election of its members by the German Bundestag and Bundesrat,[133] the Commission held its inaugural meeting on 22 May 2014 with both Ursula Heinen-Esser and Michael Müller as chairpersons. The first meetings mainly involved consultations regarding the Rules of Procedure[134] and the work programme.[135] The Commission unanimously approved its Rules of Procedure at its third meeting held on 8 September 2014. Taking its lead from the provisions set out in the Site Selection Act on the Commission's work, as well as the decision the German Bundestag passed with a broad majority when the Commission was appointed,[136] it emphasised its determination to reach a consensus. The Commission would make efforts 'to find unanimous solutions to all questions because the success of the Commission's work will ultimately depend on a broad consensus being reached,[137] as its Rules of Procedure put it.

The present final report, which the Commission has adopted by an overwhelming majority, achieves this self-defined goal. As provided for in the Site Selection Act, only the 16 Commission members who represent science and societal groups were eligible for the final vote on the report. However, all of the Commission members were able to put any dissenting opinions on record. The fact that the report includes only a few dissenting opinions shows the Commission has indeed reached a consensus, and it is delivering its recommendations unanimously. In view of the complex issues, however, reaching unanimity on the report does not mean that every formulation and every comment is supported equally and fully by each individual member of the Commission.

In its Rules of Procedure, the Commission committed itself, above all, to transparent working methods and granted its members extensive minority rights. Six of the 32 Commission members were already granted the right to commission external experts or hearings involving external experts. To make sure its work was transparent, the Commission itself met in public as a matter of principle, as did the working groups and *ad hoc* groups it set up. The public was only excluded from parts of meetings that involved consultations pertaining to third-party rights. This was the case when the Commission had to deliberate tender quotations from service providers and experts which could not be made public for commercial secrecy reasons.

The Commission's meetings were broadcast live on Bundestag Parliamentary Television and the internet, and video recordings of the meetings were subsequently published on the Commission's website. Audio recordings of the working group and *ad hoc* group meetings were also made available for

[133] Cf. Bundestag Printed Paper 18/1070 and 1071 as well as the minutes of plenary proceedings 18/30 and Bundesrat Printed Paper 143/14; for the two representatives from environmental associations as stipulated in item two of Section 3(1) of the Site Selection Act: Bundestag Printed Paper 18/1452 as well as the minutes of plenary proceedings 18/35 and Bundesrat Printed Paper 215/14.
[134] The Roles of Procedure are enclosed in the present report as section B 11.2.3.
[135] Cf. in particular K-Drs. 10 and 17.
[136] To this end, cf. the motion tabled by the parliamentary groups of the Christian Democratic Union/Christian Social Union (CDU/CSU), Social Democratic Party of Germany (SPD) and Alliance 90/The Greens, Formation of the 'Commission on the Storage of High-Level Radioactive Waste' - assume responsibility for future generations, Bundestag Printed Paper 18/1068.
[137] Rules of Procedure of the Commission on the Storage of High-Level Radioactive Waste. Section 3 Principle of consensus. Cf. enclosure of the present report.

download on the website. Furthermore, all relevant documents consulted and produced during the deliberations were accessible to the public on the website as Commission printed papers (K-Drs.) or Commission materials (K-MAT), except where third party rights stood in the way of this. Not only that, in the spring of 2015 the Commission established an internet forum and had its website redesigned such that interested persons were also able to access the website's content from mobile end devices. From then on, the website also had an integrated document archive.

The Commission on the Storage of High-Level Radioactive Waste, or 'The Commission' for short, involved interested citizens and representatives of societal groups more closely in its work by holding numerous dialogue events ranging from the Community Dialogue on the Search for a Disposal Site to a discussion event on the draft report. Some of these events were aimed at certain target audiences such as young adults, participation practitioners, scientists involved in disposal, and interested representatives of regions or counties. The Commission took on board the feedback and specific proposals for the present report it received at each of these events.[138]

1.1.1 Three phases of the Commission's work

During a two-year period, the Commission on the Storage of High-Level Radioactive Waste convened 34 times, while 93 additional meetings involving the Commission's working or *ad hoc* groups were also held during the same period. From a temporal perspective, the Commission's work can be divided up into three phases. The first phase was an organisation and orientation phase during which the Commission set itself rules, structures and, above all, held several meetings at which Commission members were provided with information to ensure that each member has the same level of knowledge. This was necessary as the members all had certain knowledge and experience of the various aspects of the site selectio procedure.

The Commission's organisation and orientation phase involved a series of hearings to 'evaluate the Site Selection Act and international experience' with disposal projects. It also looked in detail at the recommendations of the 'Committee on a Site Selection Procedure for Repository Sites' which produced a site selection procedure in 2002 that was not subsequently implemented. A directory of radioactive waste provided by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) enabled the Commission to gain an insight into the material scope of the task of permanently storing radioactive waste. Together with Peter Altmaier, Head of the Federal Chancellery, Barbara Hendricks, Federal Minister for the Environment, Johanna Wanka, Federal Minister for Education and Research, and, at a later stage Sigmar Gabriel, Federal Minister for the Economy, the Commission described aspects relating to preparation of the site selection procedure that fall within their respective remit.

During this first phase, the Commission used sub-groups to investigate their main fields of expertise. On 8 September 2014, the Commission decided to set up three

[138] On this issue, see section B 7.8 of the present report.

working groups: Working group one, which was headed at that time by bishop Ralf Meister and lawyer Hartmut Gaßner, dealt with the following topics: ‘societal dialogue, public participation and transparency based on experiences gleaned from Asse, Gorleben, Konrad and Morsleben’. It was therefore tasked with ensuring citizens’ participation in the Commission’s work and, above all, with conceiving a participative site selection procedure. Following a corresponding decision by the Commission, this working group involved in their work representatives from siting regions who were accorded the right to speak as so-called ‘permanent guests’.

Working group two, which was chaired at that time by lawyer Hubert Steinkemper and Friends of the Earth Germany (BUND) representative Klaus Brunsmeier, was given the title ‘evaluation’ and tasked with investigating legal provisions, chiefly related to the Site Selection Act, to determine any need for change. The philosopher of technology Armin Grunwald and chemist Michael Sailer were appointed chairmen of working group three titled ‘societal and techno-scientific decision-making criteria and criteria for correcting errors based on experience from Asse, Gorleben, Konrad and Morsleben’, which primarily looked into site selection procedure aspects pertaining to natural science, i.e. a way to permanently store radioactive waste with the best-possible safety, and the criteria to be used to look for the best-possible site.

At the beginning of November 2014, the Commission also invoked an *ad hoc* group called ‘foundations and vision’, which was headed by the chairpersons of the Commission, Michael Müller and Ursula Heinen-Esser. This group evaluated the foundations of the Commission’s work and grouped the storage of radioactive waste both from a societal and philosophical perspective. The Commission also invoked an additional *ad hoc* group in March 2015 after several energy companies took legal action with regard to nuclear phase-out, which in turn led to controversy within the Commission. This *ad hoc* group titled ‘energy company legal action’ was chaired by the representative of the German Environment Foundation, Jörg Sommer, and industry representative, Gerd Jäger. The group not only dealt with the claims for damages asserted by energy companies, but also devised models aimed at solving conflicts.

The initiation of working groups increased the level of work upon Commission members who, alongside monthly Commission meetings, often attended several working group meetings and were required to prepare or read a great deal of documentation either before or after meetings. The members of the Commission were given the right to be represented in working groups by persons not elected by the Bundestag or Bundesrat, i.e. by employees. These representatives had the right to speak at the working group meetings; however they did not have the right to vote.

In contrast to this, representatives from science or civil society who could not be represented by employees from an organisation or company were not able to benefit from the right of representation. The Commission therefore often discussed the large discrepancy in the amount of voluntary work the various members were required to put in on behalf of the Commission. In March 2015, the chairpersons and other members of the Commission explained to the top level of the Bundestag administration the options available to enable every member of the Commission to work together on an equal footing. This led to permanent guests of working groups also receiving a *pro rata* fee for expenses. An additional rule could not be found which would have also taken account of the situation involving Commission members who are appointed individually rather than as representatives of a group or organisation.

In 2015, the second phase largely saw the Commission's members performing their duties in three working groups and two *ad hoc* groups. These groups also devised or prepared drafts for the part of the Commission's final report that corresponded to their specific fields. Here, working group one conducted intense discussions on section B 7 of the present report 'Site selection procedure in dialogue with the regions', while working group two drafted the subsequent section B 8 'Evaluation of the Site Selection Act'. Working group three was mainly responsible for preparing drafts for section B 5 'Disposal options and their evaluation' and section B 6 'Process pathways and decision-making criteria'. Both *ad hoc* groups drafted the basic introductory report sections.

During the third phase of their work which started in autumn 2015, parts of the draft report were discussed by the entire Commission and amended accordingly prior to publication. The whole Commission also subsequently looked into the suggestions and requests submitted by citizens following the public debate on the draft that took place both online and at events.[139] This is a joint report by the entire Commission on the Storage of High-Level Radioactive Waste, and it also includes the results of public participation in the Commission's work.

The final version of the final report was approved by the Commission on 27 June 2016 with the necessary two-thirds majority as stipulated by the fourth sentence of Section 3(5) of the Site Selection Act. Of the 15 eligible Commission members present, 14 voted in favour and one voted against the report. The report was submitted to the Bundestag, Bundesrat and Federal Government in the first week of July 2016; during the very same week the report was presented to the public during a final Commission meeting and also posted online.

Important steps and interim results

In order to prepare the final report, the Commission or its working groups called upon well-known experts to attend hearings with the aim of gathering information about 'experience in large-scale projects', 'retrieval/retrievability of high-level radioactive waste from a disposal facility, reversibility of decisions' and about safety requirements for storing high-level radioactive waste formulated by the Federal Ministry for the Environment in 2010. In order to clarify important individual questions, the Commission on the Storage of High-Level Radioactive Waste also commissioned external reports, including the 'area needed for a disposal facility', 'heat generation and rock compatibility' of high-level radioactive waste, and 'transmutation', a conditioning process involving neutron bombardment which turns long-lived radioactive materials into short-lived radioactive materials.

Fact-finding trips to Switzerland, Sweden and Finland enabled the Commission members to gain personal insights into the disposal projects being carried out in those countries. The Commission members also visited the Konrad disposal facility which is currently under construction in Salzgitter (Germany), as well as

[139] On this issue, see section B 7.8 of the present report.

the former Asse II salt mine in Wolfenbüttel County (Germany), from which the radioactive waste deposited there is to be retrieved.

The Commission already gave politics a number of important impulses and advice by taking several key decisions prior to preparing its final report. One such example is where the Commission issued a decision recommending the structure of the authorities soon be set up differently to that provided for in the Site Selection Act. Another decision saw the Commission demand that the temporary moratorium only in place at the Gorleben salt dome be dispensed with in favour of a general rule to secure potential disposal sites. Barbara Hendricks, Federal Minister for the Environment, personally outlined the prospect of a swift adoption of both decisions.

A participation concept[140] developed by working group one with the assistance of external service providers and approved by the Commission was extremely important to the Commission's work itself. The participation report, which forms part of this final report, provides details of how the Commission used the participation concept to involve interested citizens in its work.

A decision regarding the 'National Programme', which the Federal Government published during the Commission's work, also played a central role. The Programme suggested that the prospective site for the final storage of high-level radioactive waste also be used to permanently store up to 30,000 cubic metres of low-heat-generating radioactive waste. This decision is subject to revision as major changes may ensue on the basis of the recommendations by the Commission on the Storage of High-Level Radioactive Waste. In its decision regarding the Programme, the Commission explained that its report would pay particular attention to the selection criteria for a site for high-level radioactive waste. At the same time, the report will also provide statements about general requirements that must be fulfilled to ensure that low-heat-generating radioactive waste can also be stored in the same disposal facility. On 3 July 2015, the Commission also decided to make use of an option provided by the Site Selection Act which allows it to extend the deadline for submitting its report by six months to mid-2016.

In doing so, the Commission accounts for the fact that the Bundestag and Bundesrat appointed the Commission members at a later time than that stipulated when the Site Selection Act was passed.

The work of the Commission in figures

In the two years that passed between appointing all of the members of the Commission on the Storage of High-Level Radioactive Waste and completing its final report, the Commission convened at a total of 127 meetings. At 34 of those meetings, the entire Commission convened, while 93 meetings involved the working groups. Three of the 93 working group meetings were joint meetings involving several working groups. The total meeting time exceeded 600 hours and resulted in over 8,500 pages of minutes. At its meetings, the Commission conducted nine expert hearings. During trips to Switzerland, Sweden and

[140] Cf. K-Drs. 108 and the revision of K-Drs. 108.

Finland, the Commission was informed of the disposal projects being undertaken there.

The Commission's website contains over 1,300 documents which its members have either deliberated or which serve to document the work of the Commission, be it in writing or as audio or video recordings. The Commission or its working groups deliberated more than 500 printed papers and 68 Commission materials, most of which were expert opinions. The Commission also held intense debates on the six different draft report versions as well as on the final report, which was finally approved on 27 June 2016 with just one opposing vote.

2 STARTING POINTS FOR THE COMMISSION'S WORK

2.1 The history of nuclear energy

We need to be able to learn from the past in order to arrive at a broader understanding of the best-possible storage of radioactive waste and to foster renewed trust within society. The conflicts surrounding nuclear energy are a political and societal lesson. They need to be considered and understood in their historical context as this will help to settle the controversies and overcome the divisions that have arisen.

In order to do this, the Commission has compiled the history of nuclear energy and disposal of radioactive waste to date. As required by the Site Selection Act, the use of nuclear energy is split up into its economic, social and cultural aspects. This underlines the course that has been set and its associated consequences in terms of nuclear energy development. This knowledge is not just of historical interest, it is also crucial to our future understanding of freedom and responsibility in handling complex technologies with far-reaching consequences.

The history of nuclear energy shows that progress is not self-perpetuating. Everyone involved needs to adopt an ethics of responsibility to prevent saddling future generations with any irresponsible burdens. This is the background against which the Commission proposes criteria for best-possible storage[141] of radioactive waste. It is not enough to provide a purely technical answer.

The last few decades have seen a number of major societal disputes arise in tandem with significant resistance to building and operating nuclear power plants and disposal facilities for radioactive waste – particularly in the Gorleben area. Following years of effort to arrive at an energy consensus, and as a result of the decision to phase out nuclear energy taken by the red-green coalition of the Social Democratic Party of Germany (SPD) and The Greens, the phasing-out of nuclear energy which was supported by every party in the Bundestag and Bundesrat in 2011 was a prerequisite for agreeing in the Site Selection Act that no more containers will be stored in Gorleben. The Commission for the Safe Storage of Radioactive Waste is now tasked with suggesting criteria for a site selection procedure that offers the best-possible storage.

[141] Cf. the definition on page 23 of the present report.

Based on the Site Selection Act, the Commission appointed by the Bundestag and Bundesrat assumes that a new start is required. The Commission is aware that it can call upon good preparatory work with sound scientific and societal criteria for the storage of radioactive waste, in particular the report by the Committee on a Site Selection Procedure for Repository Sites, or AkEnd.[142] The Commission has developed more detailed responses than those provided in the past.

The Site Selection Act and the decision by the German Bundestag on the Commission's work underline the importance of evaluation, discussion and long-term agreement in order to arrive at a broad societal consensus. To achieve this, the Commission needs to demonstrate that lessons have been learned from previous errors and that not every technological innovation and economic exploitation represents a contribution to progress.[143]

A matter-of-fact review of the past, which does not continue previous disputes, will help to explain the background and various aspects that led to the use of nuclear energy. The discovery of nuclear fission triggered a number of processes without sufficiently reflecting upon the consequences. As the historian Joachim Radkau wrote, nuclear power was surrounded by a myth right from the very outset that gave it an aura of power, strength and progress.[144] In his main philosophical work, 'The Principle of Hope', Ernst Bloch speaks of nuclear energy 'turning deserts into cropland, ice into spring; a few hundred pounds of uranium and thorium would suffice to make the Sahara and the Gobi deserts disappear and would turn Siberia, North America, Greenland and the Antarctic into the Riviera.[145] Joachim Radkau, whose research is highly focused on the history of nuclear power, showed that nuclear energy was a 'complexly charged mega-project'[146] without any widespread societal discourse on its impact and consequences.

Critical voices emerged while nuclear energy was still in its infancy; concerns were raised about the potential negative effects of radiation on humans as well as the proliferation hazards and risks involved when reprocessing fuel elements. Aside from rejection to military use, up until the 1970s there was hardly any critical public debate at all regarding civil use of nuclear fission. For many years, attention was focused on the feasibility of the technology involved, not its accountability.

2.1.1 Phase one: The race for the atomic bomb

After James Chadwick discovered the neutron in 1932,[147] Otto Hahn and Fritz Straßmann conducted the first successful nuclear fission experiment involving neutron bombardment of uranium on 17 December 1938 at the Kaiser-Wilhelm-Institut in Berlin Dahlem. In January 1939, Lisa Meitner and her nephew Otto

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[142] Cf. The Committee on a Site Selection Procedure for Repository Sites (2002), 'Site Selection Procedure for disposal Sites', Recommendations of the Committee on a Selection Procedure for Repository Sites (AkEnd). K-MAT 1.
[143] Cf. Strasser, Johano (2015): 'Der reflexive Fortschritt'.
[144] Cf. Radkau, Joachim (1983): 'Aufstieg und Krise der deutschen Atomwirtschaft', p. 92.
[145] Bloch, Ernst (1959): 'Das Prinzip Hoffnung' (translation: The Principle of Hope), p. 775.
[146] Radkau, Joachim; Hahn, Lothar (2013): 'Aufstieg und Krise der deutschen Atomwirtschaft', p. 15.
[147] Cf. Chadwick, James (1935): The Nobel Prize in Physics 1935.

Frisch described the experiment from a nuclear physics perspective, and then published their findings one month later in Nature magazine.[148]

World War II and the global threat of National Socialism led to considerations to use nuclear fission for military purposes. The atomic bomb therefore plays a key role in the history of nuclear energy.

Initiated by the Hungarian physicists Leo Szilard and Eugene Paul Wigner, in 1939 Albert Einstein signed a letter to United States President Franklin D. Roosevelt, who had decided to make the US a nuclear power. This letter described the possibility of using 'nuclear fission to make extremely powerful bombs': 'A single bomb of this type, carried by boat and exploded in a port, might very well destroy the whole port together with some of the surrounding territory.[149] Einstein saw a link between Germany halting the sale of uranium and German research into nuclear fission being carried out by Ernst von Weizsäcker, the son of the German Under-Secretary of State, Carl Friedrich von Weizsäcker.

In the years that followed, the Soviet Union and Japan also started producing atomic bombs. The American Manhattan Project was ahead in the race with the German Army Ordnance.[150] In December 1942, Italian nuclear physicist Enrico Fermi used the Chicago Pile-1 experimental reactor to create the first nuclear fission chain reaction, which in turn led to the production of large quantities of plutonium.[151]

The Third Reich also carried out work known as the 'uranium project' during World War II. The main objective was to build a demonstration reactor with the aim of acertaining opportunities to build an atomic bomb.[152] Wernher von Braun was the chief design engineer of the first liquid-propellant rockets in Germany, and he had extensive technical expertise in this field. As of September 1945, he became a pioneer for US space programmes as part of Operation Overcast. Wernher von Braun told of plans where German rockets were to be combined with a 'warhead of immense destructional power.[153] However, there is no evidence of any small nuclear weapons testing towards the end of World War II.

On 16 July 1945, the first nuclear detonation took place at a test site 430 kilometres south of Los Alamos. The Trinity Test, as it was known, involved the US Army detonating an atomic bomb with the explosive force of almost 21,000 tonnes of TNT. The Army's official report stated that an explosion had occurred at an ammunitions depot, but the truth was revealed just three weeks later. On this day, 6 August 1945, an atomic bomb was dropped over Hiroshima, with a second one released over Nagasaki three days later with the aim of destroying the Mitsubishi Works.[154]

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148 Cf. Meitner, Lise; Frisch, Otto R. (1939): 'Disintegration of Uranium by Neutrons: A New Type of Nuclear Reaction', Nature volume 143.
149 Einstein, Albert (1939): Letter sent to US President Franklin Delano Roosevelt, 2 August 1939.
150 Cf. Groves, Leslie R. (1962): 'Now it can be told – The Story of the Manhattan Project'.
151 Cf. Fermi, Enrico (1952): 'Experimental production of a divergent chain reaction', in the American Journal of Physics, vol. 20, p. 536.
152 Schaaf, Michael (2001): 'Heisenberg, Hitler und die Bombe. Gespräche mit Zeitzeugen', Berlin.
153 Cf. the film made by German public TV broadcaster ZDF: 'Die Suche nach Hitlers Atombombe'. www.zdf.de/ZDFmediathek/beitrag/video/2457436/Die-Suche-nach-Hitlers-Atombombe [Last accessed 20 June 2016]
154 Cf. Schell, Jonathan (2007): The Seventh Decade.

In the wake of World War II, this new, unprecedented level of violence was met by demands, particularly within the world of science, to prevent a nuclear arms race from taking place.

Following on from this, in 1948 the United Nations General Assembly also demanded an international body be created to assume control of all uranium mines and nuclear reactors, and to only permit peaceful use. It also called for a halt to the production of nuclear bombs and the destruction of existing nuclear bombs.[155] This never happened.

The number of nuclear powers grew along with the detonation power of the bombs themselves. Even hydrogen bombs were even developed.[156]

2.1.2 Phase two: The rise of nuclear power generation

On 20 December 1951, nuclear power was first generated at a test reactor near Arco in Idaho (US). The world breathed a sigh of relief as the 'peaceful side' of atomic energy had been discovered. However, Otto Hahn, the most prominent nuclear scientist, pointed out in 1950 that the 'large nuclear machines powered by many tonnes of uranium (...), even if they serve the most peaceful of purposes, are also permanent plutonium production sites[157] and thus represent a potential hazard in times of political tension.

On 8 December 1953, Dwight D. Eisenhower announced the 'Atoms for Peace' programme at the Plenary Meeting of the United Nations General Assembly. The US President presented the use of atomic energy as a means of generating electricity and heat, and of serving the needs of agriculture and medicine in response to major questions regarding mankind: 'I therefore make the following proposals. The governments principally involved, to the extent permitted by elementary prudence, should begin now and continue to make joint contributions from their stockpiles of normal uranium and fissionable materials to an international atomic energy agency. We would expect that such an agency would be set up under the aegis of the United Nations.[158] A UN nuclear conference was held in Geneva in August 1955, followed by the establishment of the International Atomic Energy Agency (IAEA) on 29 July 1957. This demonstrative division of civil and military nuclear technology was designed to represent a way for nuclear physicists to cut ties with military objectives. Albert Einstein was a clear proponent of this decision.

In Germany, a group of people, including Nobel Prize winner Werner Heisenberg, formed the so-called Uranium Club, which pushed for civil use of and research into nuclear technology, initially in the special commission of the German research council and, from 1952, in the Federal Government's Senate Commission for nuclear physics. However, the level of enthusiasm about nuclear energy that emerged from political and public debate could not be turned into actions as the Allied Control Council prohibited nuclear research, reactor

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[155] Cf. Neue Zürcher Zeitung of 15 November 1948.
[156] Cf. Mania, Hubert (2010): 'Kettenreaktion: Die Geschichte der Atombombe'.
[157] Hahn, Otto. (1950): 'Die Nutzbarmachung der Energie der Atomkerne', p. 22.
[158] Eisenhower, Dwight D. (1953): 'Atoms for Peace'. Speech script available at: http://www.eisenhower.archives.gov/research/online_documents/atoms_for_peace/Atoms_for_Peace_Draft.pdf [Last accessed 24 February 2016]

construction and uranium processing in Germany. Nevertheless, at the start of the 1950s the Max Planck Institute for Physics, initially located in Göttingen and later in Munich, emerged as the driving force behind German nuclear policy.

The Cold War and integration of the Federal Republic of Germany into the West led to these restrictions being lifted. The Treaties of Paris, which came into effect on 5 May 1955, provided the framework for limited sovereignty to set up a nuclear ministry, conduct nuclear research and plan the country's first reactor. On 6 October 1955, Franz-Josef Strauß became the first German minister for nuclear affairs.

He was 'convinced (...) that the use of nuclear energy for economic, cultural and scientific purposes represents the same decisive turning point in the history of mankind as the discovery of fire by early humans.[159] Siegfried Balke took over this post one year later.

The opposition, the SPD, had also been electrified by the post-war euphoria surrounding nuclear energy. At its 1956 party congress, Leo Brandt, the North Rhine-Westphalian secretary for science, expressed his enthusiasm for the 'primordial fire of the universe.[160] The Godesberg Program of 1959 stated that 'the nuclear age can allow mankind to simplify life, liberate itself from worry, and create prosperity for everyone.[161] According to claims made at that time, all forms of nuclear technology should be able to compete within a few years.

Nuclear energy was seen as an inexhaustible fountain. Nuclear scientists considered it a foregone conclusion that nuclear power plants would soon be replaced by breeder reactors, and then by fusion reactors. They saw it as an almost free source of electricity and heat that would be available for eternity. The high energy density led to the belief that nuclear energy had countless applications, and that mini-reactors could be installed in ships, aircraft, trains and even cars. High hopes were placed on radiation chemistry revolutionising the chemical industry.

At that time, there were only a few experts who brought up the fundamental questions of responsible nuclear energy management. One of those experts was Otto Haxel,[162] one of the 18 Göttingen Manifesto nuclear researchers, who said: 'Every uranium power plant (is) inevitably also a nuclear explosives factory. During times of crisis or war, no government will be able to resist the boost in military power that nuclear fission provides.[163]

Public debates involved the question of whether Germany should be allowed to become a nuclear power. On 12 April 1957, the Göttingen Manifesto consisting of 18 renowned nuclear scientists specifically warned against the plan by Federal Chancellor Konrad Adenauer and Defence Minister Franz-Josef Strauß to equip

159 Strauß, Franz Josef, interview with Northwest German Broadcasting (NWDR) on 21 October 1955. Quote from the transcript issued by NWDR.

160 Brandt, Leo: 'Die zweite industrielle Revolution', *Vorstand der SPD* (1956). Minutes of the negotiations at the Social Democratic Party of Germany (SPD) party congress held in Munich from 10 to 14 July 1956. p.148 ff.

161 Principal guidelines of the Social Democratic Party of Germany (SPD). Adopted at the extraordinary Social Democratic Party of Germany (SPD) party congress held in Bad Godesberg 13 to 15 November 1959, p.2. http://www3.spd.de/linkableblob/1816/data/godesberger_programm.pdf [Last accessed 24 February 2016]

162 From 1950, Otto Haxel created the Second Physical Institute at the University of Heidelberg.

163 Cf. Göttingen Manifesto of 1957. http://www.uni-goettingen.de/de/text-des-göttinger-manifests/54320.html [Last accessed 24 February 2016]

the German Army with nuclear weapons. The scientists rejected this plan and called for peaceful use of nuclear energy instead.[164]

Their adoption of this stance was directly linked to Adenauer's comments to the press on 5 April 1957 in which he stated that tactical nuclear weapons would only be 'an extension to artillery' and demanded that the German Army also be equipped with these 'next to normal weapons'.

Otto Hahn, Werner Heisenberg, Max Born, Carl-Friedrich von Weizsäcker and their fellow collaborators vehemently rejected these military objectives and appealed for the civil use of nuclear energy.

The German Nuclear Commission was founded on 26 January 1956, followed by the presentation of the German nuclear programme one year later. Germany's first research reactor went into operation at the Technical University of Munich in 1957. However, the arrival of nuclear energy in Germany was not entirely uncontroversial. Energy companies were initially opposed to nuclear energy as they were expected to pay for the nuclear power plants and bear the associated operating risks. Energy company RWE did not believe in the notion of major economic benefits, and their advisor for nuclear energy, Oskar Löbl, rejected the promise of a golden era by presenting specific facts.[165] Friedrich Münzinger, an experienced power plant builder at AEG, branded it 'amateur-like optimism'. He said that a 'kind of nuclear power psychosis' had gripped the world, and praised critical opinions: 'The public is rightly defending itself against everything that could lead to radioactive pollution of the atmosphere, the Earth or waterways.[166] In view of the vast quantities of inexpensive coal and, from the end of the 1950s, cheap oil, the energy industry did not see any need for nuclear energy and shied away from incalculable costs. Even the nuclear reactor working group of the German Nuclear Commission provided a pessimistic assessment of the incurred costs.[167]

Cost calculations also could not be relied on in Great Britain and the US. A kilowatt-hour of electricity produced at the Shippingport nuclear power plant in Pennsylvania, which started production in 1957, cost 21.8 pfennigs compared to 2-3.5 pfennigs per kilowatt-hour of electricity generated from coal. In a status report on the future of nuclear energy published in the same year, the OEEC (the precursor to the OECD) arrived at the conclusion that nuclear power would still only be able to cover just eight per cent of Western Europe's energy requirements, even in 1975.[168]

164Schwarz, Hans-Peter (1991): 'Konrad Adenauer 1952 – 1967. Der Staatsmann', p. 334.
165 Cf. Löbl, Oskar (1961): 'Streitfragen bei der Kostenberechnung des Atomstroms', *Arbeitsgemeinschaft für Forschung des Landes Nordrhein-Westfalen (Hrsg)*, issue 93, pp. 7-19.
166 Radkau, Joachim (2011): 'Das Gute an der „German Angst"', Geo magazine, 11 August 2011. http://www.geo.de/GEO/natur/oekologie/kernkraft-das-gute-an-der-german-angst-69334.html [Last accessed 24 February 2016]
167 Kriener, Manfred (2010): 'Aufbruch ins Wunderland', Die Zeit newspaper, 30 September 2010. http://www.zeit.de/2010/40/Atomenergie-Stromkonzerne [Last accessed 24 February 2016]
168 This report is stored in the archives of the Federal Ministry for Nuclear Energy and Water Power (1957), Federal Archives, B 138/2754.

2.1.3 Phase three: The debate surrounding the energy gap

The onset of more objectivity from a financial and energy policy perspective led to a change in the financial situation in the form of state funding and justification for the use of nuclear power as a source of energy.

Due to a purportedly imminent energy shortage that ‘threatens to significantly impede economic progress’, the EURATOM report published by the ‘three wise men’ – Louis Armand, Franz Etzel and Francesco Giordani – on 4 May 1957 called for an expansion of nuclear power generation. The European Atomic Energy Community merely stated that nuclear energy would constitute an abundant and inexpensive source of energy.[169]

The close links between the state and nuclear scientists in the 1960s were key to developing nuclear technology and the reason for extensive state funding of research programmes. State sureties in the event of loss and risk sharing schemes were put in place to safeguard the investments. However, at that time a lot of scientists were proponents of solar, wind and hydroelectric power. RWE management board member Heinrich Schöller stated that only such eternal sources of energy[170] would be sufficient to meet increasing energy needs as they are the cleanest, safest and most elegant way to generate electricity.

The ‘energy gap’ was thus the third fundamental reason in favour of nuclear power. Proponents demanded ‘*fuel self-sufficiency*’. The ‘RWE-operated Kahl experimental nuclear power plant[171] located in Karlstein am Main first fed nuclear power into the national grid in June 1961. The first commercial nuclear power plant, a 250-megawatt boiling water reactor, was built in Gundremmingen in Bavaria with significant state funding and went online on 12 November 1966.[172] Additional commercial nuclear power plants went into service in Lingen, Obrigheim and Stade in West Germany at the end of the 1960s. However, the first oil crisis in 1973 saw a major push for nuclear power along with calls to ‘end the oil dependency’, which were not followed through.

Block one of the nuclear power plant in Greifswald started providing electricity for the East German grid in 1975. Around 110 nuclear facilities, research reactors and nuclear power plants were in operation between 1957 (research reactor in Munich) and 2005 (training reactor in Dresden). As of the 1980s, no applications were submitted for new reactors. Neckarwestheim was the last nuclear power plant to be build in West Germany, and it went into operation in 1989.[173] The final new-build in East Germany, block five in Greifswald, also supplied

[169] Cf. Armand, Louis; Etzel Franz, Giordani; Francesco (1957): ‘A Target for Euratom’, report at the request of the governments of Belgium, France, German Federal Republic, Italy, Luxembourg and the Netherlands. http://core.ac.uk/download/files/213/7434607.pdf [Last accessed 24 February 2016]
[170] Cf. Schweer, Dieter; Thieme, Wolfgang (1998): ‘RWE. Der gläserne Riese: Ein Konzern wird transparent’, p. 182.
[171] Müller, Wolfgang D. (1990): ‘Geschichte der Kernenergie in der Bundesrepublik Deutschland: Anfänge und Weichenstellungen’, p. 442.
[172] According to Wolfgang D. Müller, construction of the plant cost 345 million German Marks. This amount consisted of a Euratom grant of 32 million German Marks, subsidised loans of 140 million German Marks, a state surety for additional third-party funding of up to 33 million German Marks, and a state guarantee to cover 90 per cent of any potential operating losses. Cf. Müller, Wolfgang D. (1990): ‘Geschichte der Kernenergie in der Bundesrepublik Deutschland: Anfänge und Weichenstellungen’, p. 369 f.
[173] Cooke, Stephanie (2010): ‘Atom. Die Geschichte des nuklearen Zeitalters’ (translation: In Mortal Hands: A Cautionary History of the Nuclear Age).

electricity to the grid for a short time in 1989 until a major accident occurred there.[174]

2.1.4 Phase four: Climate change and nuclear energy

The challenge mankind faces in the form of anthropogenic climate change due to a rapid increase in greenhouse gases, particularly carbon dioxide (CO_2), which became more prominent in the public eye during the second half of the 1980s did not change the German public's sustained critical view of nuclear energy. Even back then, climate researchers calculated that the Earth's temperature would rise by an average of around 2.5 degrees Celsius by the year 2100 if emissions levels were to continue as before.[175]

The Earth's climate is influenced by physical processes in the lower atmosphere as well as by the storage and transport of energy and substances, in particular carbon, in the ocean. It is also affected by changes to snow quantities and ice formation in the cryosphere, and by the biological and chemical quantity, composition and distribution of greenhouse gases. The increase in the amount of carbon in the troposphere, the term used to describe the lower atmosphere layer, is in fact attributable to burning fossil fuels, deforestation and intensive farming. This is closely linked to climate change as the release of CO_2 is the main cause and hence the main indicator of anthropogenic climate change.[176]

Nuclear energy supporters use the argument that its production is free of CO_2, although this only strictly applies to electricity generation. The GEMIS investigations into the entire process of using nuclear energy, including the construction of power plants, infrastructure, and mining and transporting the necessary raw materials, showed that nuclear energy does indeed lead to CO_2 emissions.[177] Either way, CO_2 emissions need to be reduced significantly in order to protect the Earth's climate. Achieving this, both efficiently and inexpensively remained a subject of substantial debate.

The Bundestag's study commission 'Protecting the Earth's Atmosphere' considered these issues during the 1980s and 1990s. In 1991, the commission devised the first greenhouse gas reduction scenarios that also included international relations.[178]

The commission used basic investigations and a comprehensive series of studies[179] to assess the extent to which nuclear energy can contribute towards climate protection and to ascertain whether other energy pathways are more efficient, less expensive and involve less risk.

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174 Cf. Müller, Wolfgang D. (2001): 'Geschichte der Kernenergie in der DDR', p. 205 f.
175 IPCC (1990): Drafts.
176 Cf. German Bundestag, study commission 'Protecting the Earth's Atmosphere' (1990), printed in 'Schutz der Erde', vol. II (1991), P. 139 ff.
177 German Bundestag, study commission 'Protecting the Earth's Atmosphere' (1990), printed in 'Schutz der Erde', vol. II (1991), p. 249.
178 German Bundestag, study commission 'Protecting the Earth's Atmosphere' (1991), 'Schutz der Erde', 2 volumes.
179 German Bundestag, study commission 'Protecting the Earth's Atmosphere' (1990), 'Energie und Klima', vol. 5, Kernenergie.

The assessment drew upon the FUSER (Future Stresses for Energy Resources) study from the World Energy Congress in Cannes in 1986[180] as well as the former scenarios provided by the IIASA (Institute for Applied Systems Analysis)[181] which envisaged a major expansion of nuclear energy. The FUSER study assumed that the world's population would grow to 7.8 billion by the year 2020 and 9.6 billion by the year 2060, which is slightly lower than the forecast provided by the Earth Summit in 1992.[182] Growth rates in the study performed in the last few years also remained somewhat lower than the actual growth rates.

The study categorised the different levels of national economic development into the ongoing commercial energy supply pathway, and assumed a global energy consumption increase of 0.3 per cent per capita per annum. Compared to 1984, nuclear energy was expected to see a twelve-fold increase in its share of total electricity production by 2060. Despite this and the associated drop in the amount of fossil fuels used for electricity production, CO_2 emissions were expected to more than double from 20.5 billion tonnes in 1986 to around 43 billion tonnes in 2060.[183] Other world energy scenarios came to a similar conclusion when projecting the long-term increase in energy consumption.

These nuclear energy studies led to a number of clashes. However, following intense discussions, the German Bundestag's climate commission unanimously agreed in 1988 that 'solutions which only seek to shift between existing energy sources rather than trying to replace energy with investment and technical knowledge (energy source/energy conservation) are highly unlikely to succeed. As this is both necessary and indispensable in order to overcome the problem (*of climate change – addendum by the Commission on the Storage of High-Level Radioactive Waste*), the Commission holds the opinion that energy conservation should be accorded priority.[184]

In 1990, the Commission proposed two reduction scenarios, 'energy policy' and 'nuclear phase-out', both of which focused mainly on increasing energy efficiency and energy conservation to reduce greenhouse gas emissions by 33 per cent between 1990 and 2005 by bringing about behavioural changes, overcoming barriers, promoting innovation and modernising the energy system. This did not include the former GDR. The proposals focused on increasing efficiency. The Commission used a number of studies to determine that savings of over 40 per cent could be made in terms of electricity, heat and mobility. However, the development and expansion of renewable energy sources were met with greater scepticism than the developments seen over the last twenty years.[185]The third reduction scenario put forward, 'expansion of nuclear energy', was not supported by a single member of the study commission at that time.

[180] World Energy Conference (1986): Frisch, J.-R. et al.: 'Future Stresses for Energy Resources. Energy Abundance; Myth or Reality?'
[181] International Institute for Applied Systems Analysis (1981 ff.): Energy Systems Group: 'Energy in a Finite World'.
[182] Hauff, Volker (1987): 'Unsere Gemeinsame Zukunft' (translation: Our Common Future), p. 101 ff.
[183] German Bundestag, study commission 'Protecting the Earth's Atmosphere' (1988), 'Schutz der Erdatmosphäre. Eine internationale Herausforderung', Bonn/Karlsruhe, pp. 481-482.
[184] German Bundestag (1988): study commission 'Precautions for Protecting the Earth's atmosphere'. First interim report, Bundestag Printed Paper 11/3246, p. 483.
[185] German Bundestag, study commission 'Protecting the Earth's Atmosphere' (1990), 'Energie und Klima', vol. 5, Kernenergie. pp. 38-119.

2.1.5 Phase five: Phase-out of nuclear energy

Light water reactor technology took off in West Germany in the 1960s and the first half of the 1970s. However, this situation changed with demonstrations being held against the construction of a nuclear power plant in the Kaiserstuhl hills of Baden-Württemberg that was due to have a net output of 1,300 MW. Plans to build this new plant in Wyhl were announced on 19 July 1973, and they promptly led to widespread protest. Several court rulings were issued, some decreeing that construction be halted while others granted permission to continue with the building work. This continued until 1983 when Baden-Württemberg's Minister President, Lothar Späth, surprisingly announced that construction did not need to start before 1993. A few years later, in 1987, he followed this up with another announcement that construction did not need to start before 2000. However, in 1995 the construction site was declared a nature reserve.[186]

Opposition to the Wyhl nuclear power plant had a major impact on other plants in Germany, particularly on those in Brokdorf, Grohnde and Kalkar. During the second half of the 1970s, support for nuclear energy started to dwindle. On 13 January 1977, the prevalent wintery conditions had an unexpected impact on the national energy supply. The power lines to the Gundremmingen nuclear power plant snapped due to the weight of the ice that had formed on them. Reactor A did in fact shut down, although this was not enough to prevent an accident resulting in the plant being a complete economic write-off.

The meltdown accident in block two of the Three Mile Island Nuclear Generating Station in Harrisburg in the US on 28 March 1979[187] and, above all, the nuclear disaster in Chernobyl on 26 April 1986 served to further fuel protests.[188]

In 1980, The Greens political party emerged as a result of protests surrounding the environmental and anti-nuclear movement. The first active reaction from the Federal Government occurred in 1975 when it set up a 'Nuclear Energy Community Dialogue' for the public to discuss the pros and cons of nuclear energy. As was the case with the other Bundestag parliamentary groups, the coalition between the Social Democratic Party of Germany (SPD) and the Free Democratic Party (FDP) supported nuclear energy and attributed the increasing public resistance to a lack of knowledge on the subject. The balancing act between having faith in progress and pacifying society was not working as decisions were being put off to a later date. In the wake of the serious accident in Harrisburg, the once extra-parliamentary opposition also started to gain influence in parliament. The Greens, who called for the phasing-out of nuclear power, entered the German Bundestag for the first time in 1983. From 1983 onwards, only the reactors in Germany that were under construction at that time were completed, meaning that no new reactors were approved for construction.

After a brief phase of apparent tranquillity, block four at the Chernobyl nuclear power plant suffered a core meltdown in 1986.[189]The government headed by

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[186] Cf. Engels, Jens Ivo (2003): 'Geschichte und Heimat. Der Widerstand gegen das Kernkraftwerk Wyhl', Kretschmer, Kerstin (Hrsg.), 'Wahrnehmung, Bewusstsein, Identifikation. Umweltprobleme und Umweltschutz als Triebfedern regionaler Entwicklung', pp. 103-130.
[187] Cf. Jungk, Robert (Hrsg.) (1979): 'Der Störfall von Harrisburg'.
[188] Cf. International Atomic Energy Agency (1992): 'The Chernobyl accident'.
[189] Cf. International Atomic Energy Agency (1992): 'The Chernobyl accident'.

Helmut Kohl reacted to this extremely serious accident by forming the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.[190]

The opposition, the Social Democratic Party of Germany (SPD), demanded the phase-out of nuclear energy within ten years.[191] In 1990, the former head of the VEBA electricity company, Klaus Piltz, sounded out the question after reaching a consensus with political opponents and, for the first time, spoke openly about a potential end to nuclear energy. In the years that followed, the German government and the opposition held discussions aimed at reaching a consensus regarding energy. These discussions also involved representatives from trade unions, environmental associations, the electricity supply industry and other members of industry. A consensus was not reached, however.

When the Berlin Wall fell, the former GDR had four reactor blocks in operation in Lubmin (near Greifswald), along with one block undergoing trials and three blocks that were under construction. These were all Soviet-designed pressurised water reactors (WWER-440). Due to a number of safety issues, the four blocks in operation were decommissioned in 1990, while construction and trials of the other four blocks had already been halted in 1989. Dismantling of the plant started in 1995.

After their victory in the 1998 Bundestag election, the Social Democratic Party of Germany (SPD) and The Greens initiated negotiations with four nuclear power plant operators in Germany with regard to phasing out their plants. On 14 June 2000, the red-green coalition of the Social Democratic Party of Germany (SPD) and The Greens agreed with RWE, VIAG, VEBA and EnBW ‘to limit the future use of existing nuclear power plants.’ A ten-year exploration moratorium was also agreed for the planned disposal facility in Gorleben. The two parties intended to use this agreement to end the political and societal disputes surrounding nuclear energy. On the strict basis of this agreement, the German Bundestag with the former majority of the Social Democratic Party of Germany (SPD) and The Greens passed the ‘Act on the Structured Phase-out of Nuclear Energy for the Commercial Generation of Electricity’ on 22 April 2002 to limit the operating period of nuclear power plants in Germany.[192]This Act stipulated that nuclear power plants can only produce electricity equating to a maximum of 32 operating years. This therefore imposes a limit on the amount of electricity that nuclear power plants are still permitted to generate, which also indirectly limits their remaining operating life.

Following the Bundestag election in 2009, the new majority consisting of the Christian Democratic Union (CDU) and the Free Democratic Party (FDP) agreed to prolong the operating life of nuclear power plants[193] in Germany on 28 October 2010, but this decision was rescinded shortly afterwards due to the nuclear disaster that occurred in Fukushima in Japan on 11 March 2011.

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[190] The Federal Ministry for the Environment was formed in 1986. The first minister for the environment was Walter Wallmann (CDU), who was succeeded eight months later by Klaus Töpfer.

[191] Cf. Social Democratic Party of Germany (SPD) (1986), decisions taken by the party congress, 26 August 1986, agreement between the Federal Government and energy supply companies, 14 June 2000, p. 3. ; http://www.bmub.bund.de/fileadmin/bmu-import/files/pdfs/allgemein/application/pdf/atomkonsens.pdf [Last accessed 24 February 2016]

[192] Act on the Structured Phase-out of Nuclear Energy for the Commercial Generation of Electricity, Federal Law Gazette (2002) I, p. 1351.

[193] German Bundestag (2010), Eleventh and Twelfth Act to Amend the Atomic Energy Act (Printed Papers 17/3051 and 17/3052).

After over 60 years of nuclear energy, the political parties in Germany reached a general consensus to stop using nuclear power to generate electricity. However, the final chapter of nuclear energy is yet to be written as there is currently no solution to safely store radioactive waste.

2.2 Radioactive waste management

Once spent, the fuel elements used at nuclear power plants represent the most intensive form of radioactive waste. The high-level radioactive waste only constitutes less than ten per cent of all radioactive waste, yet they contain over 99 per cent of total radioactivity.

This is compounded by radioactive waste in connection with dismantling nuclear power plants, which leads to around 5,000 cubic metres of low-heat-generating radioactive waste per dismantled plant.[194] Of the 29 nuclear power plants and seven experimental or demonstration reactors that went into commission in Germany, only eight are yet to be decommissioned. Nevertheless, only three experimental or demonstration power plants have actually been dismantled so far.[195] Existing radioactive waste is generally attributable to the operation of nuclear power plants and nuclear energy research. Only smaller quantities of radioactive waste originate from other research institutions or from medicine. This is expected to remain the case to a small extent in the future.

As set out in the Atomic Energy Act, the polluter-pays principle requires the party responsible for causing radioactive waste to bear the costs of exploration, construction and maintenance of plants in order to ensure safe storage of the waste. To date, a plant has not been completed in Germany or anywhere else in the world that can safely store high-level radioactive waste until such time that its radioactivity has decayed.

However, a disposal facility for high-level radioactive waste was approved in Finland in November 2015. According to the operator, it will be ready to permanently store such waste from the 2020s. Technical procedures for a safe and permanent disposal for high-level radioactive waste that does not come into contact with the biosphere have been the subject of international investigation for decades with various potential disposal sites already under consideration. Nevertheless, such a disposal facility for high-level radioactive waste has not yet been commissioned. A number of countries do have disposal facilities for low and intermediate-level radioactive waste, however. The Konrad disposal facility in Germany has received plan approval for such waste.

The Federal Ministry for the Environment recently estimated that a total of around 27,000 cubic metres of high-level radioactive waste will need to be safely and permanently stored in Germany as a result of the nuclear phase-out.[196] As

[194] Cf. Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (2015): National Programme, p. 15.

[195] Cf. Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (2015): Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. Report by the Federal Republic of Germany for the fifth review conference in May 2015, p. 36.

[196] Cf. Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (2015): Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste

much as 600,000 cubic metres of low-heat-generating radioactive waste will also need to be disposed of. Based on this estimate, around 100,000 cubic metres of that waste is the result of uranium enrichment, while another 200,000 cubic metres can be attributed to the radioactive waste to be recovered from the Asse II mine which currently holds around 47,000 cubic metres of waste that can only be recovered together with the surrounding salt. An additional 37,000 cubic metres of low-heat-generating radioactive waste has already been deposited in the Morsleben disposal facility, which is currently being prepared for decommissioning.[197]

The legislature in Germany has repeatedly pointed out that only a national solution will be considered when it comes to the best-possible storage of radioactive waste. The Commission agrees with this view as it aligns with the polluter-pays principle of permanently storing in Germany the radioactive materials that were also produced in Germany. Disposal of such waste is a function of the state given the hazard it presents. ‘In order to guarantee that the radioactive waste, some of which is extremely long-lived, is safely sealed from the biosphere in the long term, it should generally be delivered to state facilities. Safekeeping and disposal of radioactive waste in (central) state facilities is required to counter dispersion which would not be controllable in the long term’,[198]was the justification provided in 1976 in the so-called disposal amendment to the Atomic Energy Act which governs disposal of radioactive waste and the state’s responsibility for doing so. At this time, the first German nuclear power plant, the Kahl experimental power plant, had been commissioned for 14 years.[199]

Management. Report by the Federal Republic of Germany for the fifth review conference in May 2015, p. 92.

[197] Cf. Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (2015): National Programme, pp. 11 and 18.

[198] German Bundestag, Draft of a Fourth Act to Amend the Atomic Energy Act. Printed Paper 7/4794, 24 February 1976, p. 8.

[199] Cf. Müller, Wolfgang D. (1990): ‘Geschichte der Kernenergie in der Bundesrepublik Deutschland, Anfänge und Weichenstellungen’, p. 443.

2.2.1 The search for disposal sites

To date, Germany has only named four disposal sites and conducted specific preparatory work for site selection procedures on several occasions without any decisions being taken afterwards.

The following sites were selected as disposal sites:

- The Asse II salt mine in Wolfenbüttel County, which the German Federation purchased on 12 March 1965 for use as a disposal facility.[200]

- The Bartensleben mine in Morsleben, which VEB Kernkraft Rheinsberg took over in July 1970 and was subsequently turned into the GDR's central disposal facility.[201]

- The Konrad iron ore mine in Salzgitter, which, after iron ore mining was halted on 30 September 1976, was kept open on behalf of the Federal Government so as to perform investigations into whether the mine would be suitable as a disposal facility[202] and, after a long licensing procedure, is now being redeveloped into a disposal facility for low-heat-generating waste.

- The Gorleben salt dome in Lüchow-Dannenberg County, which the Lower Saxony government designated as a site for a nuclear waste management centre including a disposal facility on 22 January 1977 and the Federal Government proposed as a site.[203] Geotechnical exploration of the salt dome to establish its suitability as a disposal facility was halted in January 2014 after the Site Selection Act came into force.

An initial comparative search for a nuclear disposal site in the Federal Republic of Germany failed in the years 1964 to 1966. A cavern for depositing waste was to be excavated close to the coast or on the lower course of the Elbe and then undergo trial operation. To this end, seven salt domes were compared. In the wake of protests held at the preferred site in Bunde am Dollart, the land owner demanded proof of the necessity and safety of the project.[204]

At the end of a long and difficult search for a disposal site, a prototype cavern was excavated in 1976 and 1977 at the Asse mine, which was already being used as a disposal facility. No more waste was emplaced in the cavern.[205]

From 1973, during the course of another comparative selection procedure, Kernbrennstoff-Wiederaufarbeitungs-Gesellschaft mbH (KEWA) started looking for a site for a nuclear waste management centre on behalf of the Federal

[200] Cf. State Parliament (Landtag) of Lower Saxony. 'Bericht 21. Parlamentarischer Untersuchungsausschuss'. Printed Paper 16/5300, 18 October 2012, p. 5.
[201] Cf. Beyer, Falk (2005): 'Die (DDR-) Geschichte des Atommüll-Endlagers Morsleben'.
[202] Rösel, Hennig: 'Das Endlagerprojekt Konrad', in Röthemeyer, Helmut (1991): 'Endlagerung radioaktiver Abfälle', p. 65.
[203] Cf. German Bundestag, report by the first committee of inquiry during the 17th legislative period. Printed Paper 17/13700, 23 May 2013, p. 93.
[204] Cf. Tiggemann, Anselm (2004): 'Die „Achillesferse“ der Kernenergie in der Bundesrepublik Deutschland: Zur Kernenergiekontroverse und Geschichte der nuklearen Entsorgung von den Anfängen bis Gorleben 1955 bis 1985', p. 159 ff.
[205] Cf. Tiggemann, Anselm (2004): 'Die „Achillesferse“ der Kernenergie in der Bundesrepublik Deutschland: Zur Kernenergiekontroverse und Geschichte der nuklearen Entsorgung von den Anfängen bis Gorleben 1955 bis 1985', p. 162 ff.

Ministry of Research and Technology which, among other things, should consist of a reprocessing plant and a nuclear disposal facility.[206]

The resulting analyses of three potential sites in Lower Saxony that had been initiated based on expert recommendations were halted in the middle of August 1976.[207] Instead, the Lower Saxony government designated the area above the Gorleben salt dome for use as a nuclear waste management centre at the start of February 1977.

The Committee on a Site Selection Procedure for Repository Sites (AkEnd), which was established by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety in February 1999, was also tasked with putting together a comparative site selection procedure. The Committee consists of 14 experts and scientists who were commissioned 'to develop a transparent and understandable procedure to identify and select a site for the disposal of all types of radioactive waste in Germany.[208] In December 2002, the Committee issued a recommendation to build a disposal facility ensuring long-term safety at a site 'identified as being the best site, relatively speaking, based on a series of criteria within the scope of a selection procedure.[209] This recommendation was not initially implemented. It was not until the Draft Site Selection Act formulated 'on the basis of, in particular, the results of the Committee on a Site Selection Procedure for Repository Sites initiated by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety in 1999',[210] which also envisaged the formation of the Commission on the Storage of High-Level Radioactive Waste, was passed by the Bundestag and Bundesrat in 2013.

The four selected German sites produced different results: Exploration of the Gorleben salt dome started in 1979 and was met with major protests that led to exploration being halted on several occasions before it was eventually terminated. The new site selection procedure being prepared by the Commission on the Storage of High-Level Radioactive Waste will assess the salt dome and treat it like any other area in Germany.

The Asse mine, in which waste was disposed of between 1967 and 1978, is now considered a contaminated site and the radioactive waste stored there must be retrieved.

The Morsleben disposal facility built in Sachsen-Anhalt when eastern Germany was still in the GDR was used to store radioactive waste between 1978 and 1998. It is currently being decommissioned at great expense and effort. Konrad, the former iron ore mine in Salzgitter, is being redesigned as a disposal facility and is scheduled to start storing low and intermediate-level waste from the beginning of the 2020s.[211]

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[206] Cf. German Bundestag, report by the first committee of inquiry during the 17th legislative period. Printed Paper 17/13700, 23 May 2013, p. 68.

[207] Cf. German Bundestag, report by the first committee of inquiry during the 17th legislative period. Printed Paper 17/13700, 23 May 2013, p. 71.

[208] The Committee on a Site Selection Procedure for Repository Sites (2002). Recommendations of the Committee on a Selection Procedure for Repository Sites (AkEnd), K-MAT 1, p. 7.

[209] The Committee on a Site Selection Procedure for Repository Sites (2002), Recommendations of the Committee on a Selection Procedure for Repository Sites (AkEnd), K-MAT 1, P. 1.

[210] German Bundestag, Draft Site Selection Act (StandAG), Printed Paper 17/13833, 10 June 2013, p. 2.

[211] An overview of the Asse mine as well as the Morsleben and Konrad repositories are available in section B 4.1 of the present report 'National experiences with disposal projects'.

When looking back at previous disposal site decisions, the circumstances or approaches that prevented or called into question the legitimacy of these once-contentious decisions are of particular interest to the Commission on the Storage of High-Level Radioactive Waste. Actions or decisions taken by actors who, decades ago, attempted to solve a difficult problem to the best of their abilities, should not be judged by today’s standards.

However, a review of decisions taken in the past may help to avoid any weak points that have since been identified so as to prevent errors from being made again.

2.2.2 Disposal of radioactive material

During the first few years of using nuclear power, the resulting radioactive waste was more of a side issue, even though a number of experts acknowledged at an early stage that it would in fact present a number of challenges. The first comprehensive German nuclear programme launched on 9 December 1957 established that extensive development work is required in terms of radiation protection: ‘Such work must, above all, also include the safe disposal or recycling of radioactive waste and the documentation of radioactive contamination.[212]The programme’s cost budget only designated funds for a single fuel element processing plant.[213]

Soon after its founding in 1958, the Federal Institute for Ground Research, which was the precursor to the Federal Institute for Geosciences and Natural Resources, put forward initial suggestions as to how radioactive waste could be disposed of in deep rock formations. Over the following two years, it conducted an initial study into the geological/hydrological preconditions for disposal of radioactive waste. In July 1961, working group four of the German Nuclear Commission established that only underground geological strata were feasible for long-term storage of radioactive waste. ‘Salt domes and disused salt mines appear to be highly suitable’ is the phrase used in the minutes of the meeting.[214]The working group published a recommendation in January 1962 that also contained the phrase.[215] Alongside this, in September 1961, the Federal Institute for Ground Research was commissioned to produce a report on the geological preconditions for long-term underground storage as part of a research project.[216]

One year later, as part of this project, the former Federal Ministry for Nuclear Energy also commissioned the Federal Institute to prepare a report on the disposal of low to intermediate-level waste in saliferous rock.

[212] Müller, Wolfgang D. (1990): ‘Geschichte der Kernenergie in der Bundesrepublik Deutschland, Anfänge und Weichenstellungen’, Annex 10 of the memorandum of the German Nuclear Commission, p. 681.
[213] Müller, Wolfgang D. (1990): ‘Geschichte der Kernenergie in der Bundesrepublik Deutschland, Anfänge und Weichenstellungen’, Annex 10 of the memorandum of the German Nuclear Commission, p.683 f.
[214] Summary of the minutes of the meeting of working group four of the German Nuclear Commission of 7 July 1961. Quote from Möller, Detlev (2009): ‘Endlagerung radioaktiver Abfälle in der Bundesrepublik Deutschland’, p. 96.
[215] State Parliament (Landtag) of Lower Saxony, ‘Bericht 21. Parlamentarischer Untersuchungsausschuss’. Printed Paper 16/5300, 18 October 2012, p. 38.
[216] Cf. Möller, Detlev (2009): ‘Endlagerung radioaktiver Abfälle in der Bundesrepublik Deutschland’, p. 99 f.

The report, which the Federal Institute submitted to the newly renamed 'Federal Ministry of Scientific Research' in May 1963, provided 'several options to accommodate large quantities of radioactive waste.[217]

From a geological perspective, 'the Federal Republic of Germany is almost ideally suited to the secular[218] and safe storage of such substances, in particular due to the given salt formations', wrote the President of the Federal Institute, Hans Joachim Martini.[219] The report took into account 'only radioactive waste excluding nuclear fuel'.

However, the author held the opinion that 'it is already clear today that high-activity waste – be it in solid, liquid or gaseous – can be secularly and safely stored underground in large quantities.[220]

In reference to investigations by the Nuclear Commission, the Federal Institute for Ground Research estimated that several thousand cubic metres of solid and other liquid radioactive waste not consisting of nuclear fuel would need to be dealt with each year.[221] This waste was incorrectly considered to be radioactive for just 500 to 1,000 years: 'The half-lives are such that it can be assumed that the level of activity within a period of 500 to 1,000 years will be practically zero.[222]

The report stated that the waste could be deposited in various geological formations, yet it still recommended disposal in a salt formation: 'Of all rock types, salt shall be preferred as it exhibits a certain degree of plasticity under loads of a certain magnitude. Saliferous rock has no pore space or fractures worthy of mention. It is far more dense than any other type of stone, and it is practically impervious to water and gas.[223] It therefore offers 'extremely favourable preconditions for the disposal of radioactive substances.[224] The expert assessment discussed the storage of waste in excavated caverns or existing mines, and did not consider it necessary to excavate new mines purely for disposal purposes.[225] Large quantities of salt water are produced when excavating caverns.[226]

In contrast to this, mine workings could also be used to store bulky waste while also providing the opportunity to monitor deposited waste. The Federal Institute arrived at the following opinion at that time: 'Disused mines in which active

[217] Federal Institute for Ground Research (1963), 'Bericht zur Frage der Möglichkeiten der Endlagerung radioaktiver Abfälle im Untergrund', 15 May 1963, p. 23.
[218] Here, secular means occurring once in an age or century, as derived from the Latin word 'saecularis', meaning century.
[219] Federal Institute for Ground Research (1963), 'Bericht zur Frage der Möglichkeiten der Endlagerung radioaktiver Abfälle im Untergrund', 15 May 1963, p. 23.
[220] Federal Institute for Ground Research (1963), 'Bericht zur Frage der Möglichkeiten der Endlagerung radioaktiver Abfälle im Untergrund', 15 May 1963, p. 2.
[221] Federal Institute for Ground Research (1963), 'Bericht zur Frage der Möglichkeiten der Endlagerung radioaktiver Abfälle im Untergrund', 15 May 1963, p. 3.
[222] Federal Institute for Ground Research (1963), 'Bericht zur Frage der Möglichkeiten der Endlagerung radioaktiver Abfälle im Untergrund', 15 May 1963, p. 3.
[223] Federal Institute for Ground Research (1963), 'Bericht zur Frage der Möglichkeiten der Endlagerung radioaktiver Abfälle im Untergrund', 15 May 1963, p. 10.
[224] Federal Institute for Ground Research (1963), 'Bericht zur Frage der Möglichkeiten der Endlagerung radioaktiver Abfälle im Untergrund', 15 May 1963, p. 10.
[225] Cf. Federal Institute for Ground Research (1963), 'Bericht zur Frage der Möglichkeiten der Endlagerung radioaktiver Abfälle im Untergrund', 15 May 1963, p. 20 et seq.
[226] Cf. Federal Institute for Ground Research (1963), 'Bericht zur Frage der Möglichkeiten der Endlagerung radioaktiver Abfälle im Untergrund', 15 May 1963, p. 22.

mining operations are not to be expected in the future are even better suited as a disposal facility.[227] One such example is the Asse II mine.[228]

The Federal Institute's first report, which focused on the feasibility of the Asse mine as a disposal facility, was unable to exclude the possibility of 'flooding' during deep repository operation as fissures could occur in the old underground chambers.[229] It was in fact the subsequent operator of the experimental disposal facility who declared water ingress as being extremely unlikely.[230]

Since that time, existing disused mines have no longer been taken into consideration as potential disposal sites. Even the nuclear waste management centre planned in the 1970s was to be built above an 'undisturbed salt dome[231] which was designated for emplacement of all types of radioactive waste. The 'safety criteria for the disposal of radioactive waste in a mine' presented by the Reactor Safety Commission in 1982 provided guidelines for the exploration of a site as well as for the construction and operation of a deep repository.[232] These criteria should also apply to storage of all types of radioactive waste.

The German institutions' decision to store waste in deep salt formations also represented a rejection of the near-surface deposition typical in other countries and once-common practice of dumping radioactive waste at sea. In the period that followed, Germany disposed of 480 barrels of waste in the Atlantic Ocean in 1967 as part of the contentious and subsequently banned depositing of radioactive waste at sea, meaning that Germany only made a minor contribution to the total amount of radioactive waste deposited at sea.[233] Working group four of the Nuclear Commission rejected disposal on the surface due to the high population density, the potential risk to groundwater, and due to the lack of geologically suitable areas in Germany[234] .Long-time storage of radioactive waste in salt formations was also considered to be less expensive than surface storage in bunkers or halls.[235]

In December 1963, the German Nuclear Commission recommended that a survey be performed on the Asse salt mine to determine its suitability as a disposal facility for low and intermediate-level radioactive waste, and to also create a cavern disposal facility. The stipulation of Asse as a site did not involve the public or any affected local and regional authorities, but broad public participation was uncommon at that time.

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[227] Federal Institute for Ground Research (1963), 'Bericht zur Frage der Möglichkeiten der Endlagerung radioaktiver Abfälle im Untergrund', 15 May 1963, p. 21.
[228] Federal Institute for Ground Research (1963), 'Bericht zur Frage der Möglichkeiten der Endlagerung radioaktiver Abfälle im Untergrund', 15 May 1963, p. 21.
[229] Cf. Federal Institute for Ground Research (1963), 'Geologisches Gutachten über die Verwendbarkeit der Grubenräume des Steinsalzbergwerkes Asse II für die Endlagerung radioaktiver Abfälle', p. 20 f.
[230] Cf. Asse GmbH (2009): 'Zur Rolle der Wissenschaft bei der Einlagerung radioaktiver Abfälle in der Schachtanlage Asse II', p. 13.
[231] Cf. German Bundestag, 'Bericht der Bundesregierung zur Situation der Entsorgung der Kernkraftwerke' in the Federal Republic of Germany (disposal report). Printed Paper 8/1288, 30 November 1977, p. 28.
[232] Recommendation of the Reactor Safety Commission at its 178th meeting on 15 September 1982: 'Sicherheitskriterien für die Endlagerung radioaktiver Abfälle in einem Bergwerk', Federal Gazette, 5 January 1983.
[233] Cf. International Atomic Energy Agency (1999): 'Inventory of radioactive waste disposals at sea', IAEA-TECDOC-1105, pp. 13 and 35.
[234] Cf. Möller, Detlev (2009): 'Endlagerung radioaktiver Abfälle in der Bundesrepublik Deutschland', p. 96.
[235] Cf. Möller, Detlev (2009): Endlagerung radioaktiver Abfälle in der Bundesrepublik Deutschland, p. 88.

Responsible ministerial officials and the Federal Institute for Ground Research saw the planned decommissioning of the Asse II mine as an ideal opportunity to create an experimental disposal site and forge ahead with its construction.[236]

Emplacement of radioactive material in the former potash mine commenced on 4 April 1967, two years after the German Federation acquired the mine. These emplacements were considered to be a trial, with the entire mine workings given the name 'Asse experimental disposal facility.[237] However, it was in fact a pilot disposal facility for testing technical disposal methods and long-term deposition of radioactive waste. Despite its status as a pilot project, retrievability of the emplaced waste was not ensured.[238] This therefore makes it difficult and expensive to retrieve the emplaced low and intermediate-level radioactive waste. Retrieval was legally enacted in 2010 as the mine cannot be decommissioned in line with the safety requirements.

2.2.3 Societal conflicts surrounding sites

Conflicts surrounding the Asse deep repository and the Morsleben disposal facility (which was built during the GDR period) largely came about as a result of decommissioning plans. Other plans to dispose of radioactive waste were immediately opposed by the anti-nuclear movement that arose in former West Germany during the mid-1970s. The anti-nuclear movement protests against the planned construction of the Wyhl nuclear power plant in the Kaiserstuhl hills of Baden-Württemberg in 1974 and 1975 were the first to make the headlines. Occupation of the nuclear power plant's construction site was seen as an example by other movements and groups to mobilise similar campaigns throughout the country. The plans for disposal facilities, including the long licencing procedure for the Konrad disposal facility currently under construction in Salzgitter in Lower Saxony, also led to demonstrations or protests. However, the plans to dispose of high-level radioactive waste proved to be most contentious.

The first German concepts put forward to deal with high-level radioactive waste focused on the reprocessing of spent fuel elements.

The so-called integrated disposal concept the Federal Ministry of Research and Technology presented in 1974 stated that 'reprocessing, fissile material recycling, waste treatment and storage should be bundled into an integrated system.[239]This concept also planned for immediate disposal of low and intermediate-level waste at the reprocessing plant site.[240]

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[236] Cf. Tiggemann, Anselm (2004): 'Die „Achillesferse" der Kernenergie in der Bundesrepublik Deutschland: Zur Kernenergiekontroverse und Geschichte der nuklearen Entsorgung von den Anfängen bis Gorleben 1955 bis 1985', p. 142.

[237] Cf. German Bundestag, Response of the Federal Government to the 'large question' submitted by, among others, member of parliament Paul Laufs and the Christian Democratic Union/Christian Social Union (CDU/CSU) parliamentary group, responsibility of the German Federation to ensure and provide disposal of radioactive waste
in the Federal Republic of Germany. Printed Paper 9/1231, 22 December 1981, p. 1.

[238] Cf. Kühn, Klaus (1976): 'Zur Endlagerung radioaktiver Abfälle: Stand, Ziele und Alternativen', Atomwirtschaft, vol. 21, no. 7, p. 356.

[239] Schmidt-Küster, Wolf-Jürgen (1974): 'Das Entsorgungssystem im Nuklearen Brennstoffkreislauf', Atomwirtschaft, vol. 19, no. 7. p. 340.

[240] Cf. Schmidt-Küster, Wolf-Jürgen (1974), 'Das Entsorgungssystem im Nuklearen Brennstoffkreislauf', Atomwirtschaft, vol. 19, no. 7, p. 342.

In keeping with the nuclear fuel cycle at that time, reprocessing was to involve separation of the plutonium and uranium present in spent fuel elements to enable sufficient decontamination and hence 'recycling as nuclear fuels.[241] Only the other materials left over from reprocessing were earmarked for disposal. As a result of this concept, the disposal amendment to the Atomic Energy Act in 1976 accorded priority to the reprocessing of spent fuel elements instead of simply subjecting them to disposal.[242]

Attempts to implement this concept led to major protests and fierce disputes. The Karlsruhe reprocessing plant, which was designed as a pilot plant for subsequent commercial use, was the only plant in Germany to actually follow through on the concept by processing just over 200 tonnes of nuclear fuel between 1971 and 1990. Construction of a commercial reprocessing plant in Wackersdorf in Bavaria finally ended following a series of protests by anti-nuclear campaigners in 1989 and due to the fact that nuclear power plant operators opted for less expensive reprocessing abroad.[243] An amendment to the Atomic Energy Act in 1994 also permitted the direct disposal of spent fuel elements,[244] while the Nuclear Phase-out Act passed by the German Bundestag in 2001 only permitted the delivery of spent fuel elements to other countries for reprocessing until mid-2005.[245]

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[241] Schmidt-Küster, Wolf-Jürgen (1974): 'Das Entsorgungssystem im Nuklearen Brennstoffkreislauf', Atomwirtschaft, vol. 19, no. 7, p. 343.
[242] German Bundestag. Draft of a Fourth Act to Amend the Atomic Energy Act. Printed Paper 7/4794, 24 February 1976, p. 4.
[243] Cf. Der Spiegel magazine, 16/1989. Interview with the VEBA CEO, Rudolf von Bennigsen-Foerder:http://www.spiegel.de/spiegel/print/d-13494469.html [Last accessed 24 February 2016]
[244] Cf. German Bundestag, Federal Government Draft Act. Draft Act on Safeguarding the Use of Black Coal for Electricity Generation, and Amending the Atomic Energy Act. Printed Paper 12/6908, 25 February 1994.
[245] Cf. German Bundestag, Draft Act tabled by the parliamentary groups of the Christian Democratic Union/Christian Social Union (CDU/CSU), Social Democratic Party of Germany (SPD) and Alliance 90/The Greens. Draft Act on the Structured Phase-out of Nuclear Energy for the Commercial Generation of Electricity. Printed Paper 14/6890, 11 September 2001.

Reprocessing summary

Reprocessing was originally intended to enable nuclear fuels to be recycled and reused from spent fuel elements.

However, only a small proportion of the heavy metal separated from German fuel elements during reprocessing was actually re-used as a fuel. In doing so, the reprocessed uranium that makes up 99 per cent of the heavy metal in spent fuel elements generally had to be mixed with Russian uranium from nuclear weapons production.

Up until the export ban on spent fuel elements in 2005, German nuclear power plant operators delivered spent fuel rods with a total heavy metal content of 6,077 tonnes to the La Hague reprocessing plant in France and the Sellafield reprocessing plant in Great Britain.[246]

In Germany, 208 tonnes of heavy metal had already been dissolved from spent fuel elements at the Karlsruhe reprocessing plant so that the uranium and plutonium could then be separated. When combined, the plant in Karlsruhe and the plants in France and Great Britain separated a total of 5,980 tonnes of uranium and 61.8 tonnes of plutonium from reprocessing German fuel elements.[247]

All of the separated plutonium has since been used in mixed-oxide fuel elements. 97 per cent of those fuel elements were used in German nuclear power plants by the end of 2014. The remaining mixed-oxide fuel elements are to be sent to the Brokdorf, Emsland and Isar 2 nuclear power plants by the end of 2016 at the latest.[248]

However, only a seventh of the separated uranium was reused as new fuel elements for German reactors. Rediluted, highly-enriched uranium resulting from Russian nuclear weapons production or disarmament was generally added to the reprocessed uranium in order to achieve the composition required for reactor use.[249]

Until 1987, only nine fuel elements containing a total of 3.1 tonnes of enriched reprocessed uranium were sent to German reactors.[250] *Compared to processing natural uranium, renewed processing of uranium from reprocessing proved to be inefficient, in part due to impurities or other unwanted disruptive isotopes in the reprocessed uranium.*[251]

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[246] Cf. Information supplied by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016. p. 7.
[247] Cf. Information supplied by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016. p. 7.
[248] Cf. Information supplied by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016. p. 7.
[249] The German Atomic Forum considered the use of Russian-produced fuel elements in German reactors, which began in 2000 after a trial phase, to be ‘a major contribution to disarmament’. Press release of the German Atomic Forum, 2 March 2000. http://www.kernenergie.de/kernenergie-en/press/pressemitteilungen/2000/2000-03-02_Brennelemente.php [Last accessed 24 February 2016.]
[250] Cf. Gruppe Ökologie (1998), ‘Analyse der Entsorgungssituation in der Bundesrepublik Deutschland und Ableitung von Handlungsoptionen unter der Prämisse des Ausstiegs aus der Atomenergie’, p. 108 f.; Cf. also Janberg, Klaus, ‘Plutonium reprocessing, breeder reactors, and decades of debates. Bulletin of the Atomic Scientist 2015’, vol. 71, no. 4, p. 10 ff.
[251] Around 45,000 tonnes of uranium from reprocessing had accumulated worldwide as of the end of 2005. Cf. International Atomic Energy Agency (2009) Use of Reprocessed Uranium: ‘Challenges and Options. IAEA Nuclear Energy Series No. NF-

From the mid-1990s, Russia started producing fuel elements using a mixture of reprocessed German uranium and Russian uranium from nuclear weapons production.[252] *104 of these fuel elements were trialled at the Obrigheim and Neckarwestheim II nuclear power plants between 1995 and 2001.*[253] *2,130 of these fuel elements were subsequently delivered to German nuclear power plants between 2000 and 2015.*[254]

This means that a total of around 2,200 fuel elements containing reprocessed uranium were sent to German nuclear power plants[255] *In doing so, up to 800 tonnes of uranium from reprocessed German fuel elements were reused.*[256]

However, the operators of the German nuclear power plants either sold or gave most of the uranium separated during reprocessing to the operators of the reprocessing plants in La Hague and Sellafield. On 31 December 2014, the Sellafield reprocessing plant in Great Britain only had 26.8 tonnes of separated uranium still owned by Germany. In addition, the Federal Republic of Germany needed or still needs to take back 128 Castor casks containing high-level radioactive waste, plus another 157 containers holding vitrified or compacted intermediate-level radioactive waste.[257]

The former disposal concept also shaped the search for a site for a nuclear waste management centre, which ended in 1977 when the Federal Government approved the Gorleben site put forward by the State Government of Lower Saxony. From 1973, the Federal Government commissioned Kernbrennstoff-Wiederaufarbeitungs-Gesellschaft mbH (KEWA) to identify sites for a reprocessing plant. A salt dome at the given site ‘would lend particular weight in support of a site’s potential as a disposal facility.[258] KEWA adopted a systematic approach and conducted a large-scale survey based on a points system that led to the identification of 26 potential sites all over Germany.[259]

Eight sites were then surveyed in detail, with Gerd Lüttig, the Vice-President of the Federal Institute for Ground Research, and geologist Rudolf Wager both

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252 Cf. International Atomic Energy Agency (2007): ‘Use of Reprocessed Uranium. IAEA-Tecdoc-CD-1630’, including Baumgärtner, M.: ‘The use of reprocessed uranium in light water reactors: Problem identification and solution finding’.

253 Cf. International Atomic Energy Agency (2007): ‘Use of Reprocessed Uranium. IAEA-Tecdoc-CD-1630’, including Baumgärtner, M.: ‘The use of reprocessed uranium in light water reactors: Problem identification and solution finding’.

254 Cf. Information supplied by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016. p. 7.

255 Cf. Information supplied by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016. p. 7.

256 According to information supplied by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety to the Commission on the Storage of High-Level Radioactive Waste on 17 February 2016, 1,026 of the around 2,200 fuel elements had been delivered to Gundremmingen nuclear power plant. The fuel elements used at this boiling water reactor each contain 172 kilogrammes of uranium, which equates to almost 177 tonnes of heavy metal in 1,026 fuel elements. The remaining 1,180 fuel elements were used in light water reactors. Each fuel element used there contains 540 kilos of heavy metal, which equates to a total of 637 tonnes of heavy metal. When estimating the amount of uranium gained from reprocessing, the enriched Russian uranium mixed in must first be deducted from the 809 tonnes of heavy metal calculated by adding the above two figures together.

257 Cf. Information supplied by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016. p. 8.

258 KEWA GmbH (1974): ‘Ermittlung mehrerer alternativer Standorte in der Bundesrepublik Deutschland für eine industrielle Kernbrennstoff-Wiederaufarbeitungsanlange - Abschlussbericht’, p. 2.

259 Cf. KEWA GmbH (1974): ‘Ermittlung mehrerer alternativer Standorte in der Bundesrepublik Deutschland für eine industrielle Kernbrennstoff-Wiederaufarbeitungsanlange - Abschlussbericht’, p. 10 ff.

lending their geological expertise to the undertaking.[260] KEWA then proposed a work programme to the Federal Ministry of Research and Technology

T-4.4. p. 5; Regarding cost issues, cf. also: Hensing, Ingo and Schulz, Walter (1995): 'Simulation der Entsorgungskosten aus deutscher Sicht', *Atomwirtschaft*, vol. 40 (1995), pp. 97-102 that involved surveying the geology of the three salt domes deemed to be best suited to the intended purpose.[261]

KEWA's final report was published in 1974 and did not include the Gorleben site as one of the three or eight preferable sites, and not even as one of the 26 potential sites. In fact, KEWA did not mention Gorleben at all.[262]The surveys being conducted at the three sites shortlisted by KEWA – Wahn, Lichtenhorst and Lutterloh – were halted in August 1976 at the insistence of the Federal Ministry of Research and Technology. In order to produce a template for the state cabinet of Lower Saxony, a working group consisting of staff from several ministries performed a survey of the salt domes in Lower Saxony to determine whether the proposed 12 square kilometre site for the nuclear disposal centre could be accommodated above the domes.[263] The survey indicated that 23 of the salt domes were, in principle, suitable and were subsequently surveyed further to determine the size of their respective salt formation, their given depth, and a number of other criteria largely related to the potential effects that the surface nuclear waste management centre could have on the environment.[264]

Based on the decision taken by the cabinet, the Lower Saxony government specified Gorleben as the only potential site on 22 February 1977. The German Bundestag committee of inquiry involving government and opposition parties discussed the Gorleben site and remained at odds as to whether this was a scientifically justified decision or purely a political one.[265]

In July 1977, the Federal Government accepted the site proposal by Lower Saxony after initially expressing concerns about the site's safety and due to the

[260] Cf. KEWA GmbH (1974): 'Ermittlung mehrerer alternativer Standorte in der Bundesrepublik Deutschland für eine industrielle Kernbrennstoff-Wiederaufarbeitungsanlange - Abschlussbericht', Annex 3. Geological and hydrological site survey.

[261] KEWA GmbH (1974): 'Ermittlung mehrerer alternativer Standorte in der Bundesrepublik Deutschland für eine industrielle Kernbrennstoff-Wiederaufarbeitungsanlange - Abschlussbericht', p. 46.

[262] The German Bundestag committee of inquiry on the Gorleben site involving government and opposition parties remained at odds as to whether KEWA would provide a reassessment of the Gorleben site at the request of the Lower Saxony government. Cf. German Bundestag, recommendation and report from the first committee of inquiry pursuant to Article 44 of the German Basic Law (GG). Printed Paper 17/13700. pp. 72-76 and pp. 371-374.

[263] Cf. The Minister for the Economy, Labour and Transport of Lower Saxony (1977): 'Vorlage für die Kabinettssitzung am 14.12.76 betreffend Standort für ein Entsorgungszentrum', p.3; Cf. also State Parliament (Landtag) of Lower Saxony, eighth legislative period: 'Niederschrift über die 6. Sitzung des Ausschusses für Umweltfragen am 17. Oktober 1977', p. 22f; Cf. also German Bundestag: recommendation and report from the first committee of inquiry pursuant to Article 44 of the German Basic Law (GG). Printed Paper 17/13700, pp. 78 and 384.

[264] Cf. also German Bundestag: recommendation and report from the first committee of inquiry pursuant to Article 44 of the German Basic Law (GG). Printed Paper 17/13700, pp. 78 and 384.

[265] The Christian Democratic Union/Christian Social Union (CDU/CSU) and Free Democratic Party (FDP) parliamentary groups considered the choice 'exemplary and fully in line with the former state of the art in science and technology'; the Social Democratic Party of Germany (SPD) and Alliance 90/The Greens, on the other hand, stated that this was 'not a site selection procedure', but a decision taken 'for political reasons.' German Bundestag, recommendation and report from the first committee of inquiry pursuant to Article 44 of the German Basic Law (GG). Printed Paper 17/13700, pp. 258 and 424.

inner-German politics that would be involved in siting a reprocessing plant close to the former border with the GDR.[266]

The Lower Saxony government had promised to analyse the safety of the planned reprocessing plant as part of its site proposal procedure. Two years after the provisional selection of Gorleben as a site, a contentious hearing on the feasibility of a nuclear waste management centre in Gorleben from a safety perspective was held in Hanover at the end of March and beginning of April 1979.[267] This hearing took place at the same time as a serious accident at the Three Mile Island nuclear power plant in the USA and led to major protests against the proposals.

Ernst Albrecht, the Minister President for Lower Saxony, addressed the State Parliament (Landtag) in Hanover in May 1979 and stated that 'the political requirements for erecting a reprocessing plant are not present at this time[268] and recommended the Federal Government no longer pursue reprocessing but instead opting to build long-term interim storage facilities and performing drilling work at the Gorleben salt dome to evaluate its suitability as a disposal facility. The heads of the Federation and Länder agreed on new principles applicable to waste management provisions for nuclear power plants in September 1979. Instead of a nuclear waste management centre, the decision entailed interim storage facilities for spent fuel elements in Lower Saxony and North Rhine-Westphalia, along with swift exploration and a review of the Gorleben salt dome as well as other research and development work on reprocessing.[269]

The decision of 28 September 1979 was implemented by way of the construction of the fuel element storage facilities in Ahaus and Gorleben. This decision also provided for geological exploration of the Gorleben salt dome, which ended when the Site Selection Act came into force. However, this decision was unable to alleviate the conflicts surrounding disposal facilities, especially those in Gorleben. For several decades, anti-nuclear protestors from Lüchow-Dannenberg County organised demonstrations in their local area as well as in Hanover and Berlin where they protested against the construction of disposal facilities or them being supplied with radioactive waste. Commissioning of the Gorleben fuel element storage facility in April 1995 led to the protests becoming more widespread.[270] Opponents of the disposal facilities used the transports, which only occurred once per year due to the level of police protection required, as opportunities to step up their protests in favour of nuclear phase-out and to oppose the construction of a disposal facility at the Gorleben salt dome.

It was not until September 2009 that the Lower Saxony government released the available minutes and documentation produced by the Lower Saxony cabinet on

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[266] The Federal Chancellery was concerned about NATO having reservations about the plant. Cf. German Bundestag, recommendation and report from the first committee of inquiry pursuant to Article 44 of the German Basic Law (GG). Printed Paper 17/13700, pp. 95 and 408.

[267] Cf. Deutsches Atomforum (Hrsg.) (1979): 'Rede – Gegenrede. Symposium der niedersächsischen Landesregierung zur grundsätzlichen sicherheitstechnischen Realisierbarkeit eines integrierten nuklearen Entsorgungszentrums'.

[268] Statement by Minister President Ernst Albrecht of 16 May 1979.

[269] Cf. Federal Gazette, 19 March 1980: 'Bekanntmachung der Grundsätze zur Entsorgung für Kernkraftwerke, Anhang II Beschluss der Regierungschefs von Bund Ländern zur Entsorgung der Kernkraftwerke vom 28. September 1979'.

[270] Cf. the 'Gorlebenprotest' article in Wendland-Lexikon (2000), vol. 1 A – K. p. 252ff.

the provisional selection of the Gorleben site in the 1970s.[271] There is consensus within the Commission that the impending search for a site ensuring permanent storage of high-level radioactive waste with the best-possible safety must be subject to a transparent process with clearly defined criteria. There will not be any preliminary stipulation of a specific host rock.

In 1977, the Lower Saxony government looked for a waste management centre covering an area of 1,200 hectares, and excluded sites without any corresponding settled area. The disposal facilities planned in Gorleben from 1979 only covered an area of about 50 hectares.[272] The Site Selection Act, which came into force on 1 January 2014, rescinded the provisional site selection and selection of 1977. The Gorleben salt dome is no longer a disposal site. It could only become one again if a new site selection procedure shows that it is the site offering the best-possible safety for the permanent storage of high-level radioactive waste.

Citizens' initiatives often complained about a lack of community participation in terms of exploration of the Gorleben salt dome. This came about because exploration of the salt dome and construction of the exploratory mine were based on mining law, which does not require community participation. On top of that, the exploratory mine had to be built such that it would not conflict with the subsequent construction of a disposal facility. This also provoked accusations of the disposal facility already being a done deal without any public participation.

In contrast to this, the site search being prepared by the Commission already envisages community participation during each step of the selection process, i.e. well before underground exploration is performed at any of the potential sites.

A more common accusation regarding exploration of the Gorleben salt dome pertains to the treatment of critical scientists who offer differing opinions on the suitability or characteristics of the salt dome. This was also assessed very differently within the German Bundestag's Gorleben committee of inquiry. The Commission holds the view that various scientific opinions should be used to conduct productive discussions on the search for a site offering the best-possible safety. When doing so, representatives of the regions and community organisations must be able to consult scientists they trust and assign specific tasks for them to perform.

2.2.4 The end of radioactive waste production

When Germany ceases to use nuclear power for electricity generation no later than 31 December 2022, the production of high-level radioactive waste will also largely end.[273] Nuclear power plants account for most of the radioactive waste and will not be added to once the final plant shuts down. Once nuclear power generation ends, all of the radioactive waste attributable to electricity generation is already physically present, albeit not generally ready for emplacement in a disposal facility. The majority of the low-heat-generating waste will be present in shutdown reactors earmarked for decommissioning. The high-level radioactive waste are located in reactor cores to be emptied as well as in reactor cooling

[271] Cf. press release of the Lower Saxony State Chancellery, 23 September 2009.
[272] Cf. the 'Nuklearanlagen' article in Wendland-Lexikon (2008), vol. 2 L – Z. p. 192ff.
[273] Radioactive waste linked to nuclear energy will continue to accumulate due to uranium enrichment.

ponds and storage casks that are either on site or at central interim storage facilities.

Only industrial, medical and physical research applications will continue to produce much smaller quantities of radioactive waste once the nuclear power plants stop producing electricity. Radioactive waste linked to nuclear energy will only continue to accumulate in Germany within the scope of uranium enrichment in Gronau or the production of fuel elements in Lingen.

The Atomic Energy Act stipulates that the eight nuclear power plants still in operation in Germany on 30 June 2016 may only remain online until the following dates:[274]

Table 8: Maximum remaining operating lives of German nuclear power plants still in operation

Nuclear power plant	Shutdown	Difference to 30 June 2016 in years
Gundremmingen B	31 December 2017	1.5
Philippsburg 2	31 December 2019	3.5
Grohnde	31 December 2021	5.5
Gundremmingen C	31 December 2021	5.5
Brokdorf	31 December 2021	5.5
Isar 2	31 December 2022	6.5
Emsland	31 December 2022	6.5
Neckarwestheim II	31 December 2022	6.5

2.2.4.1 Low and intermediate-level radioactive waste

According to information provided by the Federal Ministry for the Environment, German nuclear power plants generate a long-term average conditioned volume of around 50 cubic metres of low or intermediate-level radioactive waste per year of operation.[275] If the calculated total remaining operating lives of 41 years are in fact reached, the nuclear power plants will generate up to 2,050 cubic metres of additional radioactive waste until the final reactors are shut down at the end of 2022. This would correspond to less than one per cent of the total licensed volume of 303,000 cubic metres of low and intermediate-level radioactive waste for the Konrad disposal facility. The quantity of waste resulting from the dismantling of nuclear power plants, which the Federal Ministry for the Environment estimates to be around 5,000 cubic metres per plant, is not expected to increase due to the limited continued operation of the eight reactors still online.

As of mid-2016, all the nuclear power plants in Germany had been in operation for a combined total of 722 years. During that time, they produced around 36,000

[274] Cf. Atomic Energy Act of 15 July 1985, Federal Law Gazette I, p. 1565, last amended by 307 of the Ordinance of 31 August 2015, Federal Law Gazette I, p. 1474, Section 7(1a)
[275] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: Information supplied to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p. 3.

cubic metres of conditioned low or intermediate-level radioactive waste.[276] The remaining operating periods of the eight nuclear power plants that remain online will increase this total volume by around six per cent. Dismantling all 36 nuclear power plants that were in operation in Germany will lead to an estimated total volume of some 180,000 cubic metres of low or intermediate-level radioactive waste. Around four-fifths of the low or intermediate-level radioactive waste generated by operating nuclear power plants will arise or have arisen due to dismantling nuclear power plants.

2.2.4.2 High-level radioactive waste

The production of high-level radioactive waste will almost completely cease after the nuclear phase-out. Between 1 July 2016 and the phase-out of the final reactors by the end of 2022, the eight nuclear power plants still in operation are expected to receive an estimated total of 850 tonnes of nuclear fuel in unspent fuel elements.[277] The remaining operational periods of these nuclear power plants will therefore increase the volume of high-level radioactive waste by this amount. All of the fuel elements placed in the reactors thus far have been irradiated, meaning that they will contain high-level radioactive waste when removed, irrespective of when that is. The spent fuel elements that will accumulate by the end of 2022 will contain around 850 tonnes of nuclear fuel, which equates to about five per cent of the total accumulated or yet to be accumulated quantity of high-level radioactive waste and estimated to contain around 17,000 tonnes of nuclear fuel in total.[278]

The up to 850 tonnes of nuclear fuel contained in fuel elements yet to be used in reactors constitute around eight per cent of the expected quantity of spent fuel elements with an estimated total of 10,500 tonnes of nuclear fuel designated for direct disposal in Germany.[279] This ratio does not take into account the radioactive waste resulting from reprocessing spent fuel elements from German reactors that are also to be emplaced in disposal facilities. In any case, the high-level radioactive waste set to accumulate in Germany by the end of 2022 will only have a minor impact on the volume of the insolating rock zone that must be present at a disposal site, particularly one for high-level radioactive waste.

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[276] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: Information supplied to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p. 3, information supplied there for 31 December 2015.

[277] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: Information supplied to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p. 2, estimate added to the information supplied there for 31 December 2014.

[278] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: Information supplied to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p. 2, estimate added to the information supplied there for 31 December 2014.

[279] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: Information supplied to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p. 2, estimate added to the information supplied there for 31 December 2014.

2.2.4.3 Waste resulting from research and federal state collecting depots

According to waste predictions from the Federal Office for Radiation Protection, around 300 to 350 cubic metres of low and intermediate-level radioactive waste is expected to accumulate each year after the phase-out of nuclear energy and its associated research institutions. Based on these forecasts, the Federal Office for Radiation Protection expects a total of 9,100 cubic metres of low and intermediate-level radioactive waste to accumulate from research and federal state collecting depots, i.e. from research, industry and medicine, between 2040 and 2070.[280] Based on around 300 cubic metres of such waste per year, it would take around 1,000 years to fill a disposal facility the size of the Konrad mine. The forecasts assume that there will be no unanticipated rise in the use of radioactive material in the fields of medicine, industry or research.

2.2.4.4 Waste resulting from uranium enrichment

Once all the nuclear power plants in Germany have been dismantled, the nuclear energy industry may continue to produce some radioactive waste due to uranium enrichment and, to a small extent, as a result of fuel element production. The enrichment facility at Gronau in North Rhine-Westphalia holds an open-ended operating licence. The production of a tonne of non-irradiated nuclear fuel results in between five and eight tonnes of depleted uranium, which can be subsequently emplaced in repositories as low-level radioactive waste. The Federal Ministry for the Environment has estimated that uranium enrichment will lead to up to 100,000 cubic metres of waste that will need to be deposited[281] if it cannot be recycled. When requested for comment, the Federal Ministry did not provide a period of time over which the up to 100,000 cubic metres of waste may accumulate.[282]

2.2.5 Need for action: Interim storage facil

The licences granted to store spent fuel elements and reprocessed waste in container storage or interim storage facilities at nuclear power plant premises are temporally limited and expire after 40 years. The storage licence for Gorleben interim storage facility, which currently holds 113 containers filled with high-level radioactive waste, will be the first to expire at the end of 2034.

It is foreseeable that the disposal site offering the best-possible safety will not have been determined by the time the first storage licences expire. According to the Site Selection Act, the disposal site should be stipulated in 2031[283] .Even if there are no delays in the incremental selection of a site offering the best-possible safety, enough time is required to grant a licence for the disposal facility at the determined site and to build the disposal facility itself. For this reason,

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280 Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: information supplied to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p. 7.

281 Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2015): National Programme, K-MAT 39. p. 11.

282 Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: information supplied to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p. 2.

283 See section B 5.6 of the present report for the required period of time proposed by the Commission.

transitional solutions are required in terms of storing high-level radioactive waste in interim storage facilities.

As well as licences for interim storage facilities and transport container facilities, permits for storing high-level radioactive waste in individual containers are each limited to a period of 40 years. The licence to store the 305 containers filled with waste from fuel elements from the former thorium high-temperature reactor in Hamm-Uentrop that are currently stored in the interim storage facility will expire in 2032. However, the licence for the entire Ahaus interim processing facility is valid until the end of 2036. For all of the other containers filled with high-level radioactive waste stored in interim storage facilities, the storage facility licence will expire sooner than the licence for the respective container. The table below provides an overview of the respective expiry dates for licences held by the interim storage facilities in Germany:

Table 9: High-level radioactive waste in German interim storage facilities
Current inventory, expected number of containers, and licence expiry date

Site	Current inventory	Future inventory	Total	Licence expires on[284]
	(Containers)	(Containers)	(Containers)	
Spent fuel elements held in on-site stores				
Biblis	51	51	102	18 May 2046
Brokdorf	26	49	75	5 March 2047
Brunsbüttel	9	10	19	5 February 2046
Emsland	32	55	87	10 December 2042
Grafenrheinfeld	21	34	55	27 February 2046
Grohnde	22	53	75	27 April 2046
Gundremmingen	42	142	184	25 August 2046
Isar	34	85	119	12 March 2047
Krümmel	19	22	41	14 November 2046
Neckarwestheim	44	69[285]	113	6 November 2046
Philippsburg	36	65	101	19 March 2047
Unterweser	16	22	38	18 June 2047
Spent fuel elements held in transport container storage facilities				
Gorleben	5	0	5	31 December 2034
Ahaus	329	0	329	31 December 2036
Zwischenlager Nord	69	0	69	31 December 2039
Jülich	152	0	152	30 June 2013

[284] This date applies to storage in the interim storage facility, not to storage in individual containers. Information provided by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. Information supplied to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016.

[285] Including 15 containers with 342 fuel elements from the nuclear power plant in Obrigheim.

Vitrified high and intermediate-level radioactive waste from reprocessing (glass canisters)				
Gorleben	108	0	108	31 December 2034
Zwischenlager Nord	5	0	5	31 December 2039
Biblis	0	7[286]	7	18 May 2046
Brokdorf	0	7	7	5 March 2047
Isar	0	7	7	12 March 2047
Philippsburg	0	5	5	19 March 2047
Compacted intermediate-level radioactive waste from reprocessing				
Ahaus	0	152	152	31 December 2036
Total	1,030	834[287]	1,864	

The table above includes containers filled with reprocessed waste yet to be returned to Germany, based on their allocation to the interim storage facilities as agreed by the Federal Ministry for the Environment and the nuclear power plant operators. For on-site stores, the 40-year licence limit applies from the time of putting the first container into storage. The respective licences to store high-level radioactive waste in transport container facilities in Ahaus, Gorleben and Zwischenlager Nord in Lubmin will expire 40 years after they are granted.

2.2.5.1 Special situations in interim storage facilities

The Commission has investigated the special situations involving the Experimental Nuclear Power Plant (AVR) container storage facility in Jülich and the on-site store in Brunsbüttel. The licence held by the Experimental Nuclear Power Plant (AVR) in Jülich to store 152 containers filled with fuel spheres from a former thorium high-temperature experimental reactor expired at the end of June 2013. On 2 July 2014, North Rhine-Westphalia demanded the immediate removal of these fuel spheres from the facility in Jülich.

The Commission on Storage of High-Level Radioactive Waste investigated the various options available to transport the fuel spheres away from the facility[288].This resulted in three options: first, the construction of a new interim storage facility in Jülich; second, transporting the 152 containers to the Ahaus interim storage facility; third, transporting the 152 containers to the US. The Commission was not tasked with providing a recommendation on the fuel

[286] Based on the concept to return vitrified waste from overseas reprocessing of 19 June 2015.
[287] Including 15 containers with 342 fuel elements from the nuclear power plant in Obrigheim.
[288] Garrelt Duin, the economic minister responsible for nuclear supervision in North Rhine-Westphalia and former member of the Commission, reported in the Commission. Cf. Ministry for Economic Affairs and Energy of North Rhine-Westphalia, investigation into the plausibility of the detailed concept by Forschungszentrum Jülich GmbH to remove nuclear fuel spheres from the Experimental Nuclear Power Plant (AVR) container storage facility - summary. http://www.mweimh.nrw.de/presse/_container_presse/Zusf-Plausibilitaetsgutachten.pdf [Last accessed 25 February 2016]

spheres stored in Jülich. However, it issued a decision 'advocating the statutory introduction of a general prohibition on the export of high-level radioactive waste.[289] The Commission called upon the Federal Government 'to draw up new provisions concerning a prohibition on the export of spent fuel elements from research reactors.[290] Such provisions must take into account binding aspects of non-proliferation and enablement of top-tier research.

Nine containers filled with spent fuel elements are currently being stored in the on-site store at the decommissioned nuclear power plant in Brunsbüttel based on an order set out in Section 19(3) of the German Atomic Energy Act.[291] A decision taken by the Federal Administrative Court on 8 January 2015 to prohibit an appeal against a lower court judgement[292] therefore upheld the Schleswig-Holstein Higher Administrative Court's decision on 18 June 2013 to revoke the Federal Office for Radiation Protection's licence for the interim storage facility.

Following notification of the Federal Administrative Court's decision, the Ministry for Energy Transition, Agriculture, Environment and Rural Areas of Schleswig-Holstein issued a 'temporary order to tolerate emplacement[293] of the nine containers with spent fuel elements in the interim storage facility. This order gave the operator, Vattenfall Europe Nuclear Energy, a period of three years to secure licensed storage of nuclear fuels in the interim storage facility. On 16 November 2015, Vattenfall Europe Nuclear Energy applied to the Federal Office for Radiation Protection for a new licence for the Brunsbüttel on-site store. In its decision issued in summer 2013, the Schleswig-Holstein Higher Administrative Court particularly admonished the fact that the licencing authority's licencing procedure failed to ascertain the potential effects of certain major terrorist attacks on the interim storage facility. However, the majority of the licencing authority's documentation on protection against terrorist attacks could not be presented to the court for reasons pertaining to secrecy and confidentiality.[294]

The revocation of the on-site store's licence had a knock-on effect on the pending return to Germany of 26 Castor casks containing reprocessed radioactive waste.[295] Before passing the Site Selection Act, the heads of the Federation and Länder agreed in June 2013 not to deliver any pending high-level radioactive waste from reprocessing to the Gorleben interim storage facility in Lower Saxony, but to send them to three other sites spread over three German Länder.[296] One of these sites was supposed to be the Brunsbüttel on-site store.

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[289] K-Drs. 131 (new), decision of the Commission, 2 October 2015.
[290] K-Drs. 131 (new), decision of the Commission, 2 October 2015.
[291] Atomic Energy Act of 15 July 1985, Federal Law Gazette I, p. 1565, last amended by 307 of the Ordinance of 31 August 2015, Federal Law Gazette I, p. 1474. In order to resolve the circumstances conflicting with the Atomic Energy Act, or to avoid any hazards from ionising radiation, Section 13(3) of the Act permits the supervisory authority to stipulate where radioactive materials are to be stored.
[292] Cf. Decision of the Federal Administrative Court, 8 January 2015, file / B 25.13.
[293] Press release from the Ministry for Energy Transition, Agriculture, Environment and Rural Areas of Schleswig-Holstein of 16 January 2015. http://www.schleswig-holstein.de/DE/Landesregierung/V/Presse/PI/2015/0115/MELUR_150116_Zwischenlager_Brunsbuettel.html. [Last accessed 25 February 2016]
[294] Cf. decision by the Higher Administrative Court of Schleswig-Holstein of 19 June 2013, file 4 KS 3/08.
[295] Cf. minutes of the 12th meeting of the 'Commission on the Storage of High-Level Radioactive Waste' on 18 May 2015 (publicly available section), p. 84.
[296] Cf. press release of the Federal Government, 5 July 2013 – way clear for Site Selection Act. https://www.bundesregierung.de/ContentArchiv/DE/Archiv17/Artikel/2013/06/2013-06-14-durchbruch-in-endlagerdiskussion.html [Last accessed 26 February 2013]

After the interim storage facility's licence was revoked, the Commission issued a decision in which it regretted 'the lack of additional options for interim storage of Castor casks containing reprocessed waste which Germany is obliged to take back from France and Great Britain.[297]These casks require 'emplacement licences that meet the requirements of the judgement of the Schleswig Higher Administrative Court on the Brunsbüttel interim storage facility.[298] The Commission called upon the Federation and Länder to swiftly find a way to store these containers in Germany.

At a later time, the Commission supported the 'overall concept for the return of vitrified radioactive waste from reprocessing in other European countries', submitted by Federal Minister for the Environment, Barbara Hendricks on 19 June 2015[299] after having agreed with the nuclear power plant operators the next steps to be taken on the issue. On 4 December 2015, the hitherto reluctant Bavarian government issued a joint statement with the Federal Ministry for the Environment in which it declared its willingness to 'assume co-responsibility' for the return of reprocessed waste.[300] Based on the Federal Ministry for the Environment's concept for the return of waste, the interim storage facilities at the Biblis, Brokdorf and Isar nuclear power plants should each accept seven containers filled with reprocessed radioactive waste, while the interim storage site in Philippsburg should take five.[301]

2.2.5.2 Potential conflicts of interest for interim storage

The Commission holds the view that emplacement of high-level radioactive waste at the intended site offering the best-possible safety could commence in 2050 if there are no unforeseen delays in the meantime.[302] However, the licences to store Castor casks at the Gorleben, Ahaus and Nord interim storage facilities will expire between 2034 and 2039, with the licence for the on-site stores due to expire between 2042 and 2047.

In order to close the temporal gap between expiry of the interim storage facility licences and availability of the disposal facility, the Federal Government's National Programme envisages the swift construction of a larger receiving storage facility at the disposal site: 'Along with the first partial construction licence for the disposal facility designed to hold, in particular, heat-generating radioactive waste, a storage facility is also to be approved at the site which will receive all spent fuel and reprocessed waste, thereby meeting the prerequisite for

[297] K-Drs. 94, decision taken at the 10th meeting held on 2 March 2015 - interim storage.
[298] K-Drs. 94, decision taken at the 10th meeting held on 2 March 2015 - interim storage.
[299] Cf. K-Drs. 115 (new), decision of the Commission, 3 October 2015. Statement on the 'overall concept for the return of vitrified radioactive waste from reprocessing'.
[300] Joint statement by the Bavarian government and the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) as the reason for additional discussions of 4 December 2015:
http://www.Bundesumweltministeriumb.bund.de/fileadmin/Daten_BM/Download_PDF/Nukleare_Sicherheit/castoren_ru eckfuehrung_bayern_erklaerung_signiert.pdf [Last accessed 26 February 2016]
[301] In slight deviation to the overall concept for the return of vitrified radioactive waste from reprocessing, information supplied by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p. 5.
[302] Cf. the recitals on time requirements in section B 5.6 of the present report.

starting to clear the existing storage facilities.[303] As the time between expiry of interim storage facility licences and commissioning of the disposal facility is yet to be determined, the National Programme must allow for a later decision as to whether all of the spent fuel elements and reprocessed waste are to be stored in the receiving storage facility simultaneously or consecutively, i.e. in an ongoing fashion.[304]
Either way, the limited interim storage facility licences mean that the search for a site offering the best-possible safety must be performed swiftly, but without any detriment to safety and community participation. **Conflicts of interest** are already foreseeable in terms of bridging the temporal gap between licensed interim storage and commencement of disposal:

- On the one hand, by issuing limited licences, the licencing authorities have made a pledge to local residents of interim storage facilities and to local authorities that the interim storage facilities do not end up becoming permanent. Dismantling of the nuclear power plants also fosters the need to empty their on-site interim storage facilities.
- Dismantling of the nuclear power plants' loading equipment would mean that there is no opportunity to repair transport containers or to move their contents from one container to another.
- (On the other hand, a concentration of the majority of the high-level radioactive waste in the receiving storage facility at the disposal site could subsequently impede the legitimacy of the site selection, especially if the waste is held in the receiving storage facility for a prolonged period.) The criteria recommended by the Commission to select a site providing disposal with the best-possible safety are in line with the provisions of the Site Selection Act. The criteria do not focus on interim storage which could, however, be of particular public interest if a receiving storage facility is large or filled for a prolonged period.[305]
- (It should also be noted that unnecessary transport of high-level radioactive waste is to be avoided and the burden of disposal should be borne by several regions rather than concentrated at a single site.) However, a potentially prolonged interim storage period would reduce the amount of heat emitted to the disposal facility for high-level radioactive waste.

There are several differences in terms of meeting the legal requirements for extending the licences of on-site stores and transport container stores. The licences for the Ahaus, Gorleben and Nord interim storage facilities, as well as the licences for the containers stored there, need to be extended by means of a licencing procedure under Section 6 of the Atomic Energy Act. When doing so, an environmental impact assessment including public participation must be carried out if an extension is for a period of more than ten years. In the case of short-term extensions, prior review is required to ascertain whether there is a duty

[303] K-MAT 39, programme for the responsible and safe management of spent fuel and radioactive waste (National Programme), p. 6.
[304] While the National Programme itself describes a 'receiving storage facility for all spent fuel elements and reprocessed waste', the environmental report for public participation in the Programme's strategic environmental review worked on the basis of a receiving storage facility with space for 500 waste containers. The Federal Ministry for the Environment explained to the Commission that the Federal Government only adopted the Programme itself and not the environmental report that was prepared beforehand.
[305] On this issue, cf. sections B 5.6 and B 5.7 of the present report: 'time requirements' and 'necessary interim storage prior to disposal'.

to perform an Environmental Impact Assessment.[306] According to the Atomic Energy Act, licences for on-site stores may only be extended on imperative grounds and following prior referral to the German Bundestag.[307]

2.3 Waste inventory

The selection of sites for a deep repository requires prior estimation of the quantities and properties of the radioactive waste to be deposited there. With high-level radioactive waste, the volume and area that need to be made available underground for disposal depend on the host rock as well as the quantity of waste and amount of heat it emits. With low and intermediate-level radioactive waste, the amount of area required is primarily determined by the waste volume. The material properties of the waste also need to be known. Material properties and, in the case of high-level radioactive material, emitted heat or radiation determine the interactions between waste and its surroundings within the disposal facility. Here, particular importance is attached to the properties and interactions that may favour or lead to mobilisation of the radionuclides contained in the waste when stored underground.

The production of radioactive waste in Germany will largely cease in 2022. This means that it is already possible to estimate the amount of radioactive waste for disposal following the phase-out of nuclear energy. The quantity of high-level radioactive waste yet to accumulate during the remaining operating lives of the power plants in commission have, by and large, been calculated. The amount of resulting low and intermediate-level radioactive waste can often only be determined once it has been separated from other materials and is available for disposal in conditioned or conditionable form.

The material properties of high-level radioactive waste only vary to a small extent as they are either present as radioactive heavy metal in spent fuel elements, or as vitrified waste from reprocessing. Intermediate-level radioactive waste resulting from reprocessing German fuel elements abroad that are finally disposed of along with high-level radioactive waste is materially similar to those of spent fuel elements or reprocessed high-level radioactive waste.[308]

Low and intermediate-level radioactive waste has a far greater material spectrum because it contains a far lower proportion of radioactive substances and, inversely, a large proportion of other waste. However, only three categories of waste is to be taken into consideration in the search for a disposal site prepared by the Commission:

- Waste to be retrieved from the Asse mine;
- Anticipated radioactive waste resulting from uranium enrichment;

[306] Cf. information supplied by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p.6.
[307] Cf. Atomic Energy Act of 15 July 1985, Federal Law Gazette I, p. 1565, last amended by 307 of the Ordinance of 31 August 2015, Federal Law Gazette I, p. 1474, second sentence of Section 6(5).
[308] These are compacted metal parts of fuel elements sent for reprocessing in order to trace vitrified flush waste containing the remains of fission product solutions back to the reprocessed high-level radioactive waste.

- Other low and intermediate-level radioactive waste that will not be deposited in the Konrad disposal facility because the radionuclides they contain or their chemical composition do not comply with Konrad's acceptance requirements.

In its National Programme, the Federal Government suggests that the stated waste from the Asse mine, the depleted uranium from uranium enrichment deemed as being waste, and the low and intermediate-level radioactive waste which cannot be stored in the Konrad disposal facility all be taken into consideration when choosing a site for a disposal facility, particularly one involving high-level radioactive waste.[309]

According to the Programme, a final decision regarding a disposal site for such waste should depend upon the disposal facility emplacement criteria to be selected on the basis of this report, as well as upon the actual properties of the waste to be retrieved from the Asse mine.[310] The Commission decided to also prepare recommendations for storing waste from the Asse mine, for depleted uranium resulting from uranium enrichment, and for low and intermediate-level waste that cannot be deposited in the Konrad disposal facility.[311] Section B 6.6[312] of the present report describes the general conditions to be met so that the site to be selected for disposal of high-level radioactive waste is also eligible as a facility for disposal of the radioactive waste stated above.

The Commission assumes that the sought site and a subsequent disposal facility will meet all of the requirements incumbent upon a storage site for toxic substances. For this reason, the chemotoxic and chemical properties of the waste will only be taken into consideration to the extent they are relevant to radionuclide mobilisation. The radionuclide spectra containing high-level radioactive waste will not be considered initially. The geological criteria the Commission developed to determine siting regions or sites are formulated such that suitable host rocks can include all potential radionuclides.

Detailed statements regarding quantities, volumes, total activity or chemotoxicity of substances, and the various radionuclides they contain, are required for preliminary safety studies to be used in subsequent disposal site procedure steps. Data pertaining to the stated waste properties still need to be comprehensively collected and stored for subsequent disposal.

2.3.1 Low and intermediate-level radioactive waste

The waste forecast provided by the Federal Office for Radiation Protection, which the Federal Government has used as a basis for its National Programme, does not yet include the waste to be retrieved from the Asse mine, nor does it include any depleted uranium from uranium enrichment that is deemed to be waste. Based on this forecast, the licensed capacity of the Konrad disposal

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309 Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2015): Programme for the responsible and safe management of spent fuel and radioactive waste (National Programme), K-MAT 39, p. 13.
310 Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2015): Programme for the responsible and safe management of spent fuel and radioactive waste (National Programme), K-MAT 39, p. 13.
311 Cf. Decision of the 'Commission on the Storage of High-Level Radioactive Waste' of 19 November 2015, K-Drs. 145.
312 Cf. section B 6.6 of the present report 'Requirements on emplacement of additional radioactive waste'.

facility of 303,000 cubic metres will be largely used up by the low and intermediate-level radioactive waste expected to accumulate by 2050. A previous waste forecast from the Federal Office for Radiation Protection was used as a basis for determining the licensed disposal facility's capacity.

The waste used in the forecast that is attributable to the use of nuclear energy should have accumulated almost entirely by 2050:[313]

Table 10: Volumes of conditioned low and intermediate-level radioactive waste

Forecast from the Federal Office for Radiation Protection

	2020	2030	2040	2050	2060	2070
Nuclear power plants	85,40	146,8	168,2	185,7	185,7	185,9
Research	55,20	62,30	65,60	69,10	71,60	71,60
Nuclear industry	11,50	12,20	12,40	13,00	13,10	13,10
WAK Karlsruhe	18,20	21,40	21,40	21,40	21,40	21,40
Federal state	4,600	5,700	6,700	7,800	8,800	9,800
Total volumes in m³	**174,900**	**248,400**	**274,300**	**297,000**	**300,600**	**301,800**

According to an estimate from the Federal Ministry for the Environment, around 78 per cent of the low and intermediate-level radioactive waste already accumulated can be attributed to electricity generation in a broader sense.[314]This estimate assumes that around half of the low and intermediate-level radioactive waste from research facilities can be attributed to electricity generation research, and the other half to research for other purposes.[315] The ratio of waste from electricity generation to low and intermediate-level radioactive waste from other processes is set to shift increasingly towards waste from electricity generation 'as the majority of waste from nuclear power plants will not accumulate until they are decommissioned.[316]

The low and intermediate-level radioactive waste not yet included in the forecast of the Federal Office for Radiation is largely attributable to electricity generation. In Germany, uranium enrichment, which is expected to generate up to 100,000 cubic metres of additional waste, is used for fuel element production. According to information provided by the Federal Office for Radiation Protection, 67 per cent of the radioactive waste in the Asse mine comes directly or indirectly from electricity generation in nuclear power plants.[317] About another 23 per cent of this waste come from nuclear research, predominantly research and development work for nuclear applications, while 8 per cent is attributable to the nuclear

[313] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: information supplied to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p. 11. Forecast based on data from 2011.
[314] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: information supplied to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p. 12.
[315] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: information supplied to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p. 12.
[316] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: information supplied to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p. 12.
[317] Cf. Federal Office for Radiation Protection: 'Schachtanlage Asse II Kenntnis über die eingelagerten Abfälle', report submitted to the Federal Ministry for the Environment, 10 September 2015, p. f.

industry itself. Only around two per cent of the waste in the Asse mine can be attributed to other applications.

2.3.1.1 Anticipated waste from the Asse mine

The volume of radioactive waste to be finally disposed of following the statutory retrieval of radioactive waste from the Asse mine could only be estimated until now. A total of 125,787 waste containers were deposited in the mine between 1967 and 1978, including 1,293 200-litre casks containing intermediate-level radioactive waste as well as 124,494 containers filled with various types of low-level radioactive waste. The containers have a total volume of around 47,930 cubic metres and a total mass of approximately 89,000 tonnes.

At the time of emplacement, the waste exhibited a total activity of around $1*10^{16}$ Bq. At the end of 2014, the calculated total activity was somewhere in the region of $2.5*10^{15}$ Bq. By way of comparison, the activity of high-level radioactive waste for which a disposal facility needs to be selected will be more than five powers of ten higher, i.e. more than a hundred thousand times higher.[318] Based on the current state of knowledge, the waste in the Asse mine contains 28.9 kilogrammes of plutonium and 30.1 kilogrammes of uranium as nuclear fuel.[319]

Detailed information is available regarding the properties of the waste deposited in the Asse mine and about the radionuclides present at the time of deposition.[320] The current state of the waste containers in which the waste was deposited in the mine is not entirely clear, meaning that it is unclear how much contaminated salt will need to be retrieved along with the waste.

The National Programme assumes a volume of around 175,000 to 220,000 cubic metres of conditioned waste that will arise as a result of retrieving radioactive waste and contaminated salt.[321] This is based on the assumption that up to 50,000 cubic metres of contaminated salt will need to be retrieved from the mine.[322] Due to its hygroscopic properties, the currently unknown quantity of salt to be retrieved is of particular importance if a disposal facility is selected at a site with claystone or crystalline rock.

When considered by waste group, around two-thirds of the intermediate-level radioactive waste emplaced in the Asse mine consist of scrap metal, while the

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[318] Cf. Federal Office for Radiation Protection: ‘Schachtanlage Asse II Kenntnis über die eingelagerten Abfälle’, report submitted to the Federal Ministry for the Environment, 10 September 2015, p. 2.
[319] Cf. Federal Office for Radiation Protection: ‘Schachtanlage Asse II Kenntnis über die eingelagerten Abfälle’, report submitted to the Federal Ministry for the Environment, 10 September 2015, p. 2.
[320] Cf. GSF – Forschungszentrum für Umwelt und Gesundheit (2002): ‘Bestimmung des nuklidspezifischen Aktivitätsinventars der Schachtanlage Asse - Abschlussbericht’, as well as GSF – Forschungszentrum für Umwelt und
Gesundheit (2003), ‘Bestimmung des Inventars an chemischen und chemotoxischen Stoffen in den eingelagerten Abfällen der Schachtanlage Asse - Abschlussbericht’, as well as Helmholtz Zentrum München: Projektgruppe Jülich (2010): ‘AG Asse Inventar - Abschlussbericht’, as well as TÜV Süd (2011): ‘Schachtanlage Asse II - Bericht zur Überprüfung des Abfallinventars’, Teil A; Recherche der Betriebsdokumente, as well as TÜV Süd (2011): ‘Schachtanlage Asse II - Bericht zur Überprüfung des Abfallinventars’, Teil B; Überprüfung der Kernbrennstoffdaten.
[321] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2015): Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. Report by the Federal Republic of Germany for the fifth review conference in May 2015, K-MAT 39, p. 13.
[322] Cf. Federal Office for Radiation Protection: ‘Schachtanlage Asse II Kenntnis über die eingelagerten Abfälle’, report of 10 September 2015. p. 1.

other third is made up of filters, filter aids, sludges, evaporator concentrates, resins and the like.

The emplacement documentation lists the following toxic substances: 26 tonnes of chrome compounds, 15 tonnes of lead, one tonne of cyanide and 0.5 tonnes of arsenic compounds.[323] Organic constituents such as cellulose, plastics and any metals present may decompose as a result of fermentation or corrosion and lead to the formation of gases.

2.3.1.2 Waste resulting from uranium enrichment

When selecting a site for disposal of high-level radioactive waste, the Federal Government's National Programme also recommends, as a precaution, taking into account the 'depleted uranium that has been generated and will be generated as a result of uranium enrichment, providing for the case that it will not be recycled.[324] In doing so, the Programme estimates 'up to 100,000 cubic metres[325] of waste containing depleted uranium from uranium enrichment[326] if this uranium is not to be recycled.

In Germany, depleted uranium is currently being accumulated at the uranium enrichment facility in Gronau, which has been producing enriched uranium to supply nuclear power plants with fuel since 1985. The resulting depleted uranium is initially deemed a reusable material as it still contains fissile uranium 235, albeit in low concentrations, which can or could be separated with an increasing amount of effort. However, further separation of uranium 235, which only constitutes around 0.2 to 0.4 per cent of depleted uranium, still results in the same amount of low-level radioactive waste at the end of the process. Among other things, the world market price for natural uranium determines whether depleted uranium is in fact recycled or can be sold for recycling by further separation of uranium 235. Depleted uranium not intended for recycling is deemed to be radioactive waste.

The Gronau plant stores depleted uranium as uranium hexafluoride in an outdoor storage facility that has a capacity of 38,000 tonnes. The plant's nuclear licence stipulated that an interim storage for uranic oxide be built at the site as soon as the outdoor facility was half full with so-called 'tails', i.e. depleted uranium in the form of uranium hexafluoride.[327] Once this filling level is reached, the plant

[323] Cf. Federal Office for Radiation Protection: 'Schachtanlage Asse II Kenntnis über die eingelagerten Abfälle', report of 10 September 2015. p. 2.

[324] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2015). Programme for the responsible and safe management of spent fuel and radioactive waste (National Programme), K-MAT 39, p. 5.

[325] According to the Federal Ministry for the Environment, the figure of up to 100,000 cubic metres of wastes from uranium enrichment to be dealt with under the Waste Management Programme is based on a calculation that assumes enrichment will continue for 40 years. The enrichment facility at Gronau holds an open-ended operating licence. In contrast to this, the facility's operator, URENCO Deutschland GmbH, stated in a letter to the Commission that it would take until the end of the century to accumulate 100,000 cubic metres of depleted uranium.

[326] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2015): Programme for the responsible and safe management of spent fuel and radioactive waste (National Programme), K-MAT 39, p. 11.

[327] Cf. Response from the Federal Government to the 'small question' submitted by members of parliament Hubertus Zdebel, Herbert Behrens, Ralph Lenkert, Eva Bulling-Schröter and The Left (Die Linke) parliamentary group (2014). Bundestag Printed Paper 18/2362. p. 2f.

operator is also required to start preparing to convert uranium hexafluoride to the more stable uranic oxide.[328] The uranic oxide storage facility, which has now been built, has a capacity of 50,000 tonnes, equating to 58,962 tonnes of uranic oxide, and is due to be commissioned in 2016.[329]

The enrichment plant in Gronau has a separation output of 4,500 tonnes per year. When working at full capacity, its annual output is 1,360 tonnes of enriched product and 10,730 tonnes of depleted product in the form of uranium hexafluoride.[330] Following corresponding deconversion, these 10,370 tonnes of uranium hexafluoride tails would equate to 8,560 tonnes of uranic oxide.

The actual ratio of enriched uranium for fuel elements to depleted uranium depends on two factors: First, the level of enrichment to be achieved in the produced fuel element; second, the level of depletion of the remaining uranium tails. Both the world market price of natural uranium and the current enrichment capacities available within the company influence the depletion level decision. Consequently, the production of a tonne of non-irradiated nuclear fuel from natural uranium results in five to eight tonnes of depleted uranium:[331]

Table 11: Ratio of natural uranium to uranium tails[332] per tonne of nuclear fuel by level of depletion

Level of enrichment: U-235	**3.6%**			**4.0%**		
Level of depletion of remaining uranium tails	**0.1 %**	**0.2 %**	**0.3 %**	**0.1 %**	**0.2 %**	**0.3%**
Tonnes of Unat required to produce one tonne of nuclear fuel	5.7	6.6	8.0	6.4	7.4	9.0
Tonnes of tails required to produce one tonne of nuclear fuel	4.7	5.6	7.0	5.4	6.4	8.0

The amount of depleted uranium from the Gronau plant that is not actually recycled or sold for recycling also depends on the given market conditions. The enrichment facility in Gronau holds an open-ended operating licence. This is

[328] Cf. Response from the Federal Government to the ‘small question’ submitted by members of parliament Hubertus Zdebel, Herbert Behrens, Ralph Lenkert, Eva Bulling-Schröter and The Left (Die Linke) parliamentary group (2014). Bundestag Printed Paper 18/2362. p. 3.
[329] Cf. Response from the North Rhine-Westphalia government to ‘small question’ 4423 of 29 January 2016 submitted by member of parliament Hanns-Jörg Rohwedder of the Pirate Party (Piraten), State Parliament (Landtag) of North Rhine-Westphalia Printed Paper 16/11283, p. 2.
[330] Cf. URENCO Deutschland (2020): ‘Urananreicherungsanlage Gronau - Kurzbeschreibung des Endausbaus und der voraussichtlichen Auswirkungen’, p. 35.
[331] Table from: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: Information submitted to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016.
[332] Uranium tails or, to phrase it another way, leftover uranium denote depleted uranium from which the fissile isotope uranium 235 is partially removed during enrichment of natural uranium. Natural uranium contains 0.7 per cent uranium 235, while depleted uranium contains 0.1 to 0.3 per cent uranium 235. In order to produce fuel elements, natural uranium is enriched to reach a uranium 235 concentration of 3.6 to 4.0 per cent.

another reason it is currently not possible to predict the amount of depleted uranic oxide to be disposed of at the end. The 100,000 cubic metres specified in the National Programme represent an estimate by the Federal Government and are indicative of the will to deal with the depleted uranium that is always left over as waste at the end of various enrichment processes by disposing of it in Germany.

From a material perspective, the depleted uranium initially equates to natural uranium. However, following conversion of uranium hexafluoride to uranic oxide, the end product will contain up to two per cent uranyl fluoride and components of hydrofluoric acid,[333] which requires spatially separated disposal of both depleted uranium from enrichment and of high-level radioactive waste.[334]

2.3.1.3 Other low and intermediate-level radioactive waste

The disposal conditions for the Konrad disposal facility stipulate upper limits for the permitted activity of a number of radionuclides per disposal container. These conditions also limit the total masses of water-contaminating substances that may be emplaced within the disposal facility as a whole. The Federal Office for Radiation Protection used the disposal facility's safety analysis and permit under water law to introduce activity limits for individual radionuclides as well as mass limits for harmful, non-radioactive substances. Radioactive or other harmful substances, which may lead to stipulated limits being exceeded, must not be emplaced in the Konrad disposal facility. To date, it has not been possible to provide a serious estimate of the extent to which this so-called non-Konrad-compliant low or intermediate-level radioactive waste will in fact accumulate.

Low or intermediate-level radioactive waste that fails to comply with Konrad's disposal conditions include radioactive waste containing C-14, tritium, tritium and beryllium, as well as waste containing thorium or paraffin.[335] Such types of waste are produced in large-scale research facilities and research reactors. Waste materials containing beryllium or paraffin can be attributed to the radiation sources used there.

Before geological exploration of the Gorleben salt dome ended, the preliminary safety analysis for the site, which has now been completed without a suitability forecast, assumed that up to 1,000 cubic metres of graphitic radioactive waste may accumulate which, despite only generating a low level of heat, are not eligible for emplacement in the Konrad disposal facility.[336] In view of this, graphitic waste resulting from the dismantling of high-temperature reactors could exceed the upper C-14 or tritium activity limits applicable to the Konrad disposal facility.

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[333] Cf. Kienzler, Bernhard; Altmaier, Marcus; Bube Christiane; Metz, Volker (2013): Radionuclide Source Term for Irradiated Fuel from Prototype, Research and Education Reactors, for Waste Forms with Negligible Heat Generation and for Uranium Tails, KIT Scientific Reports 7635, p. 19.

[334] Cf. Section B 6.6 of the present report: 'requirements on emplacement of additional radioactive waste'.

[335] Cf. German Bundestag (2010): Response from the Federal Government to the 'small question' submitted by members of parliament Sylvia Kotting-Uhl, Bärbel Höhn, Dorothea Steiner, other members of parliament and the Alliance 90/The Greens parliamentary group. Bundestag Printed Paper 17/3347, p. 5. The wastes stated can be attributed to radiation sources and to materials resulting from the dismantling of high-temperature reactors.

[336] Cf. Gesellschaft für Anlagen- und Reaktorsicherheit (2011): 'Abfallspezifikation und Mengengerüst - Basis Ausstieg aus der Kernenergienutzung (Juli 2011), Bericht zum Arbeitspaket, 3. Vorläufige Sicherheitsanalyse für den Standort Gorleben', p. 47ff.

To date, it has been difficult to forecast the total amount of additional low and intermediate-level radioactive waste that does not comply with the Konrad disposal facility emplacement conditions. A discussion paper produced by the Disposal Commission estimates that there is more than 6,000 cubic metres of such waste.[337]

Until the end of 2014, waste producers have reported to the Federal Office for Radiation Protection the accumulation of almost 22,000 tonnes of non-conditioned and more than 117,000 cubic metres of conditioned, low-heat-generating radioactive waste. According to these reports, only 144 cubic metres of conditioned waste have been classified as non-Konrad-compliant. However, only 2,929 cubic metres of waste have had their contents tested and checked for compliance with the Konrad emplacement conditions:

Table 12: Accumulated and reported low-heat-generating wastes[338]

Category	Non-conditioned waste	Conditioned waste products
	Tonnes	**Cubic metres**
Raw waste (RW)	8,222	-
Pre-treated waste (PW)	13,544	-
Waste in inner containers (P1)	-	14,845
Waste products that have undergone product control (P2)	-	1,860
Waste in Konrad containers (G1)	-	97,391
Waste containers that have undergone product control (G2)	-	2,929
Waste products not yet classified ready for Konrad containers		144
Total	**21,766**	**117,169**

Until now, other intermediate-level radioactive waste that cannot be emplaced in the Konrad disposal facility has been designated for a disposal facility for heat-generating radioactive waste. Part of the waste resulting from reprocessing in France, which Germany is obliged to take back, contains intermediate-level radioactivity, meaning that it exceeds the upper nuclide limits stipulated in the Konrad licence and can therefore not be emplaced in the Konrad disposal facility.[339]This reprocessed intermediate-level waste includes 4,104 canisters with compacted metal parts of fuel elements that Germany must take back in 152 containers. Another five containers filled with intermediate-level radioactive waste from reprocessing is scheduled for transport to the Philippsburg on-site

[337] Cf. Disposal Commission: Discussion paper, 12 May 2016. Discussion paper on a disposal site for the disposal of heat-generating radioactive waste, depleted uranium from uranium enrichment, waste to be retrieved from the Asse II mine, and other waste that cannot be disposed of at the Konrad disposal facility. p. 5.

[338] Table from the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: information supplied to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p. 10. Information applicable as of 31 December 2014.

[339] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2015): Programme for the responsible and safe management of spent fuel and radioactive waste (National Programme), K-MAT 39, p. 9.

store.[340] These containers are purported to contain canisters in which flushing solutions from the La Hague reprocessing plant in France were vitrified.

The Federal Office for Radiation Protection also estimates that there is about another 3,400 cubic metres of heat-generating, but not high-level radioactive waste from industrial conditioning plants. This waste generally consists of radioactive waste or filter residues from nuclear power plants that are stored in so-called MOSAIK casks. Such waste occurs if the high-level radioactive waste is stored in containers other than the transport and storage casks currently used for interim storage. The Federal Office for Radiation Protection also estimates that around 900 containers from the former reprocessing plant in Karlsruhe, each holding 200 litres of other heat-generating waste, will also need to be disposed of.[341]

2.3.2 High-level radioactive wastes

When Germany completes its phase-out from nuclear energy on 31 December 2022, at the latest, the production of high-level radioactive waste will end almost entirely. After a corresponding decay time, rough estimates put the amount of high-level radioactive materials to be finally disposed of at around 30,000 cubic metres.[342] By the year 2022, the use of nuclear energy in Germany will have led to spent fuel elements containing a total of approximately 17,000 tonnes of nuclear fuel or heavy metal. This already includes fuel elements holding around 850 tonnes of nuclear fuel that can, at best, be emplaced in the eight remaining nuclear power plants between mid-2016 and the end of 2022. Swifter or immediate shutdown of all the remaining nuclear power plants would have no impact on the extent of the disposal task, nor would it have any noteworthy effects on the requirements to be imposed upon a site for the safe disposal of high-level radioactive waste.

The waste designated for the disposal facility for high-level radioactive waste is generally present as waste from reprocessing and in the form of spent fuel elements which, after their decay period, must then directly undergo disposal in interim disposal facilities. The high-level radioactive waste contains over 99 per cent of the activity of all radioactive waste; however, their subsequent volume in conditioned form is only likely to constitute a twentieth of the estimated total quantity of radioactive waste for disposal.

The waste left over after the nuclear phase-out which, ideally, are intended for a disposal facility for high-level radioactive waste, will fill around 1,900 different

[340] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2015): Overall concept for the return of vitrified radioactive waste from reprocessing http://www.bmub.bund.de/fileadmin/Daten_BMU/Download_PDF/Nukleare_Sicherheit/castor_radioactive_waste_concept_bf.pdf [Last accessed 10 June 2016]

[341] Cf. Federal Office for Radiation Protection (2016): Forecast for future waste volumes. http://www.bfs.de/EN/topics/nwm/waste/forecasts/forecasts_node.html [Last accessed 9 June 2016]

[342] It may well be possible to estimate the waste quantities that could accumulate until that time, but the volume of waste for disposal depends heavily on the conditioning type used. Storage of high-level radioactive waste in Pollux disposal containers would lead to a total volume of around 30,000 cubic metres.

types of transport and storage casks to be stored in interim storage facilities until their disposal:[343]

Table 13: Expected total number of containers with high-level radioactive wastes as well as reprocessed waste in nearby and central interim storage facilities

Waste type	Number of transport and storage casks
Spent fuel elements from nuclear power plants	Around 1,100
Spent fuel elements from research, development and demonstration reactors	Around 500
High-level radioactive waste from reprocessing	134
Intermediate-level radioactive waste from reprocessing	157
Total number of containers	**Around 1,900**

As well as the fuel elements from research and demonstration reactors, there are 305 containers filled with waste from high-temperature reactors currently stored at the Ahaus interim storage. These are accompanied by 152 containers filled with fuel elements from the Jülich Experimental Nuclear Power Plant (AVR) and 65 containers holding other waste from research reactors.[344]

2.3.2.1 Already accumulated high-level radioactive waste

The Commission was provided with data for 31 December 2014 on the high-level radioactive waste produced hitherto in Germany. Up until the aforementioned date, spent fuel elements containing a total of 15,047 tonnes of nuclear fuel or heavy metal have accumulated in Germany as a result of operating nuclear power plants. Of that amount, spent fuel elements containing 6,670 tonnes of nuclear fuel were transported away from nuclear power plants, either for reprocessing or to be permanently stored abroad:[345]

[343] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: Press release 199 of 12 August 2015 (on the National Programme), 'Bundeskabinett beschließt umfassendes Konzept zur Entsorgung des Atommülls', p. 2
[344] Cf. Federal Office for Radiation Protection (2016): Forecast for future waste volumes. http://www.bfs.de/EN/topics/nwm/waste/forecasts/forecasts_node.html [Last accessed 9 June 2016]
[345] Table from the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: information supplied to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p. 2.

Table 14: Nuclear fuel from nuclear power plants transported in spent fuel elements to reprocessing plants and to overseas facilities

Destination of spent fuel element transports	Nuclear fuel content in tonnes[346]
Transported to La Hague reprocessing plant (France)	5,393
Transported to Sellafield reprocessing plant (UK)	851
Reprocessed at the Karlsruhe WAK reprocessing plant	85
Reprocessed at the EUROCHEMIC reprocessing plant (Belgium)	14
Returned to former USSR (VVER fuel elements)	283
Delivery and retention in Sweden (CLAB)	17
Reuse of weakly irradiated VVER fuel elements in Paks (Hungary)	27
Total	**6,670**

Overseas reprocessing of fuel elements from German reactors is now complete. Some of the resulting waste still needs to be transported back to Germany. Germany has already taken back 108 containers filled with reprocessed high-level radioactive waste, which are now being held at the Gorleben interim storage facility. The 157 containers filled with intermediate-level radioactive waste mentioned above still need to be taken back. The Federal Ministry for the Environment's general concept to take back vitrified radioactive waste from reprocessing also includes the Brokdorf and Biblis on-site stores each taking back seven containers filled with high-level radioactive waste, and the on-site store taking back seven to nine containers.[347] Five other containers holding vitrified high-level radioactive waste from reprocessing fuel elements at the Karlsruhe WAK reprocessing plant are currently being stored at Zwischenlager Nord.

[346] The nuclear fuel in the fuel elements consists of uranium, plutonium or thorium. On an international level, it is generally expressed in megagrams of heavy metal. For the sake of clarity and ease of comprehension, the Commission uses a different unit.
[347] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2015): Overall concept for the return of vitrified radioactive waste from reprocessing http://www.bmub.bund.de/fileadmin/Daten_BMU/Download_PDF/Nukleare_Sicherheit/castor_radioactive_waste_concept_bf.pdf [Last accessed 10 June 2016]

Table 15: Total quantities of radioactive waste from reprocessing[348]

Waste type	Number of	Number of containers
Vitrified high-level radioactive waste from France	3,024	108
Vitrified high-level radioactive waste from Great Britain	571	21
Vitrified high-level radioactive waste from reprocessing in Karlsruhe	140	5
Compacted intermediate-level radioactive waste from France	4,104	152
Vitrified intermediate-level radioactive waste from France	140	5
Total	**7,979**	**291**

At the end of 2014, the nuclear power plants' wet storage facilities and the containers at German interim storage facilities held spent fuel elements totalling 8,380 tonnes of nuclear fuel with a total activity of around 3 x 10^{20} becquerels:[349]

Table 16: Inventory of spent fuel elements from German nuclear power plants at the end of 2014

Storage location	Containers	Number of fuel elements	Total nuclear fuel content in tonnes
storage pond nuclear power plant[350]		14,013	4,258
Container storage in on-site interim storage facilities	352	9,638	3,444
Container storage at the interim storage facilities in Gorleben, Ahaus and Nord	76	5,343	85
Total		**28,994**	**8,379**

2.3.2.2 Fuel elements for disposal from nuclear power plants

The fuel elements removed from reactor cores between the end of 2014 and mid-2016, the fuel elements still present in the reactor cores at the eight remaining nuclear power plants as of mid-2016, and the previously mentioned new fuel elements still to be delivered to reactor cores between mid-2016 and the end of 2022 are to be added to the inventory of spent fuel elements compiled at the end

[348] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: information supplied to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p. 14.
[349] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: information supplied to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p. 14
[350] Table from the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: information supplied to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p. 14.

of 2014. After the phase-out of nuclear energy, fuel elements from nuclear power plants containing a total of 10,500 tonnes of nuclear fuel will need to undergo disposal. A total of around 34,600 fuel elements from nuclear power plants whose size may vary significantly depending on the type of reactor involved will need to undergo disposal.

Table 17: Estimated fuel elements for disposal from German nuclear power plants[351]

Fuel element type	Quantity	Total nuclear fuel content in tonnes
Uranic dioxide pressurised water reactors	12,450	6,415
Mixed oxide pressurised water	1,530	765
Uranic dioxide boiling water	14,350	2,465
Mixed oxide boiling water reactors	1,250	220
VVER pressurised water reactors	5,050	580
Total	**34,630**	**10,445**

2.3.2.3 Heat output and potential decay times

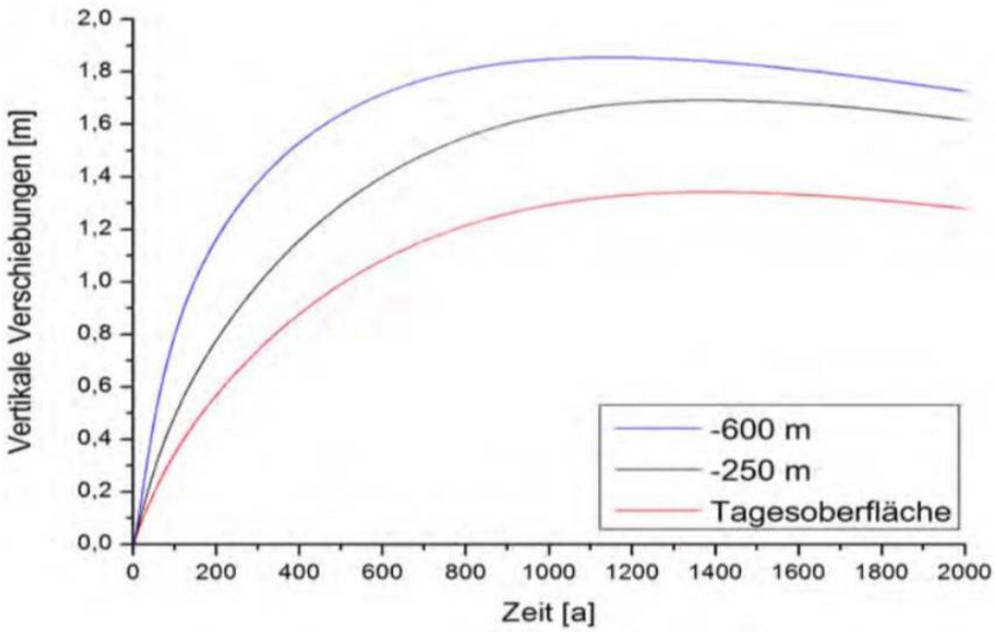
High-level radioactive waste emits both radiation and a significant amount of heat which, after disposal, will heat up the surrounding rock. This may cause an uplift in the surface level above a disposal facility. As a result of the emitted heat, the rock around a disposal facility for high-level radioactive waste may expand for several thousand years, but subsequently contract again over a similar period of time due to the waste cooling down. This process should not give cause any fissures or water flow paths in the rock which could impede the safe containment of the waste in the rock zone selected therefor.

To date, surface level uplifts of up to 1.30 metres above a disposal facility in a salt dome were deemed feasible:[352]

[351] Table from the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: information supplied to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p. 14.

[352] Cf. Gesellschaft für Anlagen- und Reaktorsicherheit (2016): 'Wärmeverträglichkeit/Gesteinsverträglichkeit - Gutachten im Auftrag der Kommission Lagerung hoch radioaktiver Abfallstoffe', K-MAT 64, p. 31.

Graphic 3: Potential vertical shifts above a disposal facility for high-level radioactive waste:



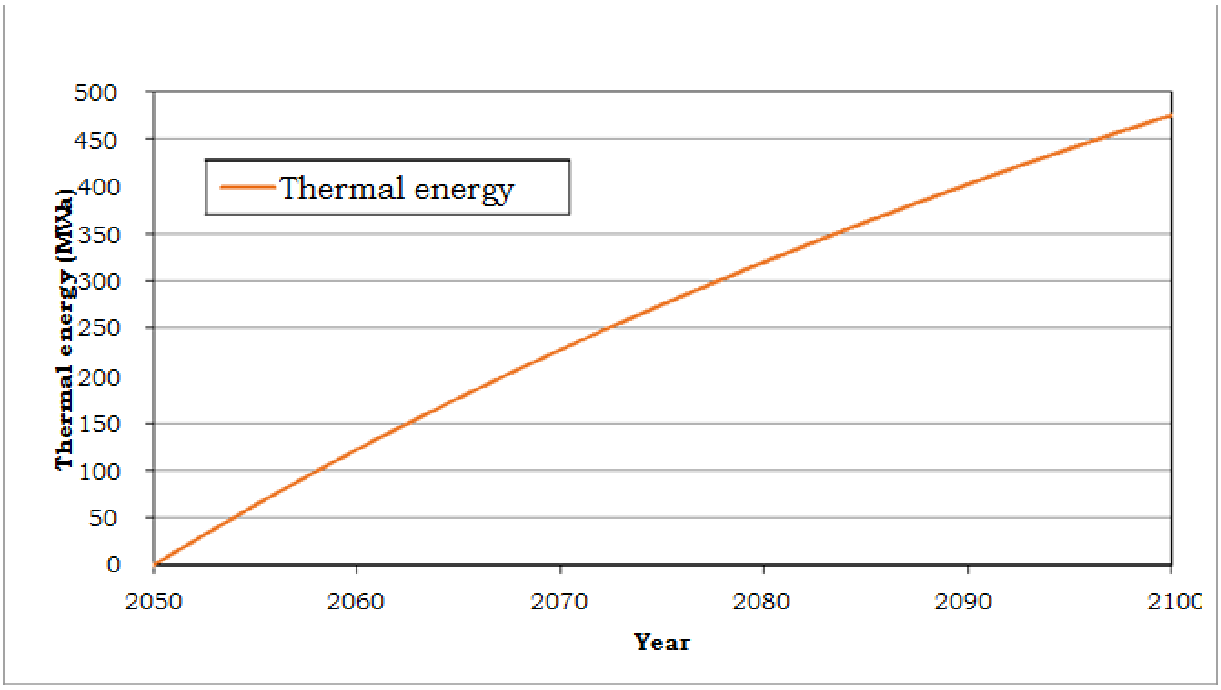
Vertikale Verschiebungen [m]	Vertical shifts [m]
Zeit [a]	Time [a]
Tagesoberfläche	Surface

The production limit on high-level radioactive waste resulting from the phase-out of nuclear energy, and the prolonged waste decay times associated with the length of time required to decide on a site will both reduce the amount of heat emitted into the disposal facility. The heat output of high-level radioactive waste will decline significantly over the first five years following removal of spent fuel elements from the reactor core. During that period, the heat output of every type of fuel element will decrease to between 0.3 and 0.1 per cent of its original value. Depending on the type of fuel elements involved, the heat output may halve again and continue to decline over the following decades.

Suitable decay times therefore help to somewhat reduce the amount of heat emitted by the waste into the area around the disposal facility, and, especially in the first few decades following emplacement, somewhat reduce the level of anticipated rock movement. However, after disposal has taken place, high-level radioactive waste will heat up the surrounding rock to a significant extent. The rock will heat up over a prolonged period and, depending on the rock type, will only be able to conduct this heat to a limited extent.

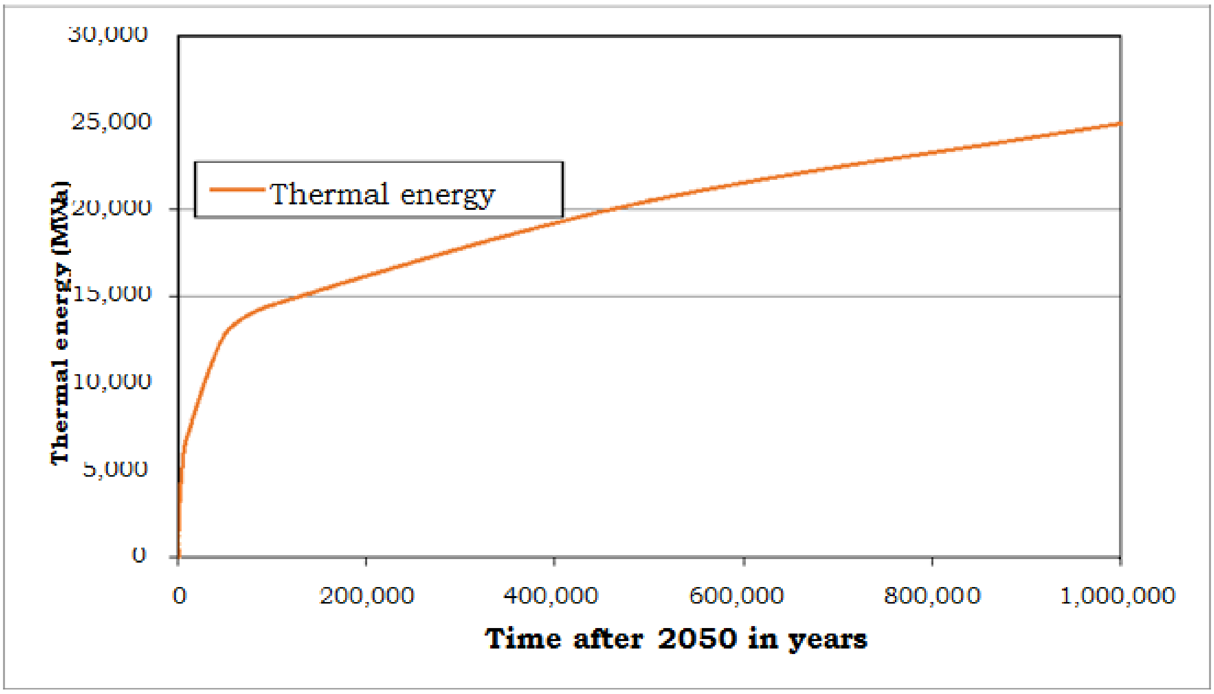
The following graphic illustrates the potential total heat input of all the spent fuel elements to be finally disposed of in a disposal facility. The model calculation commissioned by the Federal Ministry for the Environment provides a total of the thermal energy which will be emitted by all the fuel elements to be finally disposed of in Germany from the year 2050.

Graphic 4: Cumulated thermal energy emitted by spent fuel elements from the year 2050[353]



[353] Calculated by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) for the Commission on the Storage of High-Level Radioactive Waste, graphics submitted on 20 June 2016.

Graphic 5: Cumulated thermal energy emitted by spent fuel elements over a reference period of one million years[354]



The heat input from other waste is negligible in contrast to heat emitted by spent fuel elements from nuclear power plants and high-level radioactive waste from reprocessing. All of the spent fuel elements and all of the high-level radioactive waste from reprocessing that are either already present or anticipated will, according to calculations by the Federal Ministry for the Environment, have a heat output of almost 16 megawatts in the year 2045. This value will drop to almost 9 megawatts by 2085:

Table 18: Expected development of thermal output of high-level radioactive waste[355]

Waste type	Year				
	2045	2055	2065	2075	2085
Spent fuel elements	14.2 MW	12.2 MW	10.5 MW	9.2 MW	8.2 MW
Reprocessed high-level waste	1.6 MW	1.3 MW	1.0 MW	0.8 MW	0.7 MW
Total	15.8 MW	13.5 MW	11.5 MW	10.0 MW	8.9 MW

[354] Idem
[355] Table from the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: information supplied to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p. 17.

As the disposal facility for high-level radioactive waste is likely to be in operation for at least three decades, this will provide an opportunity to first emplace older waste with longer decay times that is no longer as hot, thus prolonging the decay times of other waste. In 2050, reprocessed high-level radioactive waste will generally have a decay time of more than 50 years:[356]

Graphic 6: Potential decay times of reprocessed high-level radioactive waste

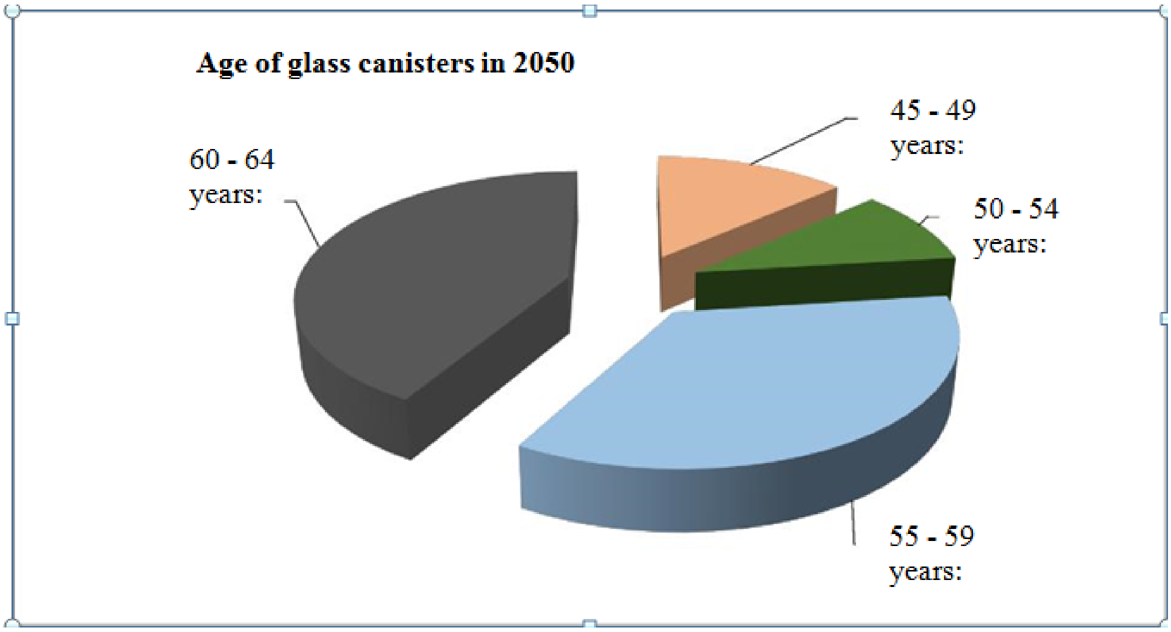


Table 19: Number of canisters containing reprocessed waste after expected decay times in the year 2050

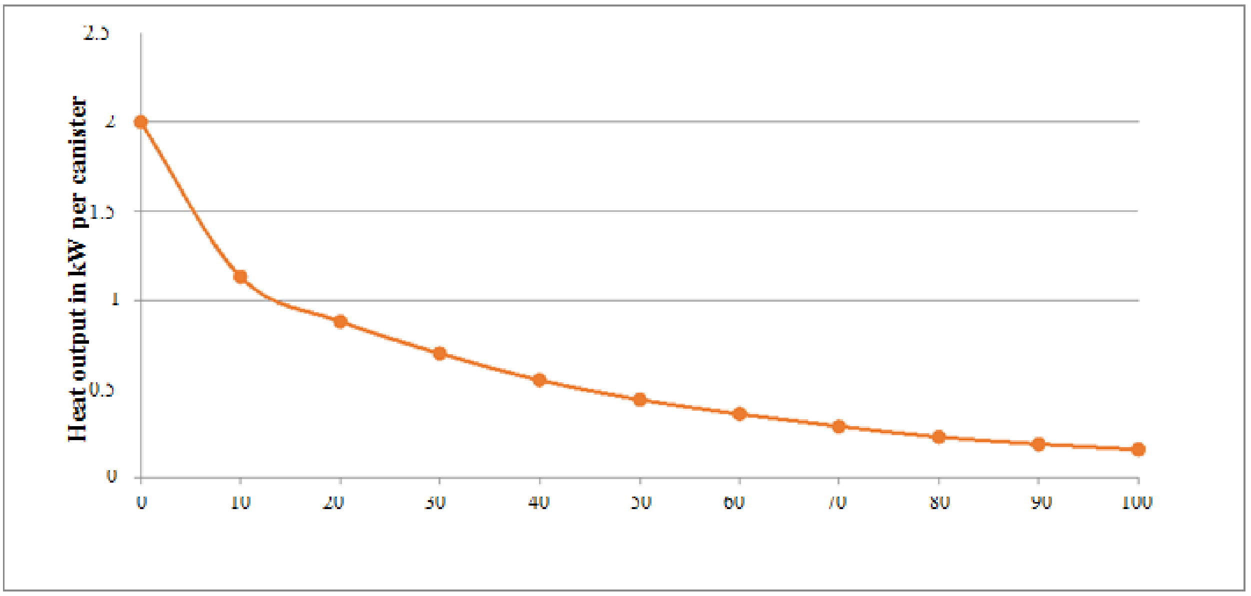
Waste type	45-49 years	50-54 years	55-59 years	60-64 years
Vitrified high-level radioactive waste	500	360	1,310	1,565
Vitrified intermediate-level radioactive waste	19	13	50	58
Other intermediate-level radioactive waste	550	395	1,445	1,714
Total	**1,069**	**768**	**2,805**	**3,337**

With high-level radioactive waste from reprocessing, the decay time starts with vitrification of the waste, i.e. with the production of glass canisters. The fuel elements sent for processing were removed from the reactor cores some time ago. This means that from the outset, the heat output of glass canisters is somewhat

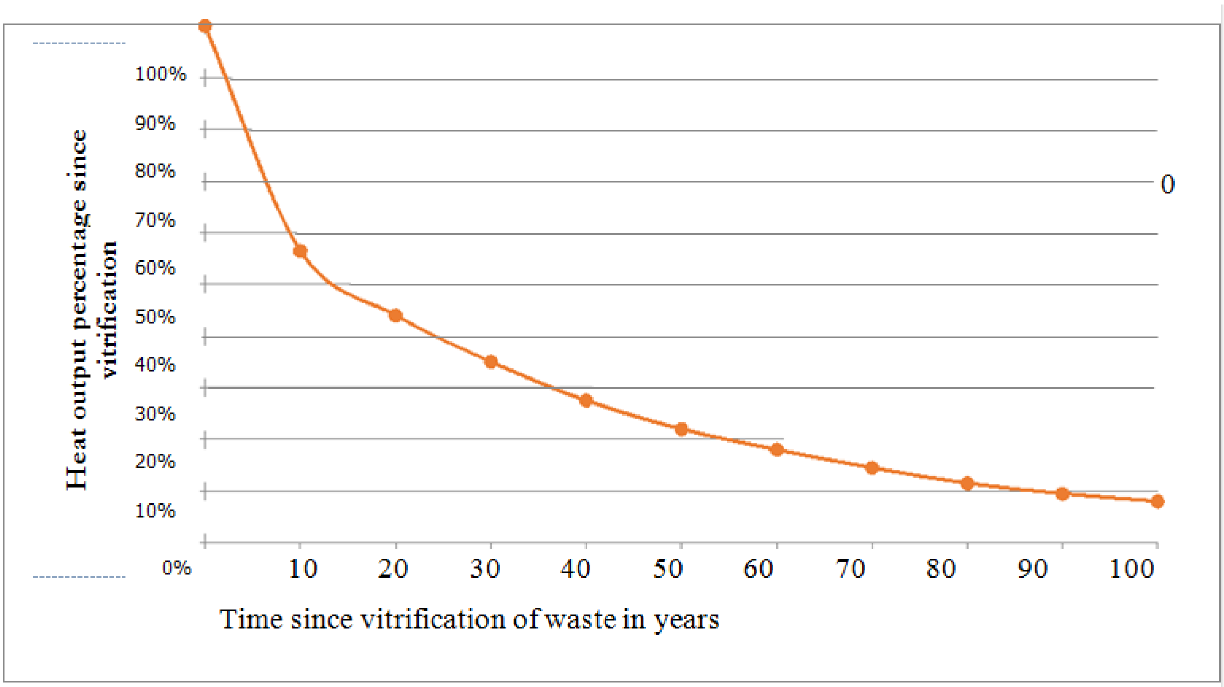
[356] Graphic from the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: information supplied to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p. 16.

lower than that of the spent fuel elements. The heat output of the glass canisters will approximately halve within 15 years of their production. The following two graphics show how the heat output from reprocessed high-level radioactive waste will develop over time:

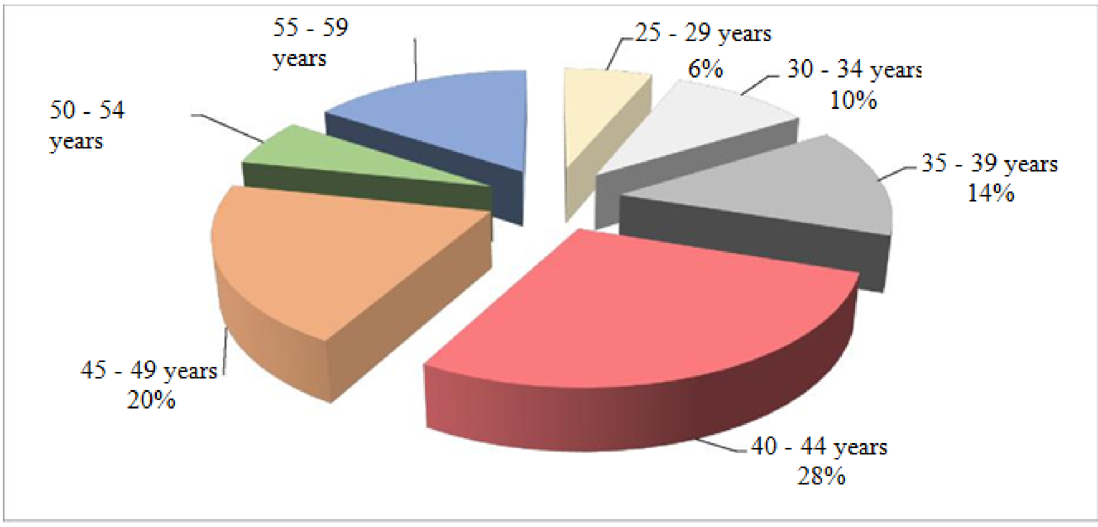
Graphic 7: Temporal development of heat output of canisters containing reprocessed high-level radioactive waste -Time since vitrification of waste in years



Graphic 8: Percentage decrease in heat output from canisters containing reprocessed high-level waste



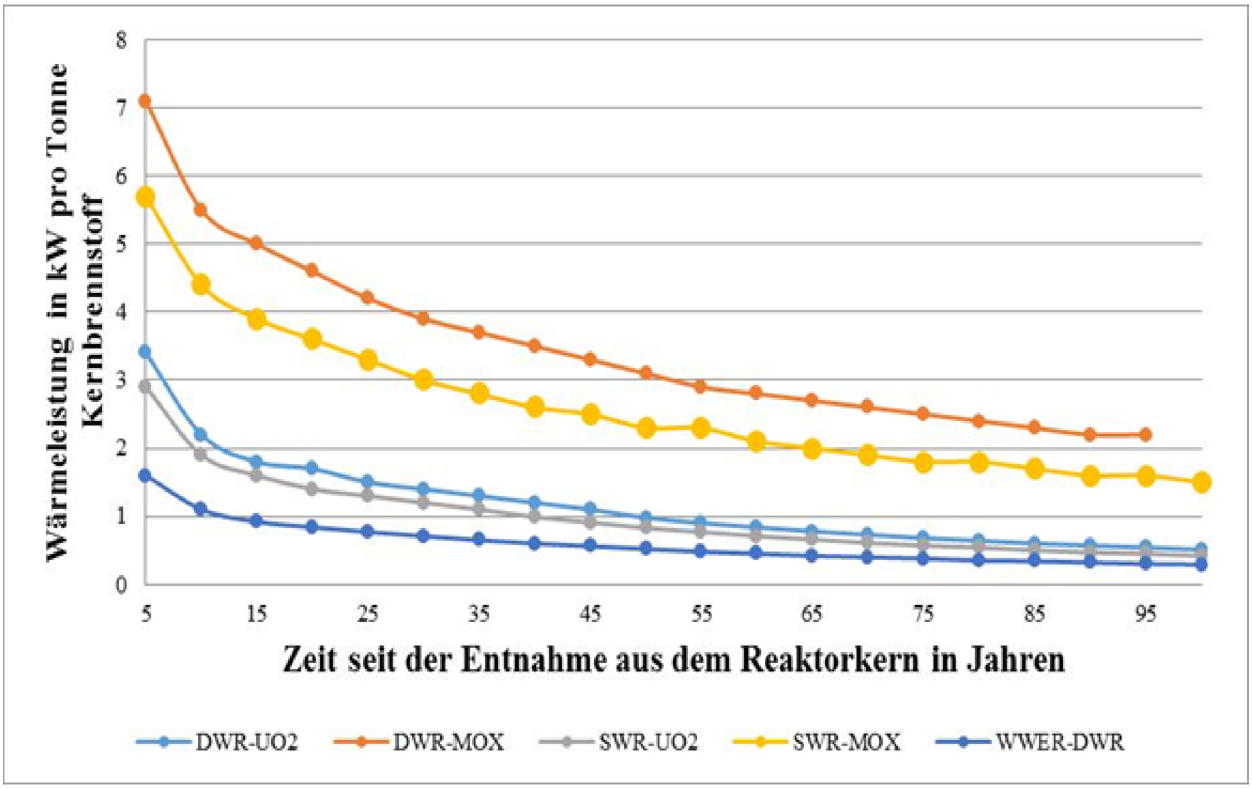
Graphic 9: Storage period of spent fuel elements following removal from the reactor core in 2050



German law initially prescribed reprocessing and, at a later time, direct disposal of spent fuel elements. For this reason, the spent fuel elements exhibit, on average, shorter decay times upon disposal:[357]

[357] Table from the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: information supplied to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p. 14.

Graphic 10: Heat output of various types of spent fuel elements after decay times

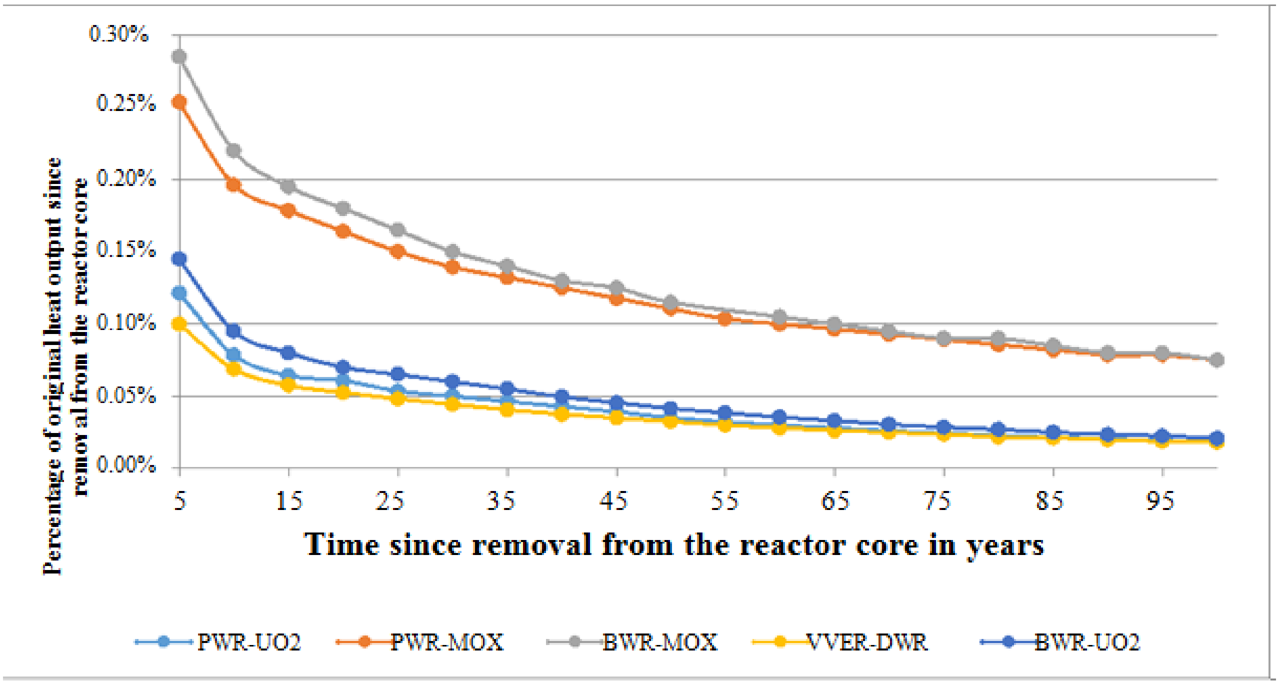


Wärmeleistung in kW pro Tonne Kernbrennstoff	Heat output in kW per tonne of nuclear fuel
Zeit seit der Entnahme aus dem Reaktorkern in Jahren	Time since removal from the reactor core in years

The heat output declines at different rates depending on the fuel element type involved. When compared with other spent fuel elements, mixed oxide fuel elements emit larger quantities of heat over prolonged periods: [358]

[358] Both tables from: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: information supplied to the Commission on the Storage of High-Level Radioactive Waste of 2 February 2016, p. 15.

Graphic 11: Percentage decrease in heat output by fuel element type and decay time



The following table provides an overview of the expected distribution of fuel element types grouped by age and their decay times:

Table 20: Expected number of various types of fuel element in the year 2050, grouped by age

Fuel element type	**Number of fuel elements per age group in the year 2050 (total nuclear fuel content in tonnes)**						
	25-29 years	30-34 years	35-39 years	40-44 years	45-49 years	50-54 years	55-59 years
Pressurised water reactor - uranic oxide	1,220 (635 t)	1,580 (820 t)	2,150 (1,120 t)	3,200 (1,680 t)	2,550 (1,300 t)	1,600 (800 t)	150 (60 t)
Pressurised water reactor - mixed oxide	60 (30 t)	110 (60 t)	160 (85 t)	700 (360 t)	450 (210 t)	50 (20 t)	
Boiling water reactor - uranic oxide	780 (135 t)	1.730 (295 t)	2.190 (370 t)	5.450 (950 t)	3.550 (610 t)	450 (75 t)	200 (30 t)
Boiling water reactor - mixed oxide	110 (20 t)		340 (60 t)	350 (60 t)	450 (80 t)		
VVER pressurised water reactor							5,050 (580 t)
Total	**2,170 (820 t)**	**3,420 (1,175 t)**	**4,840 (1,635 t)**	**9,700 (3,050 t)**	**7,000 (2,200 t)**	**2,100 (895 t)**	**5,400 (670 t)**

Heat input at a disposal facility can also be reduced by observing appropriate decay times that take account of the fuel element types' different heat outputs. Due to the necessary emplacement period, the distribution of fuel elements and waste from reprocessing across the various age groups would enable an average decay time of between 50 and 60 years

after the commissioning of a disposal facility in 2050. However, the effects of heat input on the surrounding rock depend significantly upon the conditioning of the high-level radioactive waste and the selected total size and area of the disposal facility.

2.4 Principles for handling conflicts during the participative search procedure

2.4.1 Seeking consensus on a highly contentious topic

The participative search procedure that is proposed will break new ground as far as central questions regarding social policy are concerned. It will address a highly complex topic with a previous history marked by numerous conflicts over many decades, and in doing so it will have the aim of finding a solution supported by a broad societal consensus that can ultimately be tolerated by the directly affected parties as well.

This aim can only be achieved if all the parties are not only involved fairly and unreservedly in the whole procedure, but if these parties are also willing to engage in a new culture of openness to societal conflicts that does not ignore past conflicts, continually addresses any new conflicts that arise, but is always oriented towards the principle of constructive conflict management and does not lose its focus on the shared goal of a largely consensual, societally viable solution.

This requires a participative search procedure that is described in more detail in another section of the present report.

Handling old and new conflicts during each phase of this participative search procedure will become a key touchstone in terms of arriving at acceptance of the need for a result, and indeed tolerance of the result itself. The Commission is aware of this, which is why it provides a detailed description of the requirements placed on handling conflicts throughout the procedure.

2.4.2 Consensus as the objective of the procedure

The participative search procedure is designed to arrive at a solution that will endure for generations under maximum societal consensus. Nevertheless, absolute societal consensus on this topic would be utopian. For this reason, our efforts involve fostering a stable consensus that includes as many circles of society as possible and is also robust enough to avoid any prolonged societal condemnation.

Above all else, interacting with critical groups and taking their points of view seriously will prove to be a key touchstone for the gravity of the procedure as reflection on fundamental criticism can help to improve the procedure in the long term. Sound conflict and quality management of participation will help the participation system to prove its ability to learn. This requires the constant offering of participation, which should also be extended to critical groups. This, however, also requires such groups to be willing to participate, or at least to enter into dialogue.

Particular attention must be paid to those affected in the area around the selected site. They are to be provided with information and given opportunities to participate in the decision-making process so as to enable them to contribute to or at least tolerate the end result. Inversely, this means that particular care must be taken when handling conflicts with affected people.

People who live near existing interim storage facilities – and will continue to do so for an extended period – are also affected. The experiences of people who live near existing interim storage facilities are valuable to the participative search procedure, which would do well to maintain dialogue and foster a respectful relationship with them throughout the process.

The handling of these conflicts will be decisive to the acceptance, tolerance and sustainability of the solution that is found.

The procedure itself will always have to work towards consensuses, but it will be largely dominated by the handling of various conflicts. The character of the participative search procedure will therefore have to be mediating, negotiating and creative all at the same time (yet of varying intensity depending on the given phase). The respective character of the procedure will be considered when specifically shaping the procedure itself.

2.4.3 Conflicts driving the procedure

How we deal with the paradox that the procedure seeks consensus, but is also driven by conflicts will dominate the whole participative search for a disposal site. This will confront the parties that deliver and design the search procedure with particular challenges. On the one hand, unproductive conflicts regarding the process design should be avoided; on the other hand, conflicts should be taken into account as they are key to clarifying issues.

As it is not possible to envisage all of the potential conflicts of a procedure spanning several decades, we are not able to define all the details of the procedure from the outset, nor is it possible to work through all of the conflicts that may arise and which cannot be planned for at this time. What we can do, however, is put in place the foundations and structures to ensure a fair culture of conflict so that organisations, bodies and participants may and should expect to be treated with respect.

This requires a specific, robust and learning process design that evaluates, accounts for and adapts to the experiences gleaned throughout this search procedure and other participation procedures. Professional conflict management like that presented in the community participation section of the present report will play a key role here as conflicts are often perceived as disturbances and risks during participation procedures. In our case, conflicts may also cause delays, extra work, and even decisions to return to earlier stages. Irrespective of this, it is imperative that conflicts are not perceived as conflicts, but as potential drivers for clarifying key questions, as potential contributions to improving results and their acceptance, as initiators in preparation of decisions aimed at reaching a consensus and, thus, as indispensable components of a successful procedure. Conflicts that are acknowledged and worked on collectively to arrive at a solution can ensure sound progression of the procedure as they do not run the risk of being forced to return to earlier stages. They also help to ensure that each subsequent step of the participative search procedure is shaped successfully. For this reason, the next participation step should be discussed in detail during the respective previous step and agreed on with the delivery organisation and the parties involved.

2.4.4 Conflict management

Conflict management always entails the need for flexibility and adaptability. These characteristics are therefore extremely important to a procedure conducted over such a long period of time and which meets our requirements in this regard.

2.4.5 Conflict scope of the procedure

Fundamental active and affirmative conflict management within the scope of the participative search procedure does not mean that every issue raised by actors involved in the procedure must be handled or even solved within the procedure.

Conflicts may arise without any contextual reference to the objective of the procedure that either intend to cause the procedure to fail or which cannot be solved during the course of the procedure.

The question as to which conflicts are to be handled and managed during the procedure, i.e. the conflict scope, is therefore highly sensitive and of key importance to ensuring acceptance of the procedure and its results. We would therefore like to make the following specific suggestions in this regard.

2.4.6 Neutral conflict management

In order to foster acceptance, the delivery organisation must not be solely responsible for defining the conflict scope and, in particular, its actual application. This, in turn, requires a neutral, recognised entity.

It is accepted as a matter of principle that every conflict which arises during the procedure will be addressed by way of a transparent procedure involving those concerned and assigned to a category within the abovementioned conflict scope.

2.4.7 Relevance to the procedure

If a significant proportion of participants consider a conflict to be relevant to the procedure, the given conflict will be assigned to one of the following four potential categories in a process that is as consensual as possible:

- Conflict can be solved or deescalated within the procedure
- Conflict is relevant to the procedure, but not within the procedure
- Conflict can be solved or deescalated
- Conflict is not relevant to the procedure

Conflicts assigned to the first group must be handled within the procedure. Conflicts assigned to the second group may encourage participants to adopt a mutual stance. They will definitely be addressed and monitored intensely during the procedure. Conflicts assigned to the third group will be monitored by the conflict management entity mentioned above which, if necessary, can called upon to assist with the procedure.

2.4.8 Permanent conflict localisation

Conflicts relevant to the procedure are not always known at the start of the overall procedure or at the beginning of individual phases. They may also arise during the course of the procedure and can escalate, deescalate or become increasingly or decreasingly important to the procedure.

This therefore requires a permanent, independent conflict radar to be monitored by the conflict management entity. The aim here is to localise potential conflicts of relevance to the procedure at an early stage, and to enable them to be handled at as low an escalation level as possible. This is not intended to remove the emotional aspect of conflicts, but to prevent them from escalating by simply ignoring them.

2.4.9 Avoiding conflicts by clarifying roles

Conflict-driven participation procedures are often subject to conflicts at a later stage which are attributable to the failure to clarify roles at the beginning of the procedure.

Such procedure-based conflicts can largely be avoided if roles and their associated competences are clearly defined and recognisable to all concerned, not just at the start of the procedure, but throughout the procedure as well.

For this reason, we set great store on making sure that participants can clearly identify the current participation content and specific scopes of influence at any time within the procedure.

Participants' understanding of this should be brought up at regular intervals and any issues they may have should be clarified. Alternatively, discussions should be held at the initiative of a given party. The main point here is to sufficiently heed changes in participation and the fluctuating level of intensity.

2.4.10 Equity of resources

Conflicts are always easier to handle and solve if their content remains the same and if decisions are taken authoritatively due to dramatic differences in resources.

To this end, the measures to ensure equity of resources described elsewhere within the present report are not just of importance from ethical and legitimacy viewpoints, they also have a direct influence on the quality of conflict management.

2.4.11 Alignment based on the conflict level model

Acknowledging that conflicts can also be procedure drivers does not mean that a procedure without any dominating conflicts is of a lesser quality. All it means is that conflicts do not automatically have to have a negative impact, pose a threat to the procedure, or destroy the mood of the search for consensus. Conflicts have a legitimate place within the procedure, even if they deprive it of a unanimous solution. Even conflicts of major relevance to the procedure cannot and do not always have to be solved.

A procedure without any conflicts at all would be unrealistic and inexpedient to the procedure. The aim here is therefore not to solve every conflict, but to avoid escalation, i.e. achieve maximum deescalation.

To this end, we will work with a ‘conflict level model’ to be defined as unanimously as possible with the parties involved. Below is an example of how the individual levels could be defined:

- Contextual discourse
- Focus groups
- Mediation
- Arbitration
- Decisions taken by legitimated bodies
- Legal clarification

2.4.11.1 Contextual discourse

Discourse, i.e. a respectful debate on the content of conflict topics, forms the core of our participative search procedure. Discourse does not mean avoiding conflicts; on the contrary, it involves tackling the content of conflicts based on the premise of working together to arrive at a consensus.

Discourse will be the central method to be pursued in order to handle topics within the participative search procedure. For this reason, the development of a respectful culture of discourse is the main prerequisite for a successful procedure.

2.4.11.2 Achieving consensus in focus groups

Participative management of conflicts by way of moderated focus groups is a key aspect of participation procedures. It is always appropriate if conflicts can be localised and the group of participants can be clearly defined.

Focus groups are particularly successful if they manage, with prior individual discussions where needed, to get all of the actors central to a specific conflict around a single table.

2.4.11.3 Mediation

Mediation by an accredited institution/person is a recognised participative conflict management method.

We assume that the participative search procedure will give rise to a number of mediation cases, which is why we have made it an integral part of the procedure. Here, the participation officer(s) assume(s) a key role in the form of neutral conflict management.

In an ideal scenario, most conflicts requiring management are to be handled at an escalation level no higher than this. The participation officer(s) will talk to participants before any mediation takes place to ascertain whether a case can be mediated as mediation does not work with every kind of conflict.

2.4.11.4 External arbitration

Arbitration requires every party to the conflict to agree to involve a neutral, accredited institution or person in the solution-finding process whose decision will be subsequently recognised and accepted.

By its very nature, arbitration is only participative to a small extent; nevertheless, it is initiated as a result of participation, which is why it should be preferred over legal action or political decisions on conflicts, not least because solutions resulting from arbitration generally prove more effective in the long term than decisions taken on a political level.

2.4.11.5 Decisions taken by legitimated bodies

Decisions taken by legitimated bodies, such as the German Bundestag, are provided for in the participative search procedure so as to record and document interim results. Such decisions define the completion of participative phases.

Conflicts of major importance that cannot be resolved or deescalated within the participative search procedure may require a decision taken by a legitimated body, at least on a procedural level, in order to avoid a procedure being blocked. This solution was more or less defined without any participation, meaning that this conflict resolution method (not as a method to record results!) should be avoided whenever possible. However, should the need arise, participants should strive to achieve as great a consensus as possible as this is the only way to achieve acceptance for the decision during subsequent phases of the procedure.

This expectation should also apply to potential decisions taken by bodies at federal state or local level without calling their constitutional rights and duties into question.

2.4.11.6 Legal clarification

Legal clarification by the courts is the last resort for a procedure as it means that all of the decision-making powers are transferred to the legal structures of our society.

This in turn means that participation is completely removed from the conflict. Nevertheless, legal action is a major fundamental right of our democratic society that is of course available to procedure participants and, as such, to the procedure itself. It is both a legal and legitimate right of everyone involved. Despite this, each phase of the procedure should be designed such that legal clarification does not become necessary and deescalation measures can return legal disputes to conflict levels that enable participative management.

2.4.12 Escalation level management in the procedure

A successful participative search procedure is therefore crucially dependent upon an open, transparent, respectful and solution-oriented conflict management process that handles conflicts, localises manageable conflicts as early as possible, avoids any unnecessary further escalation, and moderates deescalation.

The specific design of the participative search procedure, in particular, must ensure that in the event of a possible escalation, conflicts do not skip several steps or pass through them within an extremely short space of time.

Conflict management is not purely aimed at fully resolving conflicts as this is seldom achieved; instead it is aimed at the principle of gradual deescalation. In terms of the procedure, success does not mean ending a conflict (potentially with winners and losers), it means returning to a lower and therefore more participative escalation or management level.

We have taken these principles into account to the greatest extent possible in our proposal for a participative search procedure. However, real-life implementation of the procedure will present a constant challenge to everyone involved in the design process.

Therefore, with all due respect to the fundamental rights to take legal action described above, efforts should always be made to provide lower-level conflict management options. Within this context, care must be taken to ensure that those involved act on an equal footing. Measures should also be taken to enable participants to interact on equal terms.

In the interest of a genuinely participative search procedure, we therefore call upon all future actors to follow the primacy of participative conflict management and to accept its results.

3 THE IMPERATIVE OF RESPONSIBILITY

3.1 Enabling orientational knowledge

Efforts to create the best-possible solution for storing radioactive waste require a proposal that achieves a broad consensus among politics and society. To this end, the Commission on the Storage of High-Level Radioactive Waste must assume the 'perspective of a society viewed as a single, enduring unit',[359] as described by philosopher Volker Gerhard. This is a central prerequisite for acting responsibly, which the Commission reflects by way of its members from politics, science and society.

The proposals the Commission submits to the Bundestag and Bundesrat require a high level of scientific and technical expertise, coupled with an understanding of the socio-cultural dimension of the challenge. Conflicts, their causes, backgrounds and contexts must be stipulated accurately so that 'orientational knowledge is enabled by way of complex interactions between the various parties involved..., by way of discourse in which everyday guidance and scientifically prepared knowledge improve how uncertainty is dealt with',[360]which in turn facilitates acceptability of joint prospects for action.

The conflicts surrounding nuclear energy do not just post a technical challenge, they also touch upon central assumptions of European modernity, above all the legitimising power of growth and development, which became the aim of progress.[361] This is because the principle of trial and error, which came to form the basis of techno-scientific progress, reached its limits. This, in turn, is due to the fact that 'learning from errors' is unable to prevent the prolonged hazards of complex technology or major ecological damage which should be excluded to the greatest possible extent from the outset.[362]

Technical progress is clearly a vital means of improving economic standards and quality of life. Nevertheless, since the Industrial Revolution, mankind has become a geophysical force that is now equal to a force of nature. Paul Crutzen, who received the Nobel prize for chemistry in 1996, drew the following conclusion from this insight:[363]'For the past three decades, there has been an escalation in the global effects of mankind on the environment. ... I therefore

[359] Gerhardt, Volker (2014): Interview in Politiken 03/2014.
[360] Cf. Evers, Adalbert; Helga Nowotny (1987): Über den Umgang mit Unsicherheit, p. 13.
[361] Cf. Müller, Michael; Matthias Zimmer (2011): Zur Ideengeschichte des Fortschritts (translation: on the history of the idea of progress), German Bundestag, report by the study commission 'growth, prosperity, quality of life', p. 200.
[362] Guggenberger, Bernd (1987): Das Menschenrecht auf Irrtum, pp. 11-26.
[363] Crutzen proposes the year 1784 as the start of the Anthropocene as this was the year in which James Watt discovered the Watt's linkage, which led to a key improvement to steam engines.

consider it appropriate to introduce the term ‘Anthropocene’ to describe the current geological era defined by human activities.[364]

In this world shaped by mankind, one of the main tasks is to manage the economy and society in a sustainable manner so as to prevent serious damage from occurring. This, in turn, requires a deepening of human knowledge of complex and longer-term interdependencies, as well as reflection on the limits of our knowledge so that mankind does not become a ruler and destroyer, but instead acts as a partner to nature and future generations: Christian Schwägerl wrote that ‘it is not about longing for a primitive past, it is about longing for an enlightened future.[365]

- In terms of the division of labour, and in a world with ever-faster processes, decisions as to whether an action is ‘good’ or ‘bad’ are either taken within a short space of time or provided by technical or economic experts. No one will be held accountable ‘for the unintended subsequent effects of a well-intended, well-considered and well-executed action’. Too little time and not enough effort are put into reflection and investigating contexts. The philosopher Hans Jonas provides the following description of the emerging vacuum that also applies to the use of nuclear energy: ‘The short arm of human power does not call for a long arm of predictive knowledge.[366]

- The principle of ‘using technology to control technology’ (Günter Ropohl) does not go far enough, especially as there is no self-perpetuating world of progress. In contrast to traditional assumptions of progress that primarily involve the proliferation of knowledge, contemporary viewpoints consider it important to gain knowledge beyond the extent of our own knowledge and to account for our lack of knowledge so that technical systems do not lead to any unintentional repercussions and side effects.

This requires a future ethics based on sustainability as the guiding objective to ensure that future generations will be able to enjoy their freedom without being saddled with any irresponsible burdens. The Commission has not been tasked with developing such a future ethics theory. It does, however, provide suggestions and advice based on experience from handling nuclear energy, in particular regarding the following questions:

- What does sustainable responsibility mean, and how can we do justice to this when storing radioactive waste?

- What do a reflexive technology assessment and technology strategy require to prevent unintentional side effects to the greatest possible extent at an early stage and in a transparent and responsible fashion?

- Despite an increasing number of practical constraints, how will democracy and freedom be ensured in the long term in our technology-driven world based on the division of labour?

In order to gain an understanding of this challenge, section B 3.1.1 provides a brief description of the history of the idea of progress, followed in section B 3.1.2 by an exploration of the need for modernisation based on Ulrich Beck’s studies

[364] Crutzen, Paul (2002): The geology of mankind, Nature 415, p. 23.
[365] Schwägerl, Christian (2010): Menschenzeit, p. 293 ff.
[366] Jonas, Hans (1979): ‘Das Prinzip Verantwortung’ (translation: The Imperative of Responsibility, released in 1984), 2003 issue, p. 25.

involving the risk society, Lothar Hack's studies on the changes in technological development, and Hans Jonas' studies on the imperative of responsibility. Section B 3.1.3 describes nuclear energy as a turning point in terms of optimism within the philosophy of history. However, this optimism must not lead to us giving up the idea of progress.

3.1.1 The Idea of Progress

As is the case with many key terms in the modern age, the idea of progress originally had a religious meaning. One such example of the early understanding of progress is John Bunyan's edification allegory 'Pilgrim's Progress' published in 1678.[367] Rationalism of the 17th century retained the salvatory meaning that was subsequently adopted in secular circles. In the 18th century, Enlightenment and reason were seen as the universal source of authority and legitimacy for the key principles of the idea of progress which is primarily aimed at liberating and emancipating mankind from doctrines and dogmas that prevent mankind from coming of age. Philosopher Immanuel Kant said '*Die Maxime, jederzeit selbst zu denken, ist die Aufklärung*' (translation: Enlightenment is man's emergence from his self-imposed nonage).[368]

The idea of progress was based on the conviction that modern society is already moving forwards due to the accumulation and dissemination of its scientific and technical advancements. This tied in with aspirations for a safely progressing world in which the main problems of human cohabitation are tackled systematically. The great chain of being (*scala naturae*) is a hierarchy of all beings arranged in a linear order from simple to complex, and has been used as a reference since the Age of Antiquity.[369]This theory of progress also constitutes the temporalisation of the pyramid of being since the higher a being is ranked within the hierarchy, the later it arrived and the more evolved it is. This was coupled with the firm belief that development is heading in the right direction, i.e. linear development that leads to higher and better circumstances. Threats and hazards were considered exceptions that could be averted thanks to technical progress.

This optimism of progress and culture became the main narrative of European modernity. It is based on the adoption of a fundamentally positive attitude towards the advancement of science, technology and productive forces. Positivism, which is largely attributed to Auguste Comte, assumed that changes generally entail improvements because they replace entrenched traditions.[370] In addition to this, the process of progress was deemed infinite, as was its later counterpart, economic growth. This gave rise to an increasing gap between mankind and nature. René Descartes demanded that humans apply mathematical rationality to become like '*maîtres et possesseurs de la nature*.[371]

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[367] Bunyan, John (1678): Pilgrim's Progress, reprinted in Hamburg in 1885.
[368] Kant, Immanuel (1999): 'Was heißt, sich im Denken orientieren?', AA8, recommended study edition, p. 146.
[369] Cf. clarification provided by Linné, Carl von (1758): Systema Naturae, 10th edition.
[370] Cf. Comte, Auguste (1851-1854): Système de politique positive, four volumes.
[371] Cf. Descartes, René (1637): Discourse on the Method of Rightly Conducting the Reason.

Theologian Günter Altner viewed this understanding of nature as being an oblivion of nature: 'The vision of domination announced by philosopher René Descartes whereby humans become like 'masters and possessors of nature' is extremely ambivalent. On the one hand, we have become the victors of nature; on the other hand, our victories could lead to our downfall. And this constellation is linked to the initial situation at the start of the modern age.[372] Altner concluded that 'Cartesian subject-object dualism… in ever-renewed guises has become the general foundation of our scientific, technical and industrial exploitation of nature. The premise that nature is purely an object or resource at the disposal of mankind and serves no other purpose is the basic dogma of technical and industrial progress, which is now moving along at an ever-increasing pace.[373]

Adam Smith's notion of an 'invisible hand', a natural force that self-regulates the market economy and fosters prosperity,[374] or Immanuel Kant's idea of a natural purpose that guides the development of knowledge and ability[375] are both an expression of the deep-rooted trust that free and unimpeded human activity will lead to an overall positive development. This understanding was primarily based on experiences from that period and is not as naive as construed by postmodern representatives. The works of Enlightenment philosophers such as Jean-Baptiste d'Alembert, Denis Diderot and Immanuel Kant show that they considered science and technology primarily as the driving forces for a better life and for human emancipation. Enlightened society considered scientific progress an important means of achieving human emancipation, rather than an end.

In the 19th and, above all, 20th centuries, progressivism only extended to economic growth. Equating technical progress to societal progress became a self-assured, demonstrated world view[376] legitimised on the basis of real experiences and human rights discourse.[377] There is a long list of advances that have improved life. In terms of the workers' movement, the evolvement of productive forces and the revolutionisation of relations of production revolution formed the strategic lever used to overcome old and outdated structures within society. 'Time is on our side', was the slogan they used. This understanding of progress became deeply rooted in the consciousness of enlightened society and the workers' movement, despite the fact that technical progress was also viewed critically during the previous century.[378] It was not until the start of the 1970s that the notion of progress came under increased scrutiny, mainly due to insights into ecological hazards. The work of Dennis Meadows and his team from the

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[372] Altner, Günter (1991): Naturvergessenheit, p. 14.
[373] Altner, Günter (1991): Naturvergessenheit (translation: nature oblivion), p. 2.
[374] Smith, Adam (1776): An Inquiry into the Nature and Causes of the Wealth of Nations, London / 1937 edition, p. 423.
[375] Kant, Immanuel (1784): Idee zu einer allgemeinen Geschichte in weltbürgerlicher Absicht (translation: Idea for a Universal History with a Cosmopolitan Aim), Berlinische Monatszeitschrift, no. 11, p. 385.
[376] Müller, Michael; Johano Strasser (2011): Transformation 3.0, p. 26.
[377] Cf. Landes, David S. (1983): The Unbound Prometheus: Technological Change and Industrial Development in Western Europe.
[378] e.g. Benjamin, Walter (1940): On the Concept of History, 1991 issue, pp. 690-708. Here, particular reference is made to the description of the Angelus Novus (New Angel): 'His face is turned toward the past. Where we perceive a chain of events, he sees one single catastrophe which keeps piling wreckage upon wreckage and hurls it in front of his feet. The angel would like to stay, awaken the dead, and make whole what has been smashed. But a storm is blowing from Paradise; it has got caught in his wings with such violence that the angel can no longer close them. The storm irresistibly propels him into the future to which his back is turned, while the pile of debris before him grows skyward. This storm is what we call progress.'

Massachusetts Institute of Technology (MIT)[379] contributed significantly in terms of raising public awareness about the limits to growth.[380]

3.1.2 Risk Society and the Imperative of Responsibility

The debate surrounding future ethics arose in the 1980s and was based on the ever-forward-reaching effects of technological processes that vastly exceed the given foreknowledge. Key drivers of the debate included 'The Imperative of Responsibility'[381] by Hans Jonas, 'Risk Society: Towards a New Modernity'[382] by Ulrich Beck and 'Vor Vollendung der Tatsachen' by Lothar Hack.[383] Jonas and Beck used nuclear energy as an example to show that modern industrial society has the historically unique techno-scientific potential to improve economic standards and quality of life, yet longer-term processes could lead to both the destruction of nature and self-destruction if 'reflexive' (sustainable) modernisation does not take place soon.[384] Hack warned against 'science becoming a commodity' as it would then lose the ability to bear in mind what facts are: 'fixed and flexible.'[385]

Sociologist Ulrich Beck justified the need for a change of paradigm by stating that industrial societies are no longer production societies, but increasingly becoming societies based on the consequences of production.[386]This leads to modified forms of reality generation, particularly as a result of disregarding the temporal requirements on reflection to avoid hazards or to regenerate natural lifecycles. This transformation of industrial society has become an ethical issue.

Ulrich Beck described this new scenario a 'risk society' since the hazards of the Atomic Age can no longer be excluded. 'These hazards are the new cultural and political power. Its force is embodied by the hazard that annuls all of the protective zones and differentiations of modernity.' Beck also wrote that 'in contrast to class and social hierarchies, it (*the new hazard destiny*) is not characterised by emergency, but by fear; it is not simply a 'traditional relic', but a product of modernity in its highest form of development. Since the Chernobyl accident, nuclear power plants – the pinnacle of human productive and creative power – have also become signs of a return to the Middle Ages in terms of hazards.[387] In his description of the risk society, Beck referred primarily to the hazards of nuclear power, but also to the hazards of other complex technology that present us with entirely new challenges.

Philosopher Hans Jonas also assumed a 'self-transformation of the industrial society' in his analysis, concluding that 'the promise of modern technology has turned into a threat or become inextricably linked to one.[388] He also posited an

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[379] MIT stands for the Massachusetts Institute of Technology in Cambridge, USA.
[380] Meadows, Dennis et al. (1972): The Limits to Growth.
[381] Cf. Jonas, Hans (2003): The Imperative of Responsibility, p. 25.
[382] Beck, Ulrich (1986): Risk Society: Towards a New Modernity
[383] Cf. Hack, Lothar (1987): Vor Vollendung der Tatsachen.
[384] Strasser, Johano (2015): The Drama of Progress, p. 272.
[385] Hack, Lothar (1987): Vor Vollendung der Tatsachen, p. 10
[386]. Beck, Ulrich (1995): The Conflict of Two Modernities, in Beck, Ulrich: Democracy without Enemies, p. 21.
[387] Beck, Ulrich (1986): Risk Society: Towards a New Modernity, p. 7 f.
[388] Jonas, Hans (2003): The Imperative of Responsibility, p. 7.

'ethical vacuum' in which 'the greatest power will pair with the greatest void, while the greatest knowledge will pair with the least knowledge.[389] Jonas called for a future ethics by stating that 'the finally unbound Prometheus (*the link between fossil or nuclear fuels and the industrial revolution*), which is given unprecedented powers by science and restless impulses by the economy, calls for an ethics that will restrict its powers with voluntary reins to prevent mankind from wielding too much power and becoming a disaster. ... Nature's intended submission to human happiness has been so successful that this submission has now extended to the nature of mankind itself. This, in turn, has led to the greatest manmade challenge the human race has ever faced'. According to Jonas, this challenge is completely new and cannot be countered by way of any traditional ethics because they are not a future-oriented ethics of responsibility. His proposal to counter the 'ethics of ulterior fulfilment' is a 'love of the most distant', which he describes as the Imperative of Responsibility to distinguish between ideal knowledge and real knowledge.[390]

Such a future ethics, described by sociologist of science Lothar Hack with the words anticipation, simulation and reversibility,[391] demands a realignment of the institutional and consensual regulatory framework in today's societal and political upheaval. Hack pointed out that practical constraints are integrated within the structures of technical development, sometimes intentionally as planned, but often as a result of scientific constrictions, an increasing broadening of the division of labour, and interest-led short-sightedness. The key issue to be clarified is how *faits accomplis* will occur, how they will be arrived at, and how they will be deemed irrevocable. This is the result 'of the structural context of their formation, interlinking, societal standardisation, interpretation, assessment and acknowledgement.[392]

'In order to ensure that the dissimilarity (*of tomorrow's world in contrast to that of yesterday*) does not become disastrous in nature, previous knowledge of the scope of our power must try and catch up again while also submitting to the immediate objectives of criticism in terms of distant effects.' Jonas states that this gives rise to two urgent tasks: 'Firstly, maximise knowledge pertaining to the consequences of our actions with a view to how they may determine and pose a hazard to the future of mankind; secondly, in light of this knowledge... build up new knowledge of what is acceptable and what is not, what is permissible and what must be avoided. ... The former is factual knowledge, while the latter is value knowledge. We need both to create a compass for the future.[393]

Jonas also established that 'the new ground we are breaking with high technology remains no-man's land when it comes to ethical theory.[394] In state and public bodies at least, future ethics has only seen marginal representation to date,[395] meaning that 'it has not been able to have any sway.[396] A key cause of this is the

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[389] Jonas, Hans (2003): The Imperative of Responsibility, p. 57.
[390] Jonas, Hans (2003): The Imperative of Responsibility, p. 66.
[391] Cf. Hack, Lothar (1987): Vor Vollendung der Tatsachen, p. 227 ff.
[392] Cf. Hack, Lothar (1987): Vor Vollendung der Tatsachen, p. 10 ff.
[393] Jonas, Hans (1986): The Imperative of Responsibility: In Search of an Ethics for the Technological Age, Meyer, Thomas; Miller, Susanne (Hg.), Zukunftsethik und Industriegesellschaft, p. 5.
[394] Jonas, Hans (2003): The Imperative of Responsibility, p. 7.
[395] There are of course study commissions, institutions to estimate the consequences of technology, the advisory council for sustainability and the right of associations to initiate proceedings, all of which make important contributions to debates on the future but with little effect to date.
[396] Jonas, Hans (2003): The Imperative of Responsibility, p. 55.

fact that globalisation of the market economy is focused sharply on the here and now. Social scientist Richard Sennett called this a 'short-term regime.[397]

Early reflection of the quantitative and qualitative effects of economic and techno-scientific processes is of fundamental importance to future ethics. It facilitates the brace that prevents increasing levels of differentiation, acceleration and internationalisation of modernisation processes from becoming an intrinsic risk to modernity. This is contrasted by the future ethics of Aristotle's 'oikonomia', i.e. the teaching of good and proper 'household management' based on a trio of politics, economics and ethics.[398] The Saxon mining administrator Hans Carl von Carlowitz (1645 – 1714) referred to this in his theory of sustainability published in 1713.[399]

Instead of bidding farewell to modernity, Hack and, even more so, Beck and British social scientist Anthony Giddens called for a reflexive modernisation that must be capable of a new Enlightenment both in and against the independence of industrial society since society will encounter itself when faced with hazards. Society needs to understand reflexive modernisation as a guide leading the way to change and changeability.

Unintentional ecological and social side effects can only be permanently excluded in advance to the extent that the preconditions of industrial society are reviewed and a new regulatory framework is developed.[400] This task is of fundamental importance in the Anthropocene in which human responsibility is the key issue for the future. Crutzen not only points out mankind as being the source of global ecological problems, he also calls upon humankind to take responsibility 'by adopting an appropriate behaviour at every level.[401]

There is no blueprint available for a shift in paradigm, but there are indeed important suggestions, examples and information available from debates on technology, science and sustainability conducted in the past. Armin Grunwald, Director of the Institute for Technology Assessment and Systems Analysis (ITAS) at Karlsruhe Institute of Technology (KIT), developed an innovative, multidimensional technology assessment concept aimed at 'organising all-round responsibility.[402] Suggestions like this should be used more by science and politics.

3.1.3 Nuclear energy as a turning point

Technical progress is the focus of European modernity. The optimism of technical progress seen within the philosophy of history was justified, above all, in European modernity. Nuclear energy marks a turning point in this regard. Beck called it an 'organised irresponsibility' that must not be permitted to persist. Otherwise humans would end up as 'prisoners of a rationality that threatens to

[397] Cf. Sennett, Richard (1998): The Corrosion of Character.
[398] Cf. Löbbert, Reinhard (Hg.) (2002): Der Ware Sein und Schein.
[399] Cf. Carlowitz, Hans Carl von (1713): Sylvicultura oeconomicirca.
[400] Cf. Beck, Ulrich; Giddens, Anthony; Lash, Scott (1996): The Controversy on Reflexive Modernisation.
[401] Crutzen, Paul J. (2002): The geology of mankind, Nature 415, p. 23.
[402] Grunwald, Armin (1999): TA-Verständnis in der Philosophie, Bröchler, Stefan; Simonis, Georg; Sundermann, Karsten (Hrsg.): Handbuch Technikfolgenabschätzung (guide to assessing the impact of technology), p. 93.

become the opposite.[403] He saw a general trend behind this: 'Reasons for the protest... that are no longer just individual cases, visible hazards that can be ascribed to attributable interventions. An increasing number of hazards are emerging that are often neither visible nor tangible to laypeople, which, depending on the circumstances, may not take effect during the lifetime of those concerned, but during the lifetime of the second generation of their descendants.[404]

Beck holds the view that traditional hazard management is reaching is limits. In the future, early reflection on the long-term effects of political and technical decisions is required along with new assessment standards and development paths. The risk society is bringing the rifts between scientific and social reality to the fore. By putting forward its proposals, the Commission would like to assist in overcoming conflicts and arriving at a new consensus.

In the dispute surrounding nuclear energy, it has often been committed citizens, individual scientists, campaigns and associations that have made efforts to publicise potential hazards. Here are three such examples:

- In 1974, lawyer Erhard Gaul presented his 'warnings against the peaceful use of nuclear energy' in which he also pointed out the problems associated with radioactive waste: 'There is no other source of energy whose 'use' generates anywhere near as much waste as that of the nuclear industry; there is also no other form of waste that is remotely as dangerous as that of atomic fission products.[405]

- An academic opinion produced by the University of Bremen in 1982 came to the following conclusion: 'The comparison between the requirements of official radiation protection and recommendations from commissioned experts shows yet again that the criteria for protecting the population are not linked to reality; in fact, their requirements are reduced repeatedly until they appear implementable based on the given scientifically justifiable effort.[406]

- In August 1977, after a colloquium held at the 'Scuola Internazionale Enrico Fermi', 28 renowned physicists from twelve countries called for an end to the 'closed society' of nuclear scientists: 'We call upon the public to scrutinise the views of experts and to not simply follow the claims of anyone purporting to know more' about the subject.[407]

As a result of the hazards and subsequent burdens of nuclear energy, technology has generally become known to have two sides, i.e. it can have both positive and negative effects.[408] It is paradigmatic of the responsibility mankind bears to safeguard the biosphere and the future of mankind itself. To this end, Jonas states

[403] Beck, Ulrich (1988): Gegengifte: Die organisierte Unverantwortlichkeit (translation: Antidotes: Organised irresponsibility), p. 96.
[404] Beck, Ulrich (1986): Risk Society: Towards a New Modernity, p. 265.
[405] Gaul, Erhard (1974): Atomenergie oder ein Weg aus der Krise? p. 84.
[406] University of Bremen (1982): Wie lange müssen die radioaktiven Abfälle des Kernbrennstoffkreislaufs von der Biosphäre ausgeschlossen bleiben? (translation: How long must radioactive waste from the nuclear fuel cycle be shut away from the biosphere?) p. 25
[407] Scuola Internazionale di fisica 'Enrico Fermi' (1977): Problemi die fondamenti della fisicirca Varenna, 25 July - 6 August.
[408] Cf. the recitals in Chapter 9 of the present report.

that we should not only look at the ‘proximity of our actions’, but learn ‘future knowledge that is open to anyone of good will.[409]

In his work ‘Groundwork for the Metaphysics of Morals’, Kant stated that ‘human reason, even in the commonest understanding, can easily be brought to a high measure of correctness and accuracy in moral matters.[410] His categorical imperative, ‘act only according to that maxim through which you can at the same time will that it become a universal law’, is a generally applicable criterion for testing actions and standards based on rationality.

Mankind is rational, but not driven solely by rationality, especially when it comes to consequences in the distant future. As Jonas points out, the preconditions for the categorical imperative have changed since the world and its opportunities are now different to those of early modern Europe. The magnitude, opportunities and far-reaching consequences of technology cannot be covered by ethics applied to date. Jonas’ conclusion here is that the categorical imperative must be extended as a generally applicable moral principle that requires all of mankind to follow the maxim at all times and without exception, and to consider the right of everyone concerned, including that of future generations.[411]

Jonas thus goes further than Kant in his work ‘Ethics for the Technological Age’. His categorical imperative highlights the conceivable future consequences of potential actions, and therefore understands it as the effects of actions. He also adds to Kant’s criteria of reason on a specific level: ‘Act so that the effects of your actions are compatible with the permanence of genuine human life’, and ‘Act so that the effects of your actions are not destructive for the future possibility of such life.[412] Jonas combines factual knowledge with value knowledge. ‘We need both in order to create a compass for the future.[413] By way of his ethics of responsibility, Jonas distances himself from the positivism of Karl Popper, who defined science as being ‘the systematic presentation of our conviction experiences’. Jonas counters this with the following: ‘We cannot utter a scientific sentence that does not go far beyond what we are able to know for certain based on direct experiences.[414]

The main reason for the imperative of responsibility is presented in the call to decipher the future into its opportunities and hazards. However, this requires further clarification: Does the imperative of responsibility therefore only extend to preservation and self-limitation? Is the idea of progress obsolete because of this? Or does it remain, albeit in modified form, the basis for ‘the liberation and

[409] Jonas, Hans (2003): The Imperative of Responsibility, p. 24.
[410] Kant, Immanuel (1785/1978): Groundwork for the Metaphysics of Morals. Academic text issue, vol. 4, p. 391.
[411] Kant, Immanuel (2004, first edition from 1785): The term was first used in Groundwork for the Metaphysics of Morals,
Göttingen. It was also used extensively in (2003, first edition from 1788), Critique of Political Reason, p. 36 f.
Jonas, Hans (1986): The Imperative of Responsibility: In Search of an Ethics for the Technological Age, p. 5.
[412] Jonas, Hans (1986): The Imperative of Responsibility: In Search of an Ethics for the Technological Age, p. 36 f.
[413] Jonas, Hans (1986): The Imperative of Responsibility: In Search of an Ethics for the Technological Age, p. 5.
[414] Popper, Karl (1971): Logik der Forschung (translation: Logic of research), 4th edition, pp. 389-390.

realisation of humanity?[415], as questioned by philosopher Karl-Otto Apel who demands that the imperative of responsibility be linked to the 'demand for discursively organised, solidary responsibility of mankind for its collective actions.' This demand requires 'linking the imperative of preserving human existence and human dignity with the socio-emancipatory imperative of our surrendered progress in the realisation of humanity.[416]In today's crisis situation, this is also required for the 'application of a collective responsibility for the future across every dimension.[417]A number of questions remain open that would need to be clarified for a discourse ethics, which in turn requires more direct participation and an expansion of representative democracy. The Commission has also put forward proposals in this regard.[418]

3.2 The Conflict of Two Modernities

Nuclear energy serves as an example of the transformation process in European modernity.[419] We have adopted the distinction between *first or simple modernity* and *second or reflexive modernity*, which was primarily developed by the social scientists Ulrich Beck and Anthony Giddens.

- The first modernity applies to the period since European Enlightenment, and certainly to the period following the industrialisation and bureaucratisation of society. It began in the 18th century and resulted in the formation of a nation state and civil society.
- The second modernity is characterised by processes involving the independence of subsystems. The key differences are the irreversibility of 'globality', the individualisation of societies, and the increase in the significance of side effects of industrialisation, all of which justify a reflexive modernity. The second modernity has no exact definition, but its intended meaning is clear: raise awareness for and focus on fundamental change.

Beck made this particularly clear by pointing to the boundaries of the first modernity, which only works under the premise that risks can be calculated. Here, the functional logic of the first modernity means:

- It must be possible to manage, limit and therefore insure any damage that occurs;
- In the event of loss or accident, it must be possible to offset and compensate the consequences;

[415] Apel, Karl-Otto (1987): Verantwortung heute, Meyer, Thomas; Miller, Susanne (Hrsg.), Zukunftsethik und Industriegesellschaft (translation: future ethics and industrial society), p. 14.
[416] Apel, Karl-Otto (1987): Verantwortung heute (translation: responsibility today), Meyer, Thomas; Miller, Susanne (Hrsg.), Zukunftsethik und Industriegesellschaft (translation: future ethics and industrial society), p. 35.
[417] Apel, Karl-Otto (1987): Verantwortung heute (translation: responsibility today), Meyer, Thomas; Miller, Susanne (Hrsg.), Zukunftsethik und Industriegesellschaft (translation: future ethics and industrial society), p. 37.
[418] Cf. section B 7 of the present report: Site selection procedure in dialogue with the regions.
[419] By way of example, the first or simple modernity was described by Max Weber (1922): Economy and Society,
and by Ferdinand Tönnies (1935): The Spirit of the Modern Age. The Second or Reflexive Modernity by Ulrich Beck (1986):
Risk Society, and by Anthony Giddens (1996): The Consequences of Modernity.

- Technology must not cause any major collective consequences;
- In the event of major risks, it must be possible to interrupt the chain between cause and effect at any time by means of an 'extended police law'.

Beck considered the most important difference between the two modernities to be the difference between controllable consequences, i.e. *risks* that are inextricably linked to industrial society yet remain controllable by way of political and societal frameworks, and new consequences that are difficult to manage, i.e. *hazards* that are caused by the consequences of industrial production, e.g. ecological damage, which could pose a fundamental threat to the development of the economy and society. This means that during the course of modernisation processes, traditional frameworks of industrial society are gradually replaced by new ones.

Highly developed industrial societies no longer have a 'simple' development logic as processes are becoming increasingly complex, often with far-reaching consequences. This is not only demonstrated by nuclear energy, but – as Earth system research has shown – also by exceeding 'planetary boundaries' as a result of 'socialisation of natural destruction' in the form of anthropogenic climate change, the nitrogen cycle or the destruction of biodiversity.[420] These hazards have been becoming increasingly acute for years and are indicative of the contradiction between knowledge and action. Beck poses the question 'How is society possible in response to the ecological question?[421]

Dealing responsibly with potential consequences or a lack of knowledge requires reflection of the conceivable effects prior to the 'construction of irreversible facts' (Lothar Hack) in order to change potential technical options or not to use certain technologies at all. The difficulty of this task grows in tandem with the complexity of the technological systems and their infrastructure. For this reason, technology assessment and technology design should be extended comprehensively, and its importance increased significantly in science, the economy and society.[422]

3.2.1 Continuity becomes a turning point

In his work *The Protestant Ethic and the Spirit of Capitalism*, Max Weber described the autonomy of modern, self-perpetuating society in relation to the second major power of modernity, bureaucracy, as the 'iron casing of enslavement' which will probably only work until 'the final quintal of fossil fuel has been used up.[423]Weber described society in the first modernity. The second modernity focuses far more on what can be reasonably expected in terms of potential repercussions and side effects where nuclear energy poses the real threat of an extremely serious accident and still presents the unsolved problems of storing radioactive waste.

[420] Rockström, John et al. (2009): A safe operating space for humanity, Nature 461, pp. 472-475. Earth system research studies into climate change, the nitrogen cycle and biodiversity show that the planetary boundaries have already been exceeded.
[421] Beck, Ulrich (1991): The Conflict of Two Modernities, p. 40.
[422] See also section B 9 of the present report, 'Assessing the impact of technology and technology design.'
[423] Weber, Max (1934): The Protestant Ethic and the Spirit of Capitalism, special edition.

The risk society does not just touch upon the central ideas of European modernity, it also extends to its cultural, legal and institutional frameworks[424] as 'modernisation has always been viewed aside from the world of traditions and religions, as a form of liberation from the constraints of an irrepressible nature. What will happen if industrial society itself becomes a 'tradition'? What will happen if its own requirements, functional principles and basic concepts are broken down, dispelled and debunked with the same recklessness and momentum as the would-be eternities of previous eras?[425]

The differentiation of society and the increasing acceleration, complexity and internationalisation of economic and technical processes and their distant effects do in fact cause a separation of what was once thought to go hand in hand: the growth of production and the increase in prosperity and freedom. This therefore not only entails partial corrections, it requires fundamental furthering of the idea of modernity, which in turn gives rise to the need for Enlightenment, the ability to learn, rationality and increased democracy.

The challenges arising from the ecological question are the main focus of the second modernity. Indeed the ecological question formed the starting point for the limits of the first modernity, but it can also be used as the starting point for new progress that will shape the transformation of industrial society from social and ecological viewpoints, while political frameworks will serve to prevent any future constraints and undesired side effects from the outset.

Reflexive modernisation may take the alleged element of fate away from techno-economic development[426] by fostering knowledge and actions that understand contexts and are also sustainable. If reflexive modernisation breaks up and reforms traditional institutions and makes new forms of cooperation necessary, this may lead to globalisation being understood as an opportunity. What is important here is to understand that the development and use of technology is a social process.[427] Consequently, progress enabling an improvement in quality of life is not just a question of technical possibilities, it is also one of cultural understanding, of social and ecological compatibility, and of an extension to freedom and political frameworks.

3.3 The vision of sustainable development

The Commission's work is based on the vision of sustainable development. It was developed in the mid-1980s by the Brundtland Commission on behalf of the United Nations before being subsequently adopted and extolled as a guiding principle for the economy and society at the UN Earth Summit in Rio de Janeiro in 1992. Sustainable development can be traced back to the 'Our Common Future' report by the World Commission on Environment and Development which was published in 1987.[428] It covers ecological, social and economic goals with the aim of arriving at a form of development that 'meets today's needs

[424] Cf. Beck, Ulrich (1993): The Reinvention of Politics.
[425] Beck, Ulrich (1991): The Conflict of Two Modernities, p. 40.
[426] Dörre, Klaus (2002): Reflexive Modernisation – a Transition Theory, SOFI-Mitteilungen Nr. 30, Göttingen, p. 55.
[427] Further recitals on this are available in section B 9.
[428] World Commission on Environment and Development (1987): Our Common Future, 1987.

without running the risk of not being able to meet the needs of future generations.[429]Here, needs are to be taken in a broad sense.

Sustainable development is not a static concept; it is in fact determined at different levels and throughout different aspects of decisions based on cultural values, social requirements, technological possibilities and economic settings. Here, a temporal perspective is (permanently) added to decisions taken in politics, the economy and society which is also linked to qualitative conditions (social and environmental compatibility). Sustainable development requires a shift in the economy and economic teachings towards qualitative growth of the economy and technology as the economics applied in the last 250 years have focused on maximising the production of goods. In view of climate change, excessive use of natural resources, an overexploitation of wells and social inequality, the 'short-term economy' (Thomas Straubhaar) needs to shift towards sustainable development in order to meet the limits of natural sustainability and the principles of equity. This is in keeping with the theory of 'pluralist economics' (Real World Economics).[430]

The key starting point of the Brundtland report is: 'The balance sheets of our generations may continue to show profits – but the losses will be left behind for our children. ... Our behaviour is driven by the awareness that no one can hold us accountable.[431] If major upheavals do not occur, the sustainability of natural resources must not be overburdened. Sustainable development therefore requires a fair intergenerative and intragenerative distribution of social and ecological opportunities for current and future generations. Economic and technical innovations must be in tune with sustainable development, which in turn reinforces the imperative provided by Hans Jonas: 'Act so that the effects of your actions are compatible with the permanence of genuine human life.[432] What is most important here is that sustainable development extends the options and possibilities mankind has available to shape its economic and living conditions. This extension of freedom is key to being able to assume responsibility as there is no doubt that it is not possible to make any definitive statements about the future needs, values and technological opportunities of future generations. For this reason, sustainable development assumes the maximum possible scope in terms of shaping humane, socially just and ecologically compatible lifestyles.

Sustainable development does not mean shying away from the idea of progress; it simply entails a break with a deterministic-linear understanding. It specifies the required future ethics, based on which the Commission has put together its proposals.

3.4 Ethical principles for stipulating decision-making criteria

The stipulation of criteria for disposal sites is contingent upon various ethical principles, the first of which is, without doubt, the ethics of responsibility

[429] Hauff, Volker (Hrsg./1987): 'Unsere Gemeinsame Zukunft' (translation: Our Common Future), p. 46.
[430] Fullbrook, Edward (Hrsg./2007): Real World Economics: A Post-Autistic Economics Reader.
[431] Quote from the German Bundestag (2013): final report by the study commission 'growth, prosperity, quality of life'. Printed Paper 17/13300, p. 357.
[432] Jonas, Hans (1979): The Imperative of Responsibility, p. 36.

postulate of disposal facility safety now and in the future. This implies the need to avoid imposing unreasonable burdens on future generations.

The need for reversibility of decisions in the form of retrievability and recoverability of waste sends a different signal in which the Commission underlines the decision-making powers of future generations and the need to provide opportunities to correct errors.

The need for prescient consideration of the process pathways and feasibility of the required technical solutions through to sealing of the deep repository, i.e. the need to think the procedure through to its very end, allows research and development needs to be ascertained. To this end, conceivable scenarios that may lead to conflicts of interest between these principles must also be taken into account. In addition, high-level radioactive waste needs to be emplaced as soon as possible – whatever timeframe this may actually entail – in order to keep potential burdens resulting from the storage of waste containers at surface level low or in such a way that burdens are improbable.

3.4.1 Human and environmental safety today and tomorrow

Radioactive waste must be safely kept away from the biosphere in the short, medium and long term. This requires an ethical imperative to avoid any detriment to mankind and the environment. This affects the entire temporal spectrum when handling waste, ranging from storage in containers to their transport, any necessary interim storage, emplacement in a deep repository and, finally, a sealed deep repository and the time thereafter.

Section 3 of the Federal Ministry for the Environment's '*Safety Requirements Governing the Disposal of Heat-Generating Radioactive Waste*'[433] describes this general protection objective to be pursued by way of disposal as follows: 'To permanently protect man and the environment from ionising radiation and other harmful effects of such waste.' This protection goal needs to be specified further for it to be suitable for consideration in the development of the site selection procedure.

To this end, the Committee on a Selection Procedure for Repository Sites (AkEnd) provided the following suggestions based on previous works:

- Disposal must ensure that mankind and the environment are adequately protected against radiological and other hazards.
- The potential consequences for mankind and the environment resulting from disposal shall not exceed the degree of consequences accepted today.
- The potential transboundary consequences for mankind and the environment from disposal must not exceed those permissible within Germany.

In terms of the future, this representation specifies that future generations must not be burdened any more than today's generation, while the geographical scope relates to Germany. Further safety principles are based, in particular, on the

[433] Cf. Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (2010): 'Sicherheitsanforderungen an die Endlagerung wärmeentwickelnder Abfälle' (translation: 'Safety Requirements Governing the Disposal of Heat-Generating Radioactive Waste'). K-MAT 10.

Radiological Protection Ordinance, according to which each unnecessary radiation exposure or contamination of mankind and the environment has to be avoided, and each radiation exposure or contamination of mankind and the environment including those below the limit values must be kept as low as possible in accordance with the state of the art in science and technology and in consideration of all circumstances of the individual case.

3.4.2 Avoid imposing unreasonable burdens on future generations

The above general protection objective from the ‘Safety Requirements Governing the Disposal of Heat-Generating Radioactive Waste’ is complemented by a second one: ‘Avoid imposing unreasonable burdens and commitments on future generations.’

This protection objective, occasionally also known as ‘no post-closure maintenance’, has a completely different character because it involves the distribution of burdens, including beyond potential risks; burdens may be of an economic nature or related to observation and monitoring requirements, for example.

The central, yet problematic term here is ‘unreasonable’. This is because the term is open to interpretation and due to the fact that we now need to decide for future generations what is reasonable or unreasonable without actually being able to ask them. This therefore means that it is not a clear protection objective, but a kind of declaration of intent to keep, in particular, economic, political or psychological burdens to a minimum in the future by way of disposal.

This is based on the ‘polluter-pays principle’ of the current generation which has used nuclear energy and is therefore responsible for disposal of the waste in as far as possible. This principle may be met by all of the disposal options aimed at disposal which no longer require maintenance after a certain time, albeit perhaps a long time. However, future generations may need to perform maintenance depending on the length of time that passes until the disposal facility is sealed.

3.4.3 Reversibility of decisions

The principle of reversibility of decisions is the result of two ethical arguments. The first is the desire for opportunities to correct errors if unexpected developments occur, while the second is the general future-directed ethical principle of keeping open or opening up decision-making options for future generations. It is a central principle enabling a reversal of decisions in the event of any identified errors or other developments which suggest the need for or do in fact require a new approach. Systematic error corrections or reversals for other reasons are to be seen as opportunities rather than a case of ‘putting all your eggs in one basket’ as they alleviate concerns that there would be no options available in the event of catastrophes or newly arising risks. Viewed in this light, this principle is in keeping with the ethics of responsibility.

Reversibility is likely to become increasingly limited and the amount of effort required to perform a reversal will increase throughout the process pathway due to the need to obtain facts. However, reversal should remain a fundamental option as provided for by way of this principle. The periods of time during which the various types of reversibility, e.g. retrievability or recoverability of waste, are to remain an option must be determined on an individual basis. In theory, provided emplacement has not taken place, it should not be difficult to perform a reversal. This situation will not change until the first emplacement zones and/or galleries have been backfilled.

Even then, however, a functional deep repository still provides the opportunity to retrieve waste containers in a controlled manner. It would be more difficult – but not impossible – to perform reversal after sealing a disposal facility should it become necessary due to any alarming results while monitoring the disposal facility. The demand for recoverability of waste after sealing the deep repository means that a parallel deep repository must be constructed in order to recover the waste from there, i.e. the given geological constellation must permit the construction of such a parallel deep repository.

The disposal facility concept, or, more specifically, the host rock disposal facility concept combination, including the required deep repository technology and containers, must be designed from the outset in such a way that subsequent reversibility options in the form of retrieval or recovery are not compromised. This demand also has an impact on the requirements placed on the long-term durability of the containers.

3.4.4 Realistic assumptions about future technologies

The selection of the disposal site or the search for suitable combinations of host rock and disposal facility concept must be designed such that the current state of knowledge allows us to have a substantiated idea of the feasibility of the entire pathway. We cannot and should not plan details for the future at this time. However, plausible and understandable evidence is required to ensure that the pathway recommended by the Commission is realistic and feasible from a technical, institutional and societal perspective.

This requirement extends, in particular, to the availability of the required technology at the various relevant points in time. Above all else, container technology, potential container encasements and the materials required to ensure long-term container durability are central to meeting the desire for retrievability and recoverability. On the other hand, transport and deep repository technologies appear to be in line with the latest advances in technology. Another open question relates to the possible desire for *in situ* monitoring technologies that extend beyond the backfilling of individual galleries or the sealing of the entire deep repository.

In this regard, two aspects need to be included in the process design. Firstly, it is ethically irresponsible to place ‘blind faith’ in technical progress if there is no substantiated and reviewed prospect of solving the given technical problem within an adequate period of time. Secondly, if such a prospect is indeed given, the corresponding research and development needs, and the time spans and resources necessary to meet them also have to be given due consideration. What is important here is that the process is realistically thought out from start to finish, rather than making empty promises that cannot be kept in the future.

3.5 Conflicts of interest and consideration requirements

The given principles are due to somewhat differing arguments, which may lead to conflicts of interest that require due consideration. Foreseeable conflicts of interest include the following:

- The desire to burden future generations as little as possible, i.e. to ensure no post-closure maintenance is required, may conflict with the desire to keep as many options as possible open to future generations. Providing a range of options is inconceivable without performing any maintenance.
- The desire to keep various options for action open for future generations may end up threatening safety should the economic and scientific opportunities available to subsequent generations deteriorate significantly and if the maintenance required to ensure responsible handling of the range of options becomes impossible.[434]
- The desire for long-term safety may conflict with desires for reversibility and monitoring, especially if monitoring made it impossible to completely seal the deep repository or individual galleries.
- The desire for reversibility and keeping options open provides certain degrees of freedom, but it binds resources and can lead to increased burdens, such as cost.

It is not currently possible to resolve these conflicts of interest once and for all. The principle of safety undoubtedly takes priority. The principle of no post-closure maintenance does not justify an end to the management of radioactive waste if permanent safe storage of the waste has not been achieved.

Safety also has a higher priority than the objective of keeping options open to future generations so they can take different decisions if deemed necessary. The reason for this is that from today’s perspective, keeping options open only serves the assumption that there will be better and therefore safer ways of handling radioactive waste in the future. This may be the case if a chosen path proves to be unsafe and requires error correction considerations; it may also be the case if new technical opportunities arise that increase the level of safety compared to today’s level or because said technical opportunities are suited to ensuring permanent safe storage of waste at an earlier time or in a more simple manner.

The conflict between the principle of no post-closure maintenance and the principle of reversibility can be traced back to the fact that any attempt at keeping options open also bears the burden of responsibility of having to decide whether or not alternatives should be implemented. This is in fact justified out of respect for future generations and the will to provide them with the freedom to make their own decisions.

Depending on how complex it is to keep options open beyond the scope of simply knowing about the existence of radioactive waste, e.g. if the waste needs

434 Cf. The Committee on a Site Selection Procedure for Repository Sites (2002), Recommendations of the Committee on a Selection Procedure for Repository Sites (AkEnd), K-MAT 1.

to be monitored permanently, this may be construed as shying away from responsibility. To ensure that this negative effect does not occur, the conflict must be resolved such that future generations' freedom to make decisions is retained for as long as possible without saddling them with the need for permanent active engagement.

There is also no need to decide on a single principle at this time with the aim of settling any tensions once and for all. The notion of no post-closure maintenance is unattainable for at least one subsequent generation in any case, meaning that all of the options currently available will remain in place for decision-makers from that generation. The only thing that can happen is that these options will become more complex and more expensive.

Even the permanent state of final safe emplacement strived for by means of various disposal pathways will take decades to achieve. The current situation involving the recently initiated site selection procedure for a disposal facility focuses on choosing and, if currently required and possible, specifying in more detail the pathway that best reflects the identified ethical principles and their current forecast options as a whole.

In addition, balancing the ethical principles will remain a constant task to be taken into account by way of procedural measures. The task does not end if the technical options or knowledge required to correct a chosen course, e.g. knowledge regarding the existence of containers or their place of storage, is no longer present.

When deciding on disposal options and developing accompanying criteria for the given procedure, the ethical principles give rise to the following requirements:

- The search for the disposal pathway, disposal site and disposal facility concept must be oriented, above all, towards the goal of finding what is, from a contemporary perspective, the safest disposal solution for high-level radioactive waste since safety has primacy.
- The disposal solution is to be configured in such a way that it does not require any permanent active engagement on the part of generations to come, but ensures without any decision to the contrary the safe final status of the structures put in place for the management of all high-level radioactive waste: Future generations must be able to manage the chosen pathway by simply refraining from changing course – retrievability must only be an option.
- The option to take conscious decisions to deviate from the course taken today must not be cut off. It is not a problem if a change of course is made more difficult as a result of the safety requirements and no post-closure maintenance described above, nor if action such as retrieval is required and in fact involves a great deal of effort. In addition to that, the current generation can only be expected to act in line with the current state of technology, meaning that from a contemporary perspective at least, the durability of containers represents a temporal limit. The conclusion here is that care should be taken to prevent any unnecessary irreversibility.

Procedural provisions must be made to ensure permanent monitoring of the disposal process in line with ethical principles and the interests of future generations, at least until the final status of the disposal pathway designed in accordance with these requirements has been reached. This will apply, in particular, to decisive steps in the disposal process, but also to key societal changes. Part of this monitoring also needs to be a review of the monitoring process itself, particularly the question of how long this final status will remain in place after reaching the final maintenance-free status: Ethical process support is a permanent task.

3.6 Basic requirements on politics and society

3.6.1 Handling the change to temporal structures

Discerning developments, understanding contexts, making sense of events and their occurrence, and assuming responsibility all take time. But if we do not take the time to do this, reflection and anticipation are not possible. The demand to find more time for reflection also forms part of current sustainability concepts.[435]This must be considered against the backdrop of the far-reaching, long-distance effects of modern technology and the acceleration of all the processes in the globalised and digitalised world. This is why the acceleration of temporal structures, particularly as a result of digitalisation, does not just present opportunities, it is also one of the greatest challenges in modern society. According to social scientist Hartmut Rosa, the initially liberating and empowering effect of modern acceleration is now threatening to cause the opposite.[436]

Purported time savings could come at the expense of nature and the living conditions of future generations if impatience, short-lived mindsets and a sole fixation on the present are permitted to have a devastating effect on the future:[437]'Mankind is neither a mistake of nature, nor does it perform self-preservation automatically and as a matter of course. Humans are part of a big game whose outcome remains open-ended to them. They need to fully develop their skills in order to endure and not become the pawn of coincidence.'[438]The fact that this must apply to the permanence of a human life forms the very core of the imperative of responsibility.

For this reason, a debate on the discrepancy between natural and cultural rhythms, particularly due to the lack of consideration in the major project of progress, has been ongoing for a number of years. In its unfinished form, it has 'forced the rhythmically driven temporal orders of the living onto the defensive. Technology and the economy – and their dominance – dictate the pace of our industrial society ... rather than the rhythmic structure of becoming and passing, activity and breaks, sleeping and awakening, assembling and dismantling.'[439]

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[435] Jürgen Kopfmüller/Volker Brandl/Juliane Jörissen/Michael Paetau/Gerhard Banse/Reinhard Coenen/Armin Grunwald
(2001): Nachhaltige Entwicklung integrativ betrachtet: Konstitutive Elemente, Regeln, Indikatoren (translation: Integrative analysis of sustainable development: constitutive elements, rules, indicators), p. 305 ff.
[436] Rosa, Hartmut (2005): Acceleration - The Change in Temporal Structures in Modernity.
[437] Rinderspacher, Jürgen (1996): Zeitinvestitionen in die Umwelt (translation: investing time in the environment), Rinderspacher, Jürgen (Hg.): Zeit für die Umwelt (translation: time for the environment), p. 83.
[438] Eigen, Manfred; Winkler, Ruthild (1976): Ludus vitalis, p. 14.
[439] Held, Martin; Geißler Karlheinz (1995): Editorial, Held, Martin; Geißler Karlheinz (1995): Von Rhythmen und Eigenzeiten, p. 7.

Social philosopher Norbert Elias sees the handling of time as an expression of human synthesis: ‘It could be said that time is a symbol of a relationship between two or more events that involves a group of people, to wit a group of living beings with the biological capacity to remember and synthesise, who then take one of these events and use it as a frame of reference or standard to be applied to the other event(s).’ The switch to ‘temporal prosperity’, or, as social ethicist Jürgen Rinderspacher describes it, to ‘time investments’ is a key prerequisite for intergenerative justice, not least because it also improves the prerequisites of reflexive modernisation. This aligns with the notion of qualitative growth or ‘prosperity through avoidance.[440]The ‘*Zukunftsfähiges Deutschland*’ (Sustainable Germany) study conducted by the Wuppertal Institute on behalf of BUND and Misereor calls for a limit to an extent ‘that the Earth can cope with as a whole.[441]

Time management is a central coordinator of a reflective politics that is indispensable to social cohesion, our relationship with nature, and our future living conditions. This is also the basic idea of sustainable development, which is essentially time policy. ‘We live in an age in which we act in an increasingly short-lived manner and take decisions faster than ever before. Our lives are dictated by the short-term... All kinds of costs incurred as a result of our current prosperity are being deferred to the future on a massive scale’, is how former UNEP Secretary-General Klaus Töpfer described the fact that the consequences of human actions are not being sufficiently addressed at present.[442]His accusation is that politics ‘has also allowed itself to be dictated by the short-term. It is unnerving to see... that politicians in parliaments are forced to give in to the lack of alternatives to constraints.’

This is contrasted by the vision of sustainable development, which demands reflexive and holistic reviews of political, economic and societal decisions. This in turn needs institutions that are able to systematically evaluate the consequences of key decisions. To this end, political decisions, scientific research, and economic and technical innovation must be steered in a direction which, in the interests of sustainability, brings economic innovation, social justice and ecological compatibility into line with one another. The Commission therefore proposes further institutional anchoring of sustainabile development than that seen to date. An important option here is to enhance the image and rights of the parliamentary advisory council in the German Bundestag.

3.6.2 Holistic progress indicator

The history of nuclear energy can be traced back to the desire for an inexhaustible source of energy to solve the question of energy, which was seen as the basis of unlimited economic growth. In this regard, quantity over quality was practised for many years. However, the shift towards quantitative growth as an indicator of progress, measured in terms of the increase in gross domestic product (GDP), is now starting to be viewed critically. Firstly, because quantitative growth does not necessarily lead to an increase in satisfaction and quality of life; secondly, irrespective of significant progress made in terms of efficiency, growth

[440] For example Eppler, Erhard (1975): Ende oder Wende? (translation: The End or a Turning Point?), Stuttgart, or Müller, Michael; Hennicke, Peter (1994): Wohlstand durch Vermeiden (translation: Prosperity through Avoidance).
[441] BUND/Misereor (Hrsg. 1996): Zukunftsfähiges Deutschland (translation: Sustainable Germany), p. 206 ff.
[442] Töpfer, Klaus (2013): Interview in: Lutz Engelke/Günther Bachmann (Hrsg.). future lab Germany.

often comes at the cost of nature.[443] GDP is not an indicator of sustainabile development.

The study commission ‘growth, prosperity, quality of life’ of the German Bundestag therefore put forward a proposal as to ‘how the influencing factors of quality of life and societal progress can be given adequate consideration and brought together in a joint indicator[444]with the aim of ‘using economic, ecological and social criteria to create a suitable basis for assessing political decisions.’ Particularly when it comes to energy and resources policy, this is indispensable if we intend to make the switch to sustainable development.

The Commission sees a link between the energy transition and a new progress and prosperity model. The study commission developed a set of prosperity indicators that links key economic, social and ecological data and then makes them available to the public. This is intended to make longer-term trends regarding improvements or declines in quality of life clearer to everyone and would lead to the following changes:

- Prosperity would be defined over a longer period of time;
- Links would become clear and can/need to be evaluated and heeded;
- Decisions would not be made subject to short-term pressure.

The Commission suggests adopting this proposal in order to raise more awareness of longer-term developments, both in the economy and society.

3.6.3 More participation for more democracy

The Commission calls for a national disposal duty requiring domestically produced radioactive waste to be stored in Germany. It is aware that the best-possible storage of radioactive waste may well be linked to social conflicts and political disputes, especially since several major projects over the last few years have been met with considerable resistance, despite them being far less controversial. In order to boost acceptability and generate more transparency in terms of objectives and motives, the Commission recommends that the legislature increases community participation and specifies citizens’ rights on a permanent basis. Maximum possible acceptance for the decision on a disposal site requires

- Learning from the history of nuclear energy;
- A transparent selection procedure before deciding on a certain site;
- Politics and society assuming responsibility for the future on a permanent basis;
- Giving citizens more participation rights;
- Scientifically justified criteria without requiring expert knowledge to understand them.

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[443] Jackson, Tim (2009): Prosperity without Growth, report for SCD.

[444] German Bundestag (2011): Final report by the study commission ‘growth, prosperity, quality of life’, p. 231.

3.6.4 Advice on the consequences of technology

The German Bundestag has used various methods over many years to investigate the challenges surrounding technical developments. The Office of Technology Assessment (TAB) is of key importance in this regard as it is tasked with advising politics on techno-scientific developments as well as with presenting the options for action available in order to take advantage of opportunities and avoid risks. To date, TAB has conducted more than 160 investigations.

TAB's client is the Committee on Education, Research and Technology Assessment, which is responsible for stipulating what the TAB should work on. The Committee decides on the requirements of other expert committees when conducting analyses, and handles communication with the bodies of the German Bundestag. Many European states, and an increasing number of countries further afield, also have similar parliamentary technology assessment institutions in place. However, in view of the importance of the 'knowledge society', the work performed by TAB and other similar institutions has received little attention on a political level and among the general public. In order to arrive at rational assessments, the Commission proposes that this institution be enhanced.[445]

3.7 Ten principles for the work of the Commission

1. The Commission has focused its work on the vision of *sustainable development*, in particular the imperative of long-term responsibility. Sustainabile development means that, in its recommendations on the best-possible storage of radioactive

waste,[446] the Commission has focused on the needs and interests of both current and future generations. The Commission has attempted to reconcile different interests on the basis of intergenerational justice.

2. The Commission has based its proposals on six guiding objectives: The primacy of safety; comprehensive transparency and participation rights; a fair and just procedure; broad consensus in society; the polluter-pays principle and the precautionary principle. Following an open-ended process, the Commission has described a pathway that is scientifically informed and capable of guaranteeing the best-possible safety.

3. The Commission has affirmed the *principle of national storage* for domestically produced radioactive waste. National responsibility is a central foundation for its recommendations. In this respect, the Commission has oriented itself towards a dynamic precautionary approach[447] to the prevention of damage

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[445] Cf. also section B 9 of the present report.

[446] On this issue, see the 'Definition of the site with the best-possible safety' on p. 23.

[447] To this end, the Commission follows the Kalkar-I decision by the Federal Constitutional Court: 'Precautions against damage must be taken if they are deemed necessary in light of the latest scientific findings. If they cannot yet be translated into reality technically, the licence may not be granted; the requisite precautions are therefore not limited by what is currently technologically feasible.' In this passage, the Federal Constitutional Court defined in 1978 the mandatory obligation the legislature introduced by gearing the Atomic Energy Act towards the latest advances in science and technology, which means the Act's legal provisions keep pace with scientific and technological development. According to the Federal Constitutional Court, these considerations also apply with regard to what is referred to as residual risk: In particular, with its linkage to the latest advances in science and technology, the Act therefore commits the executive normatively to the principle of the best-possible defence against hazards and prevention of risks.' Decision by the Federal Constitutional Court, 8 August 1978, AZ: 2 BvL 8/77, BVerfGE 49, 89 (136 ff.).

that demands precautionary measures against potential damage to be taken in line with the latest advances in science and technology.

4. The Commission provides criteria and recommendations in preparation for the search for a disposal site guaranteeing the best-possible safety when storing, in particular, high-level radioactive waste for a period of one million years.[448] At the same time, it wishes to preserve future generations' civil liberties and rights to self-determination as far as is practical without limiting the necessary protection of humans and nature.

5. Like the overwhelming majority of the German Bundestag, the Commission assumes the *statutorily anchored phasing-out of nuclear energy* will go ahead. The phasing-out of nuclear energy has defused a major societal conflict. At the same time, the Commission regards the generations that have used, or are using, electricity from nuclear power as bearing a responsibility to ensure the best-possible storage of the waste produced as a result of its use. These generations have a duty to forge ahead in the search for the disposal site. On this basis, the Commission wishes to foster a culture of openness to conflict that makes a permanent settlement possible.

6. The Commission understands its work and the subsequent search for a site as a *learning process*. During this process, decisions are to be examined thoroughly to identify possible errors or undesirable developments. Provision is to be made for opportunities to subsequently correct errors. This is also why the public is to be involved broadly in the search from the very beginning. The aim is an open, pluralist discourse. The disposal pathway and alternatives, fundamental safety requirements, selection criteria and opportunities for the correction of errors must be developed in a scientifically based, transparent manner, described precisely and publicly debated before the search for a disposal site actually begins. This must also be guaranteed if a decision to change course or correct errors is taken in the future.

7. It is the Commission's aspiration to gain *broad approval from society* for the recommended selection procedure. It has drawn on the experiences of regions in which sites have been designated or selected in the past. The consensus to which it aspires would also be served by the open-ended evaluation of the Site Selection Act. The greatest possible transparency demands that all the data and information held by the Commission, as well as further decisions on the storage of radioactive waste be made publicly accessible and permanently conserved by an institution governed by public law, and that such data and information be made generally accessible.

8. The Commission views the best-possible safe storage of radioactive waste as a function of the state. Irrespective of the stance each individual has taken in the debate about nuclear energy, there is a societal duty to do everything to ensure that the efforts to cope with this task prove successful. Under the polluter-pays principle, the operators of nuclear power plants and their legal successors are liable for the costs of the storage of radioactive waste produced as a result of

[448] The 'Safety Requirements Governing the Disposal of Heat-Generating Radioactive Waste - GRS draft' led to the Federal Office for Radiation Protection (BfS) stating a protection period 'in the order of 1 million years' in its statement. Cf. Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (2010): 'Sicherheitsanforderungen an die Endlagerung wärmeentwickelnder Abfälle' (translation: 'Safety Requirements Governing the Disposal of Heat-Generating Radioactive Waste'), K-MAT 10.

their power generation operations. A separate commission appointed by the German Federal Government has also been looking at the issue of the costs of the best-possible storage of radioactive waste.

9. The Commission has surveyed and assessed earlier experiments and projects relating to the permanent storage of radioactive waste. It has attempted to learn from the conflicts about nuclear energy, repositories or disposal facility projects, and to avoid the repetition of earlier errors. It wishes to express its great respect for the diverse forms of commitment shown over long periods of time by numerous citizens, many scientists, and the environmental and anti-nuclear movements who campaigned for the phasing-out of nuclear power in Germany. It also recognises the hard work done by the employees of nuclear power plants to guarantee the safe operation of the installations and minimise risks. The Commission also wishes to place on record its gratitude for the societal and company-level efforts that are being made to manage the phasing-out of nuclear power in a socially benign manner.

10. Beyond the question of the handling of radioactive waste, the Commission sees its work as a contribution to the more conscious handling of complex technologies that have far-reaching, long-distance effects. It wishes to counter unintended and undesirable side effects by strengthening technology assessment and technology strategy. For this purpose, new technologies and industrial developments are to be examined at an early stage in order to identify harmful or unmanageable side effects so it is possible to choose between different options. The high-level radioactive waste we will leave behind for coming generations stand in an exemplary fashion for the possible side effects of complex industrial developments.

4 EXPERIENCE OF THE STORAGE OF RADIOACTIVE WASTE

4.1 National experience of disposal projects

The search for the site with the best-possible safety for the permanent storage of, in particular, high-level radioactive waste must take account of what has been learned by policymakers, authorities and communities in Germany, and the experiences they have had to go through during earlier disposal projects. This is why the Commission has looked at the development of the four most important German disposal projects: Asse II, from which the emplaced radioactive waste are to be retrieved, the Morsleben Disposal Facility, which was constructed in the German Democratic Republic (GDR) and whose decommissioning has been applied for, the Konrad site at Salzgitter, which is currently being converted into a disposal facility for low and intermediate-level radioactive waste, and the Gorleben salt dome, whose geotechnical exploration was ended by the Site Selection Act.

4.1.1 Asse II

The Federal Institute for Ground Research suggested the use of the Asse salt mine as a disposal facility for radioactive waste at an early stage. According to press reports about the planned discontinuation of the extraction of rock salt from the mine, the Federal Institute drew the Lower Saxon mining authorities’ attention to the site in August 1962 and also informed the Federal Ministry for Scientific Research in March 1963.[449] In October 1963, the Ministry requested an expert opinion from the Federal Institute on whether the mine could be used 'for the disposal of radioactive waste'. This opinion referred to the mine as 'a unique asset' and an opportunity for the storage of waste that was hardly likely to recur in the next few years.[450] However, the expert opinion also said there was a possibility that it might be necessary to abandon the underground facility prematurely because fissures and clefts could form in the overburden and 'by all means lead to the gradual inundation of the mine.'[451] In this passage, the expert opinion accurately described the cause of the inflows that were actually to occur at the facility decades later. As a consequence, the expert opinion recommended that the preferred option ought to be 'emplacing the waste in the lower mine workings.'[452] Should the storage facility be inundated, it appeared that 'filling the waste store with brine would guarantee effective shielding from surface waters.'[453]

Scientists from the Federal Institute for Ground Research who argued early on for the Asse mine to be used for the storage of radioactive waste were also responsible for the important expert opinions on the salt mine produced in the years from 1963 to 1965.[454] It was on the basis of these expert opinions that the German Federation entered into negotiations about purchasing the mine. Gesellschaft für Strahlenforschung (GSF), a company that had been established by the Federation and placed within the jurisdiction of the Research Ministry, concluded a contract with the owner of Asse II in 1964 concerning the use of the salt mine, and purchased it for the Federation in March 1965 for 800,000 deutschmarks.[455] The Federation gave GSF the mandate to use the mine to develop, and trial procedures and technologies for the safe emplacement of radioactive substances. GSF founded the Institute for Geological Storage for this purpose in 1965.[456] The Technical Division of the Institute for Geological Storage was then active as the operator of the underground facility, while the Institute's Scientific Division produced safety studies about the site.[457] These studies countered the doubts about the disposal facility's safety that were expressed on many occasions, above all by employees of the mining

[449] Cf. Tiggemann, Anselm (2004): Die 'Achillesferse' der Kernenergie in der Bundesrepublik Deutschland: Zur Kernenergiekontroverse und Geschichte der nuklearen Entsorgung von den Anfängen bis Gorleben 1955 bis 1985, p. 141.
[450] Federal Institute for Ground Research (1963): 'Geologisches Gutachten über die Verwendbarkeit der Grubenräume des Steinsalzbergwerkes Asse II für die Endlagerung radioaktiver Abfälle', p. 22.
[451] Federal Institute for Ground Research (1963): 'Geologisches Gutachten über die Verwendbarkeit der Grubenräume des Steinsalzbergwerkes Asse II für die Endlagerung radioaktiver Abfälle', p. 20.
[452] Federal Institute for Ground Research (1963): 'Geologisches Gutachten über die Verwendbarkeit der Grubenräume des Steinsalzbergwerkes Asse II für die Endlagerung radioaktiver Abfälle', p. 22.
[453] Federal Institute for Ground Research (1963): 'Geologisches Gutachten über die Verwendbarkeit der Grubenräume des Steinsalzbergwerkes Asse II für die Endlagerung radioaktiver Abfälle', p. 22.
[454] 'Here, the existence of a conflict of interest should have been examined and/or other experts involved as well,' found, for instance, the majority parliamentary groups of the Christian Democratic Union (CDU) and Free Democratic Party (FDP) in the Lower Saxon Landtag. Lower Saxon Landtag (2012): 'Bericht: 21. Parlamentarischer Untersuchungsausschuss', Printed Paper 16/5300, 18 October 2012, p. 41.
[455] Cf. Tiggemann, Anselm (2004): *Die „Achillesferse" der Kernenergie in der Bundesrepublik Deutschland: Zur Kernenergiekontroverse und Geschichte der nuklearen Entsorgung von den Anfängen bis Gorleben 1955 bis 1985*, p. 145.
[456] Cf. Lower Saxon Landtag (2012): 'Bericht: 21. Parlamentarischer Untersuchungsausschuss', Printed Paper 16/5300, 18 October 2012, p. 5.
[457] On how these functions were divided up, cf.: Gesellschaft für Strahlenforschung (1974): 'Institut für Tieflagerung: Endlagerung radioaktiver Abfälle: Jahresbericht 1973', p. 1.

authorities.[458] In 1967, scientists from the Institute put forward the opinion that, 'the danger of an inflow of water or brine' on the endangered southern flank of the mine 'is exceptionally unlikely.'[459]

During the conversion work in the mine, 'low-level radioactive waste was emplaced for experimental purposes' as early as April 1967.[460] In the following eleven and a half years up to the end of 1978, the operator deposited a total of 125,787 waste packages there: 124,494 packages of low-level radioactive waste and 1,293 packages of intermediate-level radioactive waste.[461] In the course of the 'trial emplacement' of waste from April 1967 to July 1972, 10,327 barrels were moved into the mine. The number of packages deposited each year rose dramatically when licences were subsequently granted for the permanent emplacement of waste. Just in 1978, the last year of emplacement operations, 30,500 waste packages were deposited in the former salt mine.[462] Recoverability was dispensed with at this time.[463]

Nor was there any public debate or public participation when the transition was made from experimental to permanent emplacement. 'In addition to this, the events and processes at the Asse II mine were insufficiently transparent. Externally, there was far more reporting about the research than about the emplacement that was actually taking place.'[464] It was accepted consciously or at least approvingly that a false impression of the work done at the mine had been conveyed in the public sphere. In consequence, the emplacement activities had not been discussed by the wider public. The 21st Parliamentary Committee of Inquiry of the Lower Saxon Landtag,[465] which looked into the Asse nuclear waste storage facility, later found that 'critical circumstances had been hushed up.'

The legal requirements placed on disposal facilities changed while emplacement activities were going on at Asse. In 1964, employees of the Lower Saxon Ministry of Economics discussed whether a licence under nuclear law was necessary for the emplacement of waste there. In view of the research work planned at the site, the Federal Ministry for Scientific Research regarded a licence for the handling of radioactive substances under the Radiation Protection Ordinance as sufficient. All emplacement activities were then based on plans of operations under mining law, licences for the handling of radioactive substances

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[458] Cf. Asse-GmbH (2009): 'Zur Rolle der Wissenschaft bei der Einlagerung radioaktiver Abfälle in der Schachtanlage Asse II'.

[459] Asse-GmbH (2009): 'Zur Rolle der Wissenschaft bei der Einlagerung radioaktiver Abfälle in der Schachtanlage Asse II', p. 13.

[460] Gesellschaft für Strahlenforschung (1987): 'Salzbergwerk Asse: Forschung für die Endlagerung', p. 18.

[461] Lower Saxon Landtag (2012): 'Bericht: 21. Parlamentarischer Untersuchungsausschuss', Printed Paper 16/5300, 18 October 2012, p. 6 and p. 35. According to information from the Federal Office for Radiation Protection, some of the substances emplaced as low-level radioactive waste also contained intermediate-level radioactive waste materials.

[462] Lower Saxon Landtag (2012): 'Bericht: 21. Parlamentarischer Untersuchungsausschuss', Printed Paper 16/5300, 18 October 2012, pp. 35f.

[463] Cf. Klaus Kühn (1976): 'Zur Endlagerung radioaktiver Abfälle: Stand, Ziele und Alternativen', in: Atomwirtschaft 21, 7, Düsseldorf, July 1976, p. 358. The then head of the Institute for Geological Storage's Scientific Division wrote in 1976 of the waste materials deposited at Asse since 1967: 'Recoverability has deliberately been dispensed with for these waste materials from the outset.'

[464] Lower Saxon Landtag (2012): 'Bericht: 21. Parlamentarischer Untersuchungsausschuss', Printed Paper 16/5300, 18 October 2012, p. 38.

[465] Lower Saxon Landtag (2012): 'Bericht: 21. Parlamentarischer Untersuchungsausschuss', Printed Paper 16/5300, 18 October 2012, p. 38.

under the Radiation Protection Ordinance or licences for the storage of radioactive substances under nuclear law.[466]

From September 1976, the Atomic Energy Act required a plan approval procedure for the licensing of disposal facilities. In September 1978, the German Federation and the Land Lower Saxony agreed at ministerial level to initially discontinue emplacement activities at the end of the year, and to seek to work for retrievable interim storage in the mine until the conclusion of a plan approval procedure for a disposal facility at Asse II.[467] Gesellschaft für Strahlenforschung applied for a licence for the interim storage of retrievable waste there in April 1979. Furthermore, in September 1979, the National Metrology Institute of Germany (PTB) applied to the Land Lower Saxony for plan approval for a disposal facility at Asse. However, the Federal and Land governments then agreed in September 1981 that research and development work for the Gorleben disposal facility that was being planned at that time should now be prioritised at Asse. In the mean time, the former Konrad iron mine at Salzgitter was also being considered in principle as a disposal facility.[468] Possible waste management functions for the Asse mine were only to be further pursued as a secondary line of inquiry. Nevertheless, the plan approval application for a disposal facility at Asse was not withdrawn, but not pursued further. The German Federal Government later referred to it as closed.[469]

At the latest as of 1988, salt solution was flowing into Asse II from the overburden through fissures in the southern flank of the mine.[470] The inflow of brine was at first 0.16 cubic metres a day, but increased sharply several times to reach about twelve cubic metres a day in 1997, since when it has varied around this level.[471]

In 1992, the Federal Research Ministry decided to discontinue the research work at the underground facility, which came to an end in 1995. After this, Gesellschaft für Strahlenforschung and, subsequently, its successor institution, the Helmholtz Zentrum München German Research Centre for Environment and Health (HMGU), made preparations for the closure of the facility. In the years from 1995 to 2003, cavities left from the extraction of salt in the mine's southern flank were backfilled with ground potash salt. The collapse of this salt later created cavities once again in the chambers.

At the beginning of 2000, Gesellschaft für Strahlenforschung launched a 'long-term safety project' that was to involve the drafting of a safety report and a long-

[466] Lower Saxon Landtag (2012): 'Bericht: 21. Parlamentarischer Untersuchungsausschuss', Printed Paper 16/5300, 18 October 2012, p. 43.

[467] Cf. German Bundestag (1981): 'Antwort der Bundesregierung auf die Große Anfrage der Abgeordneten Laufs u.a. und der Fraktion der CDU/CSU: Verantwortung des Bundes für Sicherstellung und Endlagerung radioaktiver Abfälle in der Bundesrepublik Deutschland', Bundestag Printed Paper 9/1231, 22 December 1981, p. 4.

[468] Cf. German Bundestag (1981): 'Antwort der Bundesregierung auf die Große Anfrage der Abgeordneten Laufs u.a. und der Fraktion der CDU/CSU: Verantwortung des Bundes für Sicherstellung und Endlagerung radioaktiver Abfälle in der Bundesrepublik Deutschland', Bundestag Printed Paper 9/1231, 22 December 1981, p. 5.

[469] Cf. German Bundestag (2007): 'Antwort der Bundesregierung auf die kleine Anfrage der Abgeordneten Hill u.a.', Bundestag Printed Paper 16/5223.

[470] Lower Saxon Landtag (2012): 'Bericht: 21. Parlamentarischer Untersuchungsausschuss', Printed Paper 16/5300, 18 October 2012, p. 9.

[471] On this topic, cf. also Helmholtz Zentrum München (2008): 'Zusammenfassende Darstellung der Laugensituation Asse', 29 February 2008.

term safety case for the closure of the underground facility.[472] In January 2007, it applied to the Lower Saxon mining authorities for a final plan of operations under mining law for the underground facility that provided for parts of the mine to be backfilled and the rest flooded with saturated salt brine.[473] The Land classified the documents that had been submitted as incomplete and, in November 2007, acting in consultation with the Federal Environment Ministry and the Federal Research Ministry, demanded an environmental impact assessment for the facility's closure and the conduct of a plan approval procedure under mining law.[474] Following press reports about contaminated brine seeping into the facility, the Lower Saxon Environment Ministry found in September 2008 that, 'for many years, radioactive brine has been handled without the requisite licence under radiation protection law at Asse.'[475] In June 2009, the Lower Saxon Landtag established a committee of inquiry on the Asse II facility.
In the spring of 2006, Wolfenbüttel County demanded that it be 'comprehensively investigated by experts how and where the radioactive waste stored at Asse are to be managed safely over the long term.'[476] In April 2007, to mark the 40th anniversary of the first waste being emplaced in the facility, regional anti-nuclear and environmental groups published the Remlingen Declaration, which rejected the flooding of Asse, called for the application of nuclear law to the site and demanded preparations for the retrieval of the waste.[477] In November 2007, the competent ministries of the German Federation and the Land Lower Saxony agreed that various options should be examined, including the retrieval of the waste, and that representatives of the region's population should participate in decision-making. In January 2008, the Asse 2 Monitoring Group constituted itself. It consisted of members with voting rights from local politics and community groups, as well as advisory members from ministries and federal institutions.
In November 2008, the German Federal Government decided that the facility, which had been run under mining law until then, was to be placed under nuclear law, and mandated the Federal Office for Radiation Protection (BfS) to take over the installation as its operator.[478] An amendment to the Atomic Energy Act that entered into force in March 2009 also required the immediate decommissioning of the installation.[479] The take-over of Asse II by the BfS led to a reorganisation of operational radiation protection and a new approach to the management of the brines that were seeping into the underground facility. In order to stabilise the underground structure, work began in December 2009 to backfill cavities in

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[472] Cf. Günther Kappei: 'Abriss der Geschichte der Schachtanlage Asse II', in: Action for Nuclear-Free Asse (2001): 'Dokumentation Fachgespräch zur Situation Im Atommüll-Endlager Asse II', p. 25.
[473] Cf. Lower Saxon Ministry of the Environment and Climate Protection (2008): 'Statusbericht über die Schachtanlage Asse II', p. 131.
[474] Cf. Lower Saxon Ministry of the Environment and Climate Protection (2008): 'Statusbericht über die Schachtanlage Asse II', p. 132.
[475] Lower Saxon Ministry of the Environment and Climate Protection (2008): 'Statusbericht über die Schachtanlage Asse II', p. 6.
[476] This resolution is documented on the website of the Asse 2 Monitoring Group, online: http://www.asse-2-begleitgruppe.de/begleitprozess.html, last accessed 5 February 2016.
[477] Cf. http://www.asse2.de/download/flyer-remlinger-erklaerung.pdf, last accessed 25 November 2015; English translation: 'Demands of the Remlingen Declaration', Information About the Research Mine Asse II, online: http://bellona.org/assets/sites/3/2015/06/fil_NuclearHeritage_Infoflyer_ASSE_150dpi1.pdf.
[478] Cf. Federal Office for Radiation Protection (2009): 'Endlager Asse II, Ausgangsbedingungen und Weichenstellungen seit der Übernahme durch das Bundesamt für Strahlenschutz am 01.01.2009', p. 9.
[479] Cf. German Bundestag: Draft of a Tenth Act Amending the Atomic Energy Act, Bundestag Printed Paper 16/11609, 15 January 2009, p. 8.

chambers where salt had been extracted and other areas of the mine with special concrete.[480]
Furthermore, Asse-GmbH, a federally owned company established at the beginning of 2009 that managed geotechnical operations in accordance with the specifications laid down by the Federal Office for Radiation Protection, evaluated the archive of files it had inherited, and reviewed older safety reports and expert opinions.[481] As a result, Asse-GmbH described the safety reports and expert opinions that had been presented 'at the time of the first emplacement activities' as 'containing no more than assertions'. [482] The fundamental data required for the appraisal of the rock-mechanical and hydrogeological situation at Asse had only been gathered during the ensuing years. 'The statements made in these reports and expert opinions were later disproved once concrete facts were available,' it noted.[483]
The starting point for the use of the underground facility had been the thesis that, 'salt formations were best suited for the disposal of radioactive waste. The positing of this thesis had been preceded by neither comparative analyses of various host rocks nor suitability studies at the Asse site,'[484] stated the new company in charge of the facility. All the critical geological issues at Asse had already been known about in principle at the beginning of the emplacement activities. 'They were not taken seriously. Critical facts, such as the brines seeping out of joints in host rock that was described as dry and impermeable, were ignored.'[485] The history of the Asse underground research facility showed, 'that the work done under the generic term "research" was exceptionally unscientific.'[486] The case of Asse raised 'questions of scientific ethics'.[487] For decades, unproven assertions had been allowed to stand without being reviewed by critical scientists. No notice had been taken of critical scientific voices.[488]
After the facility had been taken over, the Federal Office for Radiation Protection (BfS) examined three options for its decommissioning: The filling of all the cavities with salt concrete, the relocation of the radioactive waste into deeper areas of the salt dome and the retrieval of the waste from the underground facility. In January 2010, a technical assessment of the options for decommissioning by the BfS found that only retrieval held out 'the justified expectation that, in accordance with the current level of knowledge, a long-term safety case can be made.'[489] To prepare for the retrieval of the waste from the underground facility, the BfS launched a fact-finding exercise in April 2010 and

[480] Cf. Federal Office for Radiation Protection (2013): Asse Einblicke 20, pp. 2f.
[481] Cf. Asse-GmbH (2009): 'Zur Rolle der Wissenschaft bei der Einlagerung radioaktiver Abfälle in der Schachtanlage Asse II', p. 5.
[482] Cf. Asse-GmbH (2009): 'Zur Rolle der Wissenschaft bei der Einlagerung radioaktiver Abfälle in der Schachtanlage Asse II', p. 29.
[483] Asse-GmbH (2009): 'Zur Rolle der Wissenschaft bei der Einlagerung radioaktiver Abfälle in der Schachtanlage Asse II', p. 29.
[484] Asse-GmbH (2009): 'Zur Rolle der Wissenschaft bei der Einlagerung radioaktiver Abfälle in der Schachtanlage Asse II', p. 29.
[485] Asse-GmbH (2009): 'Zur Rolle der Wissenschaft bei der Einlagerung radioaktiver Abfälle in der Schachtanlage Asse II', p. 30,
[486] Asse-GmbH (2009): 'Zur Rolle der Wissenschaft bei der Einlagerung radioaktiver Abfälle in der Schachtanlage Asse II', p. 30.
[487] Asse-GmbH (2009): 'Zur Rolle der Wissenschaft bei der Einlagerung radioaktiver Abfälle in der Schachtanlage Asse II', p. 30.
[488] Cf. Asse-GmbH (2009): 'Zur Rolle der Wissenschaft bei der Einlagerung radioaktiver Abfälle in der Schachtanlage Asse II', p. 30.
[489] Federal Office for Radiation Protection (2010): 'Optionenvergleich Asse – Fachliche Bewertung der Stilllegungsoptionen für die Schachtanlage Asse II', p. 194.

commissioned expert opinions to assess the emplaced radioactive inventory in greater detail.[490] From June 2012, one of the 13 emplacement chambers with waste was explored by drilling boreholes. Very recently, it was envisaged the actual retrieval of the waste from the mine could start in 2033. This work is due to take approximately 35 to 40 years.[491]
The Act to Accelerate the Retrieval of Radioactive Waste and the Decommissioning of the Asse II Mine, which entered into force in April 2013, specified the clearance of waste from the mine as the preferred option. According to the Act, retrieval is only 'to be broken off if its implementation is not acceptable for the population and employees on radiological or other safety-relevant grounds.'[492] According to an estimate made by the Federal Environment Ministry, the costs just for the renewed deposition of the waste to be retrieved from Asse could reach around five billion euros.[493] The additional costs for the retrieval of the waste could amount to a similar sum.

4.1.2 Morsleben Disposal Facility

In the former GDR, responsibility for the disposal of radioactive waste lay initially with the State Centre for Radiation Protection, then the State Office for Nuclear Safety and Radiation Protection (SAAS). The GDR's first power reactor started operation in 1966 at Rheinsberg. The first studies of sites for the disposal of waste began in 1965. The GDR's state radiation protection authority decided early on to deposit radioactive waste in a former salt mine. Ten of these mines were assessed to ascertain how economically efficient and safe they would be, three of them being investigated in greater detail at the end of the process.[494] In 1970, the choice fell on the Bartensleben salt mine close to the village of Morsleben, which had been closed the previous year and was at that time located directly on the border between the two German states. The State Office for Nuclear Safety and Radiation Protection later listed seven decision-making criteria for the choice of the mine: 'the convenient transport links' to the GDR's power plants, 'the size of the available cavity', 'the safety criteria at this mine', 'the attractive costs of taking it on economically', 'the conditions for the

[490] Cf. TÜV Süd (2011): 'Bericht zur Überprüfung des Abfallinventars: Überprüfung der Kernbrennstoffdaten: Teil A: Recherche der Betriebsdokumente'; TÜV Süd (2011a): 'Bericht zur Überprüfung des Abfallinventars: Überprüfung der Kernbrennstoffdaten: Teil B', online: http://www.bfs.de/SharedDocs/Downloads/Asse/DE/IP/studien-gutachten/2011/abfallinventar.html, last accessed 4 November 2015.
[491] Cf. DMT GmbH & Co. KG (2014): 'Konkretisierung der Machbarkeitsstudie zum optimalen Vorgehen bei der Rückholung der LAW-Gebinde: Hier: Abschlussbericht', p. 24, online: http://www.asse.bund.de/SharedDocs/Downloads/Asse/DE/IP/studien-gutachten/2014/141126-dmt-optimales-vorgehen-rueckholung.pdf?__blob=publicationFile&v=2).
[492] Act on the Peaceful Utilisation of Atomic Energy and the Protection against its Hazards (Atomic Energy Act) of 23 December 1959, last amended on 31 August 2015, Federal Law Gazette I, p. 1474, Section 57b(2).
[493] Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (2015): 'Bericht über Kosten und Finanzierung der Entsorgung bestrahlter Brennelemente und radioaktiver Abfälle', p. 12.
[494] Cf. Federal Office for Radiation Protection (1997): '25 Jahre Einlagerung radioaktiver Abfälle im Endlager Morsleben', p. 11.

excavation of further cavities', 'the availability of this mine' and the 'scale of the measures required for its future decommissioning'.[495]

As of December 1971, about 500 cubic metres of waste from the GDR interim storage facility at Lohmen were deposited on a trial basis at the Morsleben Disposal Facility for Radioactive Waste (ERAM).[496] This was followed by approval for the disposal site in 1972, approval for the construction of a disposal facility in 1974, a limited-term approval for permanent operation in 1981 and, in 1986, an unlimited-term permanent operating licence, which then remained valid after reunification on the basis of the Unification Treaty.[497] There was no public participation when the disposal facility was constructed. The installation was hardly mentioned in the GDR media. The border area in which the disposal facility was located was only accessible to local residents, people employed at ERAM or individuals with special permits.[498] Information events for teachers and school pupils were held on the disposal site as part of preparatory courses for the official coming of age ceremony (*Jugendweihe*).[499]

Overall, in the years from 1971 to 1998, the Morsleben Disposal Facility for Radioactive Waste (ERAM) accepted 36,754 cubic metres of low and intermediate-level radioactive waste – about 14,400 cubic metres in the years from 1971 to 1990 and another 22,300 cubic metres in the years from 1994 to 1998. This means a good 60 per cent of the waste there was emplaced following German reunification. Furthermore, ERAM serves as an interim storage facility for small quantities of intermediate-level radioactive waste that do not comply to the conditions for final disposal formulated by the GDR. These materials consist of radium waste from GDR hospitals, and radiation sources – mainly cobalt-60 – that were used in the GDR to kill bacteria in wells and for experiments relating to the disposal of high-level radioactive waste.[500] In 2015, despite their low total volume of approximately 0.3 cubic metres, this waste interim stored in eight special containers contributed approximately half of the total activity of the radioactive substances in ERAM of less than 6×10^{14} Becquerels.[501]

When Germany was reunified, the Federal Office for Radiation Protection (BfS) took over the Morsleben Disposal Facility for Radioactive Waste (ERAM) as its operator on 3 October 1990. Under the Unification Treaty, the operating licence granted by the GDR continued to be valid until 30 June 2000. A plan approval procedure under Federal German nuclear law would be required if the facility were to be operated further beyond this point in time. The BfS also applied to the

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[495] State Office for Nuclear Safety and Radiation Protection of the GDR (1988): 'Aufgaben des Strahlenschutzes bei der zentralen Erfassung und Endlagerung radioaktiver Abfälle', Report SAAS-360, p. 42.

[496] Cf. Federal Office for Radiation Protection (1997): '25 Jahre Einlagerung radioaktiver Abfälle im Endlager Morsleben', p. 31.

[497] Cf. Federal Office for Radiation Protection (1997): '25 Jahre Einlagerung radioaktiver Abfälle im Endlager Morsleben', p. 24. Cf. also Tiggemann, Anselm (2004): Die „Achillesferse" der Kernenergie in der Bundesrepublik Deutschland: Zur Kernenergiekontroverse und Geschichte der nuklearen Entsorgung von den Anfängen bis Gorleben 1955 bis 1985, p. 172.

[498] Ebel, Klaus (1991): 'Das Endlager Morsleben für niedrig- und mittelradioaktive Abfälle', Die Atomwirtschaft – Atomtechnik: atw 36, 1991, pp. 500-503. Cf. Müller, Wolfgang (2001): Geschichte der Kernenergie in der DDR, vol. III, p. 264.

[499] Cf. Federal Office for Radiation Protection (1997): '25 Jahre Einlagerung radioaktiver Abfälle im Endlager Morsleben', p. 36.

[500] Cf. Federal Office for Radiation Protection (2015): 'Die zwischengelagerten Abfälle im Endlager Morsleben', *online: http://www.bfs.de/SharedDocs/Downloads/BfS/DE/fachinfo/morsleben/150317-vortrag-drgerler-zwischengelagerte-abfaelle.pdf?__blob=publicationFile&v=1, last accessed 11 January 2016.*

[501] Cf. Federal Office for Radiation Protection (2009): 'Plan zur Stilllegung des Endlagers für radioaktive Abfälle Morsleben', pp. 9, 109 and 122.

Ministry of Agriculture and the Environment of the Land Saxony-Anhalt for the institution of such a procedure in October 1992.
Environmental organisations and community groups rejected the further operation of the disposal facility, fearing it would not meet Federal German standards and criticising, for instance, the fact that the permanent operating licence granted by the GDR did not include a long-term safety case. The GDR State Office for Nuclear Safety and Radiation Protection had planned to guarantee the long-term safety of the Morsleben Disposal Facility for Radioactive Waste (ERAM) after it had been decommissioned by flooding the underground workings with magnesium chloride brine. However, this concept did not comply with the requirements of the Atomic Energy Act, which ERAM had to fulfil from the outset, and at the latest under the plan approval procedure for its decommissioning, despite the continuing validity of the GDR licence.[502]
In February 1991, Magdeburg Administrative Court stopped the emplacement of waste at Morsleben Disposal Facility for Radioactive Waste (ERAM) because it believed a formal error had been made when the licence was transferred from the state-owned enterprise Energiekombinat Bruno Leuschner to Energiewerke Nord, which had been privatised before reunification. The Federal Administrative Court corrected this decision in June 1992. Emplacement activities were resumed again at ERAM in January 1994. After further legal action by local residents, community groups and environmental associations had led to emplacement being stopped again, the emplacement of radioactive waste at ERAM was ended in September 1998. Previously, in 1997, the Federal Office for Radiation Protection (BfS) had limited the plan approval procedure for ERAM to its decommissioning. Following a fundamental re-evaluation of the disposal facility, the BfS decided irrevocably in 2001 against the disposal of further radioactive waste at ERAM. Further emplacement activities were no longer justifiable from a safety point of view, the Federal Office stated when it explained the grounds for this decision.
Once the emplacement activities had ended, the Federal Office for Radiation Protection (BfS) concentrated on the stabilisation of the underground workings. In 2000, two blocks of salt, each weighing over 1,000 tonnes, threatened to fall down from the roofs of chambers inside the facility, and the BfS warned there was a danger of the underground structure collapsing. In 2001, about 5,000 tonnes of salt actually came away from the roof of one chamber. Thanks to the prompt backfilling of 27 chambers where salt had been extracted in the threatened central part of the facility with almost one million cubic metres of salt concrete, it was possible to secure the stability of the rock sufficiently in order to conduct a plan approval procedure under nuclear law for the disposal facility's decommissioning. An application has been made to close the disposal facility in accordance with the requirements of nuclear law. In 2005, the operator submitted the plan for the decommissioning of the disposal facility to the Saxony-Anhalt Environment Ministry. Nearly 14,000 objections to the decommissioning concept were raised prior to a hearing held in 2011. The Ministry for the Environment, Agriculture and Energy of the Land Saxony-Anhalt has not yet issued a plan approval decision.
151 million euros of charges were paid to the Federal Office for Radiation Protection for the emplacement of radioactive waste at the Morsleben Disposal

[502] Cf. Gesellschaft für Reaktorsicherheit (1991): 'Sicherheitsanalyse des Endlagers für radioaktive Abfälle Morsleben (ERAM)', p. 13.

Facility for Radioactive Waste following reunification.[503] The Federal Environment Ministry recently estimated that the German Federation's total expenditure on the facility's operation from the time when it was taken over, for its stabilisation, for the backfilling of most of the workings and for its sealing, would be more than 2.4 billion euros. Of this sum, costs of about 1.2 billion euros have already been incurred.[504]

The GDR authorities also selected the salt dome in the upper Aller Valley as a disposal facility site in 1970 on economic grounds: The Bartensleben salt mine was available, the extraction of rock salt had ceased the year before and there were large cavities that could accommodate radioactive waste. Later, these supposed advantages of the site resulted in high costs. Of the originally excavated 8.7 million cubic metres of cavities in the mine, 4.8 million cubic metres are to be filled with salt concrete at the end of its decommissioning to delay the transportation of solutions and pollutants in the substrate. A further 2.5 million cubic metres have already been filled with various backfilling materials, such as salt grit or filter ash. In the end, merely 1.4 million cubic metres of cavity are to remain underground.[505]

4.1.3 Konrad disposal facility

The former Konrad iron ore mine at Salzgitter was selected as a possible site for a disposal facility for radioactive waste during the period that saw the founding of various West German initiatives against the use of nuclear power. The first investigations of the site began in 1974. The works council at the iron ore mine and Gesellschaft für Strahlenforschung (GSF), which was running the Asse nuclear waste storage facility, had suggested to the Federal Ministry for Research and Technology that the Konrad site be given a new use as a disposal facility for problematic waste when it became apparent at the beginning of the 1970s that the end of iron ore extraction was imminent.[506] Following a project study by GSF about the mine, a study of the site's suitability as a disposal facility was started after extraction ceased in October 1976.[507] This too was conducted by GSF on behalf of the Federal Research Ministry. A Working Party against Atomic Energy that was opposed to the disposal facility was founded in 1976 at Salzgitter. In October 1982, a large demonstration against the project, the first of many, attracted about 8,000 protestors.[508]

Following the conclusion of its suitability studies, the National Metrology Institute of Germany applied on 31 August 1982 for the institution of a plan approval procedure for a disposal facility at the Konrad mine. The Lower Saxon Land

[503] Cf. http://www.bfs.de/DE/themen/ne/endlager/morsleben/endlager/finanzierung.html.

[504] Cf. Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (2015): 'Bericht über Kosten und Finanzierung der Entsorgung bestrahlter Brennelemente und radioaktiver Abfälle', pp. 10f.

[505] Federal Office for Radiation Protection (2009): 'Plan zur Stilllegung des Endlagers für radioaktive Abfälle Morsleben', p. 145.

[506] Cf. Tiggemann, Anselm (2004): Die „Achillesferse" der Kernenergie in der Bundesrepublik Deutschland: Zur Kernenergiekontroverse und Geschichte der nuklearen Entsorgung von den Anfängen bis Gorleben 1955 bis 1985, p. 167.

[507] Cf. National Metrology Institute of Germany (1988): 'Schachtanlage Konrad – vom Erzbergwerk zum Endlager für radioaktive Abfälle', p. 3.

[508] Cf. Fischer, Dirk, Ness, Klaus, Perik, Muzaffer, Schröder, Claus (1989): Atommüllendlager Schacht Konrad, p. 12.

Government was not at first opposed to the project as a matter of principle.[509] The commissioning of the disposal facility was initially planned for 1988.[510] In the mean time, the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety expects the Konrad disposal facility will be able to go into operation in 2022 at the earliest. This date too is still overshadowed by uncertainties, according to the National Waste Management Programme.[511] It is expected that about half a century will have passed between the first project study for a disposal facility at the Konrad mine and the actual commissioning of the facility. This is not solely to be blamed on the complexity of any disposal project, for the political parameters have contributed to it as well: conflicts between the German Federation and the Land Lower Saxony, and resistance from local authorities and community groups. Furthermore, the large amount of conversion work required at the mine only became apparent at a late stage.
The plan documents presented as of 1986 by the National Metrology Institute of Germany were classified as incomplete several times by the licensing authority, the Lower Saxon Environment Ministry. Furthermore, the Christian Democratic Union (CDU)/Free Democratic Party (FDP) Land Government demanded an assurance from the German Federation that only nuclear waste produced in Germany would be deposited at the mine.[512] In June 1990, the CDU/FDP Land Government, which had lost a Landtag election, but was still continuing in office for a short period until the next minister president was elected, then declared the plan approval documents ready to be disclosed for public inspection after all. The Social Democratic Party of Germany (SPD)/Green Land Government that succeeded it opposed a disposal facility at Konrad and did not wish to accept this decision. Instructions from the German Federation to the Land were decisive for the further licensing procedure. In April 1991, the Federal Constitutional Court ruled that, as the Land was acting in the context of the execution of legislation by the Länder on behalf of the Federal Government, it had to follow such instructions.
The German Federation purchased the Konrad mine from Salzgitter AG in 1987 for 84 million deutschmarks. However, the contract only became effective when the positive plan approval decision for the disposal facility was issued in May 2002. Following the disclosure of the plan approval documents for public inspection, about 290,000 objections to the planned disposal facility were submitted. These objections were discussed publicly over 75 days from the autumn of 1992 on at Salzgitter. It was not until ten years later, following further instructions from the German Federation, that the Lower Saxon Environment Ministry issued the plan approval decision for the disposal facility at the Konrad site. The conversion of the disposal facility was preceded in 2007 by the confirmation of the plan approval decision by the Federal Administrative

[509] Cf. German Bundestag (1981): ‘Antwort der Bundesregierung auf die Große Anfrage der Abgeordneten Laufs u.a. und der Fraktion der CDU/CSU: Verantwortung des Bundes für Sicherstellung und Endlagerung radioaktiver Abfälle in der Bundesrepublik Deutschland’, Bundestag Printed Paper 9/1231, 22 December 1981, p. 2.
[510] Cf. German Bundestag (1983): ‘Bericht der Bundesregierung zur Entsorgung der Kernkraftwerke und anderer kerntechnischer Einrichtungen’, Bundestag Printed Paper 10/327, 30 August 1983, p. 10.
[511] Cf. Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (2015a): ‘Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management: Report of the Federal Republic of Germany for the Fifth Review Meeting in May 2015’, p. 78.
[512] Cf. Lower Saxon Environment Ministry (1992): Was Sie schon immer über Konrad wissen wollten..., p. 10.

Court.[513] In January 2008, the main plan of operations for the construction of the Konrad disposal facility was approved by the Lower Saxon Land Office for Mining, Energy and Geology.

Furthermore, in November 2009, the Federal Constitutional Court did not give leave for a constitutional complaint to be brought against the plan approval decision by a local resident who lived near the disposal facility. With regard to the long-term safety of the disposal facility, about which doubts were raised in the complaint, the Federal Constitutional Court found in its order that the complainant was not able to derive a fundamental right 'to prevent threats to the environment and subsequent generations that would not occur until after his own lifetime' from the German Basic Law.[514] Constitutionally, there could be no objections to Lüneburg Higher Administrative Court's finding that people who were living today did not have the ability to assert a right to protect future generations. In its order, however, the Federal Constitutional Court dealt only with the disposal of low and intermediate-level radioactive waste: 'No decision is required on whether, and to what extent, the remarks below also lay claim to validity for the disposal of heat-generating radioactive waste.'[515] According to the plan approval decision, exclusively radioactive waste with negligible heat generation and a total volume of waste packages of up to 303,000 cubic metres may be deposited at the Konrad disposal facility. In addition to this, irrespective of how much heat they generate, particular radionuclides and radionuclide groups may only be deposited in the disposal facility up to particular activity limits. The Konrad site is therefore able to accommodate a large proportion, but not all, of Germany's low and intermediate-level radioactive waste.[516]

The overall costs of the Konrad disposal facility were estimated recently by the Federal Environment Ministry at about 7.5 billion euros.[517] According to the Ministry, the planning and exploration of the disposal facility cost 930 million euros in the years from 1977 to 2007. Very recently, it was estimated the conversion of the mine into a disposal facility during the years from 2008 to 2022 would cost 3.4 billion euros. The costs of the emplacement operations were quantified by the Ministry at about 82 million euros a year, the total costs of its decommissioning at 340 million euros. In the course of the disposal facility's construction, the equipment at the underground facility will be comprehensively replaced. What will survive of the former iron mine will above all be cavities. However, the planning of the disposal facility in an existing mine will offer the opportunity to exploit the geological information obtained while ore was being extracted. The operation of a metal mine at the site means it has already been explored extensively underground.

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[513] Cf. Federal Office for Radiation Protection (2008): Endlager Konrad, p. 27.

[514] Federal Constitutional Court (2009): Order of 10 November 2009 – 1 BvR 1178/07, para. 55.

[515] Federal Constitutional Court (2009): Order of 10 November 2009 – 1 BvR 1178/07, para. 18.

[516] Cf. Federal Office for Radiation Protection (2014): 'Anforderungen an endzulagernde radioaktive Abfälle – Endlager Konrad'.

[517] Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (2015): 'Bericht über Kosten und Finanzierung der Entsorgung bestrahlter Brennelemente und radioaktiver Abfälle', August 2015, p. 10.

4.1.4 Gorleben exploratory mine

The storage of radioactive waste has been associated with massive societal conflicts in Germany since the 1970s. This is true to a particular degree of the Gorleben site. It will only be possible for a new start to succeed if this history is analysed. It offers important experience that will have to be borne in mind in the new search for a disposal site. However, the Commission – as previously the German Bundestag's committee of inquiry on Gorleben – has not been able to agree on a shared view of the history of the Gorleben exploratory mine, something that is regretted by all its members. In consequence, two parallel accounts are found in this section of the report. They display essentially the same differences as the final reports of the parliamentary committee of inquiry on Gorleben established during the 17th electoral term, one of which was adopted by the Christian Democratic Union/Christian Social Union (CDU/CSU) and Free Democratic Party (FDP) governing coalition, and one by the then opposition. The Commission does not wish to conceal these differences, which are not only integral to the reappraisal of Germany's nuclear history, but also have to be borne in mind if a societal understanding is to be arrived at.

Text A:[518]	Text B:[609]
Following the selection of the Lower Saxon village of Gorleben in Lüchow-Dannenberg County as the site for a nuclear waste management centre, a political and societal conflict of unparalleled duration and great bitterness broke out there, over which the dispute about nuclear energy also came to a head.[519] Following the decision about the site in 1977, growing sections of the region's population agitated for almost four decades against the construction of waste management installations or transports of radioactive waste, collaborating with anti-nuclear-power activists from other areas, and organising demonstrations of various sizes, campaigns and blockades. The protests were initially directed	Following the selection of the Lower Saxon village of Gorleben in Lüchow-Dannenberg County as the site for a nuclear waste management centre, a political and societal conflict of unparalleled duration and great bitterness broke out there, over which the dispute about nuclear energy also came to a head.[610] Following the decision about the site in 1977, growing sections of the region's population agitated for almost four decades against the construction of waste management installations or transports of radioactive waste, collaborating with anti-nuclear-power activists from other areas, and organising demonstrations of various sizes, campaigns and blockades. The protests were initially directed

518 Text A is based on a draft drawn up by the Commission Secretariat, which was amended in line with the points put forward by a number of the Commission's members. Text B represents an attempt to reach a minimal compromise over Text A, and was drawn up by a number of the Commission's other members.

519 In section 2.2, the Commission traced the history of waste management up until the preliminary designation of Gorleben as a site for a waste management centre. In this section, it gives an account of the history of the exploratory mine, which was frequently the focus of disputes.

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610 In section 2.2, the Commission traced the history of waste management up until the preliminary designation of Gorleben as a site for a waste management centre. In this section, it gives an account of the history of the exploratory mine, which was frequently the focus of disputes.

against the planned waste management centre, later against the exploration of the Gorleben salt dome to ascertain its suitability for the disposal of radioactive waste and the storage of Castor casks. The demonstrations against the transports of high-level radioactive waste to the Gorleben interim storage facility were usually also opportunities, and levers with which, to argue against the construction of a disposal facility in the salt dome, as well as against the use of nuclear energy in general. These two conflicts about the phasing-out of nuclear energy and the Gorleben disposal facility have to be seen both discretely and in a shared context. Furthermore, the waste management installations planned or constructed at Gorleben were controversial in party politics, and between the German Federation and the Land Lower Saxony under different constellations of actors. Even 36 years after the site had been chosen, it was not just how the facts were to be assessed, but also which facts were to be investigated in the first place that was disputed between the governing and opposition parliamentary groups on the German Bundestag's committee of inquiry, which met during the years from 2010 to 2013 and looked into important decisions relating to the Gorleben waste management site.[520] The possible suitability of the Gorleben salt dome as a disposal facility was the subject of controversial discussions among scientists early on as well. The new start in the search for a disposal facility initiated with the adoption of the Site Selection Act and the establishment of the Commission on the Storage of High-Level Radioactive Waste also go back not least to the persistent conflict about the Gorleben site. The	against the planned waste management centre, later against the exploration of the Gorleben salt dome to ascertain its suitability for the disposal of radioactive waste and the storage of Castor casks. The demonstrations against the transports of high-level radioactive waste to the Gorleben interim storage facility were usually also opportunities, and levers with which, to argue against the construction of a disposal facility in the salt dome, as well as against the use of nuclear energy in general. These two conflicts about the phasing-out of nuclear energy and the Gorleben disposal facility have to be seen both discretely and in a shared context. Furthermore, the waste management installations planned or constructed at Gorleben were controversial in party politics, and between the German Federation and the Land Lower Saxony under different constellations of actors. Even 36 years after the site had been chosen, it was not just how the facts were to be assessed, but also which facts were to be investigated in the first place that was disputed between the governing and opposition parliamentary groups on the German Bundestag's committee of inquiry, which met during the years from 2010 to 2013 and looked into important decisions relating to the Gorleben waste management site.[611] The possible suitability of the Gorleben salt dome as a disposal facility was the subject of controversial discussions among scientists early on as well. The new start in the search for a disposal site initiated with the adoption of the Site Selection Act and the establishment of the Commission on the Storage of High-Level Radioactive Waste also go back not least to the persistent conflict about the Gorleben site. The Commission's aim

[520] Cf. German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013.

[611] Cf. German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013.

Commission's aim is to bring an end to this major societal conflict. The Site Selection Act halted the geotechnical exploration of the Gorleben salt dome in July 2013 and stipulated that, like every other site in Germany, the salt dome would be included in a new disposal site selection procedure.[521] This is part of the political compromise required in order to make a new start possible. As provided for in the Act, the preliminary safety study of the Gorleben site was discontinued as well.[522] The salt dome there will not be used as a reference site during the new search for a disposal site. Furthermore, in April 2015, the Commission asked the German Federal Government to draw up statutory provisions 'that make it possible for early action to be taken to secure siting regions and planning zones for potential disposal sites.'[523] Such general provisions were to render superfluous the moratorium on development with which the Gorleben salt dome alone has been secured against interference hitherto and were intended to bring an end to the salt dome's continuing special status. In June 2015, the Bundesrat only gave its consent to the extension of the temporary moratorium subject to the proviso that it would expire on 31 March 2017, by which time a statutory basis would be put in place that would make it possible for early action to be taken to secure siting regions and planning zones for potential disposal sites.[524] The Commission did not have the task of analysing or appraising the possible suitability of the Gorleben salt dome as a disposal site. Section 4 of the Site	is to bring an end to this major societal conflict. The Site Selection Act halted the geotechnical exploration of the Gorleben salt dome in July 2013 and stipulated that, like every other site in Germany, the salt dome would be included in a new disposal site selection procedure.[612] This is part of the political compromise required in order to make a new start possible. As provided for in the Act, the preliminary safety study of the Gorleben site was discontinued as well.[613] The salt dome there will not be used as a reference site during the new search for a disposal site. Furthermore, in April 2015, the Commission asked the German Federal Government to draw up statutory provisions 'that make it possible for early action to be taken to secure siting regions and planning zones for potential disposal sites.'[614] Such general provisions were to render superfluous the moratorium on development with which the Gorleben salt dome alone has been secured against interference hitherto and were intended to put an end to the salt dome's continuing special status. In June 2015, the Bundesrat only gave its consent to the extension of the temporary moratorium subject to the proviso that it would expire on 31 March 2017, by which time a statutory basis would be put in place that would make it possible for early action to be taken to secure siting regions and planning zones for potential disposal sites.[615] The Commission did not have the task of analysing or appraising the possible suitability of the Gorleben salt dome as a disposal site. Section 4 of the Site

[521] Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553. Section 29.

[522] Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553, Section 29: 'The preliminary safety study of the Gorleben site shall be discontinued at the latest with the entry into force of this Act without any forecast of suitability for the Gorleben site being made.'

[523] Commission on the Storage of High-Level Radioactive Materials (2015): 'Beschluss der Kommission vom 20. April 2015', Commission Printed Paper K-Drs. 102 neu.

[524] Cf. Gorleben Moratorium Ordinance of 25 July 2005, Federal Gazette 2005, 153, p. 12385, amended by Article 1 of the Ordinance of 7 July 2015, Federal Gazette 2015, Official Section, 21 July 2015, V1. See section B 8.4 of the present report.

Selection Act also states that 'recommendations concerning the treatment of previously adopted decisions and specifications relating to the disposal question' are to be drawn up by the Commission.[525] In this respect, from a contemporary point of view, the decisions on the Gorleben site are the most important that are to be subjected to examination. It is this tension between the experience that has been gained and the desire for a new start that has formed the backdrop to the Commission's work.	Selection Act also states that, 'recommendations concerning the treatment of previously adopted decisions and specifications relating to the disposal question' are to be drawn up by the Commission.[616] In this respect, the significant experiences gone through during the Gorleben disposal project are to be taken into account in particular.
Until the cross-party agreement on a new search for a disposal site, Gorleben caused grave political conflicts and societal divisions. Against this background, it is imperative to learn from the conflicts over the Gorleben site and avoid the repetition of earlier errors. At the same time, it is necessary to explain why the decisions taken about Gorleben failed to gain acceptance and too often provoked fierce protest.	Until the cross-party agreement on a new search for a disposal site, Gorleben caused grave political conflicts and societal divisions. Against this background, it is imperative to learn from the conflicts over the Gorleben site and avoid the repetition of earlier errors.
4.1.4.1 Search for a site for a waste management centre Under the Site Selection Act, the best-possible site in Germany for the disposal of high-level radioactive waste in terms of safety is to be determined in a comparative selection procedure.[526] If a satisfactory solution is to be reached, a site will have to 'be selected in a readily understandable, transparent and fair	4.1.4.1 Search for a site for a waste management centre Under the Site Selection Act, the best-possible site in Germany for the disposal of high-level radioactive waste in terms of safety is to be determined in a comparative selection procedure.[617] If a satisfactory solution is to be reached, a site will have to 'be selected in a readily understandable, transparent and fair

612 Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553. Section 29.
613 Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553, Section 29: 'The preliminary safety study of the Gorleben site shall be discontinued at the latest with the entry into force of this Act without any forecast of suitability for the Gorleben site being made.'
614 Commission on the Storage of High-Level Radioactive Materials (2015): 'Beschluss der Kommission vom 20. April 2015', K-Drs. 102 neu.
615 Cf. Gorleben Moratorium Ordinance of 25 July 2005, Federal Gazette 2005, 153, p. 12385, amended by Article 1 of the Ordinance of 7 July 2015, Federal Gazette 2015, Official Section, 21 July 2015, V1. See section B 8.4 of the present report.
525 Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553.
526 'A comparative disposal site selection procedure is to be newly established that is directed towards the identification of the best-possible site in Germany in terms of safety,' the explanatory memorandum to the draft bill says in its introductory discussion of the background to the legislation. German Bundestag (2013): Draft Act tabled by the parliamentary groups of the Christian Democratic Union/Christian Social Union (CDU/CSU), the Social Democratic Party of Germany (SPD) and Alliance 90/The Greens: Draft Act on the Search for and Selection of a Site for a Disposal Facility for Heat-Generating Radioactive Waste Materials and on the Amendment of other Acts (Site Selection Act – StandAG), Bundestag Printed Paper 17/13471, p. 14.

procedure in which the affected local and regional authorities, and the public are involved from the beginning,' as the explanatory memorandum to the draft bill summarises the fresh approach.[527] Furthermore, the bill emphasises that the requirements and criteria for the selection of the site are to be specified prior to the beginning of the procedure. If the decisions about the Gorleben site are judged retrospectively against these ambitions, serious deficiencies become apparent that at least partly explain the low levels of acceptance. From a contemporary point of view, there was a lack of transparency and easily understandable, well founded, accepted selection criteria. The main purpose of the site proposed on 22 January 1977 by the Lower Saxon Land Government under Minister President Ernst Albrecht and accepted on 5 July 1977 by the German Federal Government under Federal Chancellor Helmut Schmidt changed after a good two years: Instead of a twelve-square-kilometre nuclear waste management centre, there were now plans for an exploratory mine and an interim storage facility at Gorleben that would occupy less than one twentieth of the area of land on the surface that had initially been sought. The change in the site's main purpose devalued the selection procedure because meaningful criteria for the selection of	procedure in which the affected local and regional authorities, and the public are involved from the beginning,' as the explanatory memorandum to the draft bill summarises the fresh approach.[618] Furthermore, the bill emphasises that the requirements and criteria for the selection of the site are to be specified prior to the beginning of the procedure. The main purpose of the site proposed on 22 January 1977 by the Lower Saxon Land Government under Minister President Ernst Albrecht and accepted on 5 July 1977 by the German Federal Government under Federal Chancellor Helmut Schmidt changed after a good two years: Instead of a twelve-square-kilometre nuclear waste management centre, there were now plans for an exploratory mine and an interim storage facility at Gorleben that would occupy just a fraction of the area of land at the surface that had initially been sought.

[616] Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553.

[617] 'A comparative disposal site selection procedure is to be newly established that is directed towards the identification of the best-possible site in Germany in terms of safety,' the explanatory memorandum to the draft bill says in its introductory discussion of the background to the legislation. German Bundestag (2013): Draft Act tabled by the parliamentary groups of the Christian Democratic Union/Christian Social Union (CDU/CSU), the Social Democratic Party of Germany (SPD) and Alliance 90/The Greens: Draft Act on the Search for and Selection of a Site for a Disposal Facility for Heat-Generating Radioactive Waste Materials and on the Amendment of other Acts (Site Selection Act – StandAG), Bundestag Printed Paper 17/13471, p. 14.

[527] German Bundestag (2013): Draft Act tabled by the parliamentary groups of the Christian Democratic Union/Christian Social Union (CDU/CSU), the Social Democratic Party of Germany (SPD) and Alliance 90/The Greens: Draft Act on the Search for and Selection of a Site for a Disposal Facility for Heat-Generating Radioactive Waste Materials and on the Amendment of other Acts (Site Selection Act – StandAG), Bundestag Printed Paper 17/13471, p. 15.

[618] German Bundestag (2013): Draft Act tabled by the parliamentary groups of the Christian Democratic Union/Christian Social Union (CDU/CSU), the Social Democratic Party of Germany (SPD) and Alliance 90/The Greens: Draft Act on the Search for and Selection of a Site for a Disposal Facility for Heat-Generating Radioactive Waste Materials and on the Amendment of other Acts (Site Selection Act – StandAG), Bundestag Printed Paper 17/13471, p. 15.

any site depend on the project that is being planned. The proposal concerning the site made by the Lower Saxon Land Government, which had been prepared by an interministerial working party, met with scepticism from scientists at an early stage. Subsequently, unclear suitability criteria for the disposal facility contributed to controversies about the site among scientists. The quality of the search for a site on the basis of which the Lower Saxon Land Government proposed Gorleben as the location for a nuclear waste management centre in 1977 was extremely controversial within the German Bundestag's committee of inquiry on Gorleben. The majority of the committee saw a decision rooted in the primacy of safety that had been taken during a selection procedure based on an extensive catalogue of criteria,[528] while the representatives of the opposition spoke of a selection made on political grounds for which the interministerial working party of the Land Government that was dealing with the matter at that time had merely produced an overview of the issues.[529] This also has to be seen in the light of the state of the art of science and technology during the period. The requirements placed on such a site at that time were not guided by the best-possible safety, but by the achievement of protection targets. Nonetheless, by contemporary standards, the selection procedure was marked by the following deficiencies: The search for a site was limited to the Land Lower Saxony.[530]	The proposal concerning the site made by the Lower Saxon Land Government, which had been prepared by an interministerial working party, met with scepticism from scientists at an early stage. Subsequently, the suitability criteria applied to the disposal facility contributed to controversies about the site among scientists. The quality of the search for a site on the basis of which the Lower Saxon Land Government proposed Gorleben as the location for a nuclear waste management centre in 1977 was extremely controversial within the German Bundestag's committee of inquiry on Gorleben. The majority of the committee saw a decision rooted in the primacy of safety that had been taken during a selection procedure based on an extensive catalogue of criteria,[619] while the representatives of the opposition spoke of a selection made on political grounds for which the interministerial working party of the Land Government that was dealing with the matter at that time had merely produced an overview of the issues.[620] The Land Government had essentially made the provisional selection of the Gorleben salt dome on three grounds: 'We wanted to have a salt dome that was as untouched as possible, in other words that had not yet been drilled into.' Furthermore, those involved had hoped for a salt dome of sufficient size. The top of the salt dome was also to 'be located no more than 400 metres below the surface.'[621] All this had been the case at

[528] Cf. German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013.

[529] Cf. German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013.

[530] This does not apply for the preceding search for a disposal site initiated by the then Federal Ministry for Research and Technology, which was ended in 1976 at the proposal of Lower Saxony. Cf., on this issue, section B 2.2.1 of the present report.

In line with the general opinion at that time, only salt was considered as a disposal medium, and only salt domes were therefore taken into consideration as sites. The proposal for a site was prepared confidentially by the Lower Saxon Land Government in cabinet meetings. Documents drawn up for its preparation were kept under lock and key for a long time by various Lower Saxon Land governments, and the Land only published them decades later. The lack of transparency encouraged speculation about the motives for, and foundations of, the site's provisional designation. The area available for the construction of facilities above the salt dome was of decisive significance when the Lower Saxon site proposal was being elaborated. Until 1994, there was a statutory requirement for spent fuel rods to be recycled. The Land Government excluded more than four fifths of the salt formations that were available in Lower Saxony as potential sites because there was not enough space above them for a waste management centre that would occupy twelve square kilometres.[531] The amount of land required on the surface for the exploratory mine subsequently constructed at Gorleben was then just under 30 hectares, about one fortieth of	Gorleben. The possible impacts of the surface waste management centre planned until 1979 at Gorleben and, above all, the reprocessing plant envisaged there indisputably stood in the foreground during the selection process. Geologists from the Lower Saxon Geological Survey and the Federal Institute for Geosciences and Natural Resources (BGR) distanced themselves from the political statement that the Gorleben salt dome was suitable for the disposal of high-level radioactive waste with the term *eignungshöffig*: 'Here and on other occasions, the Gorleben salt dome has therefore only ever been described as potentially suitable [*eignungshöffig*] by the BGR and the Lower Saxony Geological Survey.'[622] The German word *eignungshöffig* means there is a – not precisely quantified – hope of suitability,[623] and no information is available that rules out the site's suitability. This implies a geological formation is *eignungshöffig* for as long as its unsuitability has not been demonstrated. The scientists' attitude accorded with the decision taken in July when the German Federal Government accepted the provisional selection of Gorleben as a site for a nuclear waste management centre without already assuming the

[619] Cf. German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013.

[620] Cf. German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013.

[621] German Atomic Forum (1979): Rede – Gegenrede: Symposium der Niedersächsischen Landesregierung zur grundsätzlichen Realisierbarkeit eines integrierten nuklearen Entsorgungszentrums, p. 178.

[531] Cf. German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013, p. 78. Breloer and Beyer also mention 140 salt domes considered at the outset: 'To begin with, 23 salt domes were identified above which a site of at least three by four kilometres was available,' they write, describing the first selection step that excluded 117 sites. Breloer, Bernd J., Beyer, Wolfgang (2013): 'Die Entsorgung ist nicht gesichert: Wie es Dazu kam', atw – International Journal for Nuclear Power 58, 8/9, p. 3.

[622] Erich Hofrichter (1978): 'Interner Bericht Endlagerung radioaktiver Abfälle: Kurze chronologische Zusammenstellung der Beteiligung der BGR und des NLfB an diesem Projekt', Hanover, 27 July 1978, p. 6.

[623] According to information provided by the geologist Prof. Gregor Borg to the Bundestag Administration, Höffigkeit means 'the probability that a body of ore suspected in the course of the exploration of a deposit from the Earth's surface will actually be found when mining at depth as well.' As a combination of Höffigkeit ('potentiality') and Eignung ('suitability'), the term Eignungshöffigkeit means 'the greater or lesser probability that a salt dome will be suitable for the final disposal of radioactive waste.'

the 1,200 hectares that had been estimated for a nuclear waste management centre.

The decisions taken by the Lower Saxon Land Cabinet and the Federal Cabinet concerning the selection of the site had not been preceded by any geological investigations of the site or comparative geological studies of multiple sites.

The possible impacts of the surface waste management centre planned until 1979 at Gorleben and, above all, the reprocessing plant envisaged for the site indisputably stood in the foreground during the selection process. In 1978, the Lower Saxon Geological Survey criticised in an internal report the fact that a points-based scheme for the assessment of the sites that remained in contention after the first selection steps had, above all, taken account of the surface situation and accorded this aspect ‘a priority that was inappropriate to the geological problems of the disposal facility.’[532]

The Gorleben salt dome had emerged as the victor from this ‘odd assessment scheme’. ‘Of course, this structure, the internal features of which are not known from boreholes, was not described by us as the only suitable site, as was claimed over and over again by politicians a short while later, i.e. in February 1977.’[533]

When the Lower Saxon Land Government announced the Gorleben salt dome was the only one suitable for a disposal facility, it could not cite statements from the Geological Survey to

site’s suitability. At that time, the German Federal Government’s Cabinet Committee on the Peaceful Use of Nuclear Energy recommended, ‘as a precaution’, that ‘yet other sites’ ought to be ‘examined alongside the Gorleben site so that the implementation of the waste management concept can be driven ahead at another location with the least possible delay if the studies at Gorleben have a negative outcome.’[624] However, alternative sites were not examined on account of the potential suitability (*Eignungshöffigkeit*) of the Gorleben salt dome.

Federal Chancellor Helmut Schmidt wrote to the Lower Saxon Minister President, Albrecht, on 6 July 1977 that, ‘setting aside significant misgivings that are connected with the proximity of the Gorleben site to the GDR,’[625] the Cabinet Committee had decided to instruct the National Metrology Institute at Brunswick to institute a plan approval procedure for a disposal facility at the site provisionally selected by the Lower Saxon Land Government. Furthermore, Schmidt expressed the expectation that the licensing and plan approval procedures would be conducted expeditiously and, ‘it will be possible for the exploration work that is still necessary (in particular, trial boreholes) to begin soon, in order to obtain certainty that the requisite preconditions for such a site are fulfilled as soon as possible.’[626]

Furthermore, in May 1977 the heads of

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[532] Cf. Erich Hofrichter (1978): ‘Interner Bericht Endlagerung radioaktiver Abfälle: Kurze chronologische Zusammenstellung der Beteiligung der BGR und des NLfB an diesem Projekt’, Hanover, 27 July 1978, p. 5.

[533] Erich Hofrichter (1978): ‘Interner Bericht Endlagerung radioaktiver Abfälle: Kurze chronologische Zusammenstellung der Beteiligung der BGR and des NLfB an diesem Projekt’, Hanover, 27 July 1978, p. 5.

[624] Excerpt from the text of the decision adopted at the meeting of the Cabinet Committee of the German Federal Government on the Peaceful Use of Nuclear Energy on 5 July 1977, quoted in: German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013, p. 98.

[625] Letter from Federal Chancellor Helmut Schmidt to Minister President Ernst Albrecht, 6 July 1977, in: German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013, Electronic Annex, Document No. 59.

[626] Letter from Federal Chancellor Helmut Schmidt to Minister President Ernst Albrecht, 6 July 1977, in: German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013, Electronic Annex, Document No. 59.

support this view. Similar remarks were also made at that time by the President of the Federal Institute for Geosciences and Natural Resources (BGR), Friedrich Bender. On 18 August 1977, the *Hannoversche Allgemeine Zeitung* quoted the Lower Saxon Minister President, Ernst Albrecht, who had made the political statement that the Gorleben salt dome was the only suitable one in Lower Saxony, as had also previously been concluded by geologists. By contrast, a teleprinter message Bender sent the same day to the Federal Economics Ministry made it clear that, 'This statement is not attributable to geologists in my Institute.'[534]

Geologists from the Lower Saxon Geological Survey and the Federal Institute for Geosciences and Natural Resources (BGR) distanced themselves from the political statement that the Gorleben salt dome was suitable for the disposal of high-level radioactive waste with the term *eignungshöffig*: 'Here and on other occasions, the Gorleben salt dome has therefore only ever been described as potentially suitable [*eignungshöffig*] by the BGR and the Lower Saxony Geological Survey.'[535]

The word means there is a – not precisely quantified – hope of suitability,[536] and no information is available that rules out the site's suitability. Ultimately, this implies a geological formation has to be regarded as *eignungshöffig* for as long as its unsuitability has not been demonstrated.

The scientists' attitude accorded with the decision taken in July when the German Federal Government accepted the government of the German Federation and the Länder had reached agreement on 'Principles for Precautionary Waste Management Measures for Nuclear Power Plants'. According to the 'Principles', operators of nuclear power plants had to provide evidence that residual radioactive substances would be recycled or disposed of, while this evidence was to be given concrete form by the 'adaptation of precautionary measures to the progress made in the implementation of the waste management centre in the Federal Republic of Germany'[627] or the conclusion of reprocessing contracts with foreign countries. For opponents of nuclear power, the tying of the operation of power plants to the provision of evidence of precautionary waste management measures was another reason to demand an end to the use of nuclear energy because the failure to build a waste management centre meant the promise that radioactive waste would be managed implicit in the evidence had not been fulfilled. Furthermore, the evidence that was demanded strengthened their ability to oppose the use of nuclear power in general by protesting against waste management installations. In requiring the provision of such evidence, policymakers also put themselves under pressure when it came to the implementation of the waste management centre.

During the Gorleben Hearing at Hanover in March 1979, which coincided with the severe nuclear accident at the US Three Mile Island nuclear power plant and

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534 Telex from Prof. Dr. F. Bender to Ministerial Director-General Dr. Engelmann, Directorate- General II, Federal Ministry for Economic Affairs (BMWi), Bonn, 18 August 1977.

535 Erich Hofrichter (1978): 'Interner Bericht Endlagerung radioaktiver Abfälle: Kurze chronologische Zusammenstellung der Beteiligung der BGR und des NLfB an diesem Projekt', Hanover, 27 July 1978, p. 6.

536 According to information provided by the geologist Prof. Gregor Borg to the Bundestag Administration, Höffigkeit means 'the probability that a body of ore suspected in the course of the exploration of a deposit from the Earth's surface will actually be found when mining at depth as well.' As a combination of Höffigkeit ('potentiality') and Eignung ('suitability'), the term Eignungshöffigkeit means 'the greater or lesser probability that a salt dome will be suitable for the final disposal of radioactive waste.'

627 German Federal Government (1977): 'Grundsätze zur Entsorgungsvorsorge für Kernkraftwerke', in: 'Bericht der Bundesregierung zur Situation der Entsorgung der Kernkraftwerke in der Bundesrepublik Deutschland (Entsorgungsbericht)', Bundestag Printed Paper 8/1281, 30 November 1977, p. 10.

provisional selection of Gorleben as a site for a nuclear waste management centre without already assuming the site's suitability. At that time, the German Federal Government's Cabinet Committee on the Peaceful Use of Nuclear Energy recommended, 'as a precaution', that 'yet other sites' ought to be 'examined alongside the Gorleben site so that the implementation of the waste management concept can be driven ahead at another location with the least possible delay if the studies at Gorleben have a negative outcome.'[537] However, no such alternative sites were examined. On 6 July 1977, Federal Chancellor Helmut Schmidt wrote to the Lower Saxon Minister President, Albrecht that, 'setting aside significant misgivings that are connected with the proximity of the Gorleben site to the GDR,'[538] the Cabinet Committee had decided to instruct the National Metrology Institute at Brunswick to institute a plan approval procedure for a disposal facility at the site provisionally selected by the Lower Saxon Land Government. Furthermore, Schmidt expressed the expectation that the licensing and plan approval procedures would be conducted expeditiously and, 'it will be possible for the exploration work that is still necessary (in particular, trial boreholes) to begin soon, in order to obtain certainty that the requisite preconditions for such a site are fulfilled as soon as possible.'[539]	against which 100,000 opponents of nuclear power demonstrated in the Lower Saxon Land capital, Lower Saxony's Minister President, Ernst Albrecht, spoke of the 'provisional selection' of the Gorleben site. 'But this provisional selection is indeed, as has been said, still not a final decision,'[628] he said at the opening of the six-day hearing's discussion of the disposal facility. Truly reliable information about a salt dome could first be supplied following a lengthy research programme, 'after deep boreholes have been drilled, after a shaft has been sunk, after drifts have been driven and everything these things entail.'[629] Following a public debate on the decision about the site (Gorleben Hearing), the Lower Saxon Land Government distanced itself from the idea of a nuclear waste management centre at Gorleben, but maintained its support for the disposal site. On 16 May 1979, in a policy statement before the Lower Saxon Landtag, Minister President Albrecht recommended that 'the reprocessing project not be pursued any further,'[630] but instead interim storage facilities constructed, and disposal research and development driven ahead. Furthermore, the Minister President argued for deep boreholes to be drilled at Gorleben: 'If there is a positive result, the geotechnical engineering of the salt dome at Gorleben, and should the

[537] Excerpt from the text of the decision adopted at the meeting of the Cabinet Committee of the German Federal Government on the Peaceful Use of Nuclear Energy on 5 July 1977, quoted in: German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013, p. 98.

[538] Letter from Federal Chancellor Helmut Schmidt to Minister President Ernst Albrecht, 6 July 1977, in: German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013, Electronic Annex, Document No. 59.

[539] Letter from Federal Chancellor Helmut Schmidt to Minister President Ernst Albrecht, 6 July 1977, in: German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013, Electronic Annex, Document No. 59.

[628] The Minister President's remarks are documented in: German Atomic Forum (1979): Rede – Gegenrede: Symposium der Niedersächsischen Landesregierung zur grundsätzlichen Realisierbarkeit eines integrierten nuklearen Entsorgungszentrums, p. 178.

[629] German Atomic Forum (1979): Rede – Gegenrede: Symposium der Niedersächsischen Landesregierung zur grundsätzlichen Realisierbarkeit eines integrierten nuklearen Entsorgungszentrums, p. 177.

Furthermore, in May 1977 the heads of government of the German Federation and the Länder had reached agreement on ‘Principles for Precautionary Waste Management Measures for Nuclear Power Plants’. According to the ‘Principles’, operators of nuclear power plants had to provide evidence that residual radioactive substances would be recycled or disposed of, while this evidence was to be given concrete form by the ‘adaptation of precautionary measures to the progress made in the implementation of the waste management centre in the Federal Republic of Germany’[540] or the conclusion of reprocessing contracts with foreign countries.

For opponents of nuclear power, the tying of the operation of power plants to the provision of evidence of precautionary waste management measures was another reason to demand an end to the use of nuclear energy because the failure to build a waste management centre meant the promise that radioactive waste would be managed implicit in the evidence had not been fulfilled. Furthermore, the evidence that was demanded strengthened their ability to oppose the use of nuclear power in general by protesting against waste management installations. In requiring the provision of such evidence, policymakers also put themselves under pressure when it came to the implementation of the waste management centre.

During the Gorleben Hearing at Hanover boreholes prove to be negative, the exploration of other disposal sites.’[631]

The German Federal Government regretted the recommendation that the reprocessing project not be pursued any further but, at the same time, welcomed Lower Saxony’s willingness, ‘to begin immediately with the necessary deep drilling to explore the suitability of the Gorleben salt dome.’[632] Simultaneously, it expressed understanding for the worries of citizens in the affected Lower Saxon county of Lüchow-Dannenberg. In a letter to Federal Chancellor Helmut Schmidt, the Lower Saxon Minister President, Albrecht, wrote on 8 June 1979 that the building site for a waste management centre at Gorleben could not be protected with justifiable police resources, ‘as long as there is an overwhelmingly hostile attitude among the population on the ground and strong commitment on the part of broad sections of the population against the nuclear waste management centre.’[633] If the reprocessing plant were to be removed from the planning, there would ‘at least be a good chance of being able to drill the deep boreholes.’[634]

In his letter, excerpts from which were soon quoted by various print media, Albrecht also pointed out that when he had rejected reprocessing he had used terms that were open to interpretation such as ‘for this generation’ or ‘for a generation of politicians’. Later, in 1982, the Minister President proposed that a reprocessing plant be built 25 kilometres west of Gorleben. However, Deutsche

630 Lower Saxon Landtag (1979): Stenographic Record, 9th electoral term, 15th plenary sitting, 16 May 1979, p. 1715.

540 German Federal Government (1977): ‘Grundsätze zur Entsorgungsvorsorge für Kernkraftwerke’, in: ‘Bericht der Bundesregierung zur Situation der Entsorgung der Kernkraftwerke in der Bundesrepublik Deutschland (Entsorgungsbericht)’, Bundestag Printed Paper 8/1281, 30 November 1977, p. 10.

631 Lower Saxon Landtag (1979): Stenographic Record, 9th electoral term, 15th plenary sitting, 16 May 1979, p. 1716.

632 Press and Information Office of the German Federal Government (1979): Bulletin: Presse- und Informationsamt der Bundesregierung, 16 May 1979.

633 Letter from the Lower Saxon Minister President, Ernst Albrecht, to Federal Chancellor Helmut Schmidt, 8 June 1979.

634 Letter from the Lower Saxon Minister President, Ernst Albrecht, to Federal Chancellor Helmut Schmidt, 8 June 1979.

in March 1979, which coincided with the severe nuclear accident at the US Three Mile Island nuclear power plant and against which 100,000 opponents of nuclear power demonstrated in the Lower Saxon Land capital, Lower Saxony's Minister President, Ernst Albrecht, spoke of the 'provisional selection' of the Gorleben site. 'But this provisional selection is indeed, as has been said, still not a final decision,'[541] he said at the opening of the six-day hearing's discussion of the disposal facility. Truly reliable information about a salt dome could first be supplied following a lengthy research programme, 'after deep boreholes have been drilled, after a shaft has been sunk, after drifts have been driven and everything these things entail.'[542] The Land Government had essentially made the provisional selection of the Gorleben salt dome on three grounds: 'We wanted to have a salt dome that was as untouched as possible, in other words that had not yet been drilled into.' Furthermore, those involved had hoped for a salt dome of sufficient size. The top of the salt dome was also to 'be located no more than 400 metres below the surface.'[543] All this had been the case at Gorleben. Following the Gorleben Hearing, the Lower Saxon Land Government distanced itself from the idea of a nuclear waste management centre at Gorleben, but maintained its support for the disposal site. On 16 May 1979, in a policy statement before the Lower Saxon Landtag, Minister President Albrecht recommended that 'the reprocessing project not be pursued any further,'[544]	Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen decided in favour of Wackersdorf as the site for this plant in 1985.

[541] The Minister President's remarks are documented in: German Atomic Forum (1979): Rede – Gegenrede: Symposium der Niedersächsischen Landesregierung zur grundsätzlichen Realisierbarkeit eines integrierten nuklearen Entsorgungszentrums, p. 178.
[542] German Atomic Forum (1979): Rede – Gegenrede: Symposium der Niedersächsischen Landesregierung zur grundsätzlichen Realisierbarkeit eines integrierten nuklearen Entsorgungszentrums, p. 177.
[543] German Atomic Forum (1979): Rede – Gegenrede: Symposium der Niedersächsischen Landesregierung zur grundsätzlichen Realisierbarkeit eines integrierten nuklearen Entsorgungszentrums, p. 178.
[544] Lower Saxon Landtag (1979): Stenographic Record, 9th electoral term, 15th plenary sitting, 16 May 1979, p. 1715.

but instead interim storage facilities constructed, and disposal research and development driven ahead. Furthermore, the Minister President argued for deep boreholes to be drilled at Gorleben: 'If there is a positive result, the geotechnical engineering of the salt dome at Gorleben, and should the boreholes prove to be negative, the exploration of other disposal sites.'[545] The German Federal Government regretted the recommendation that the reprocessing project not be pursued any further but, at the same time, welcomed Lower Saxony's willingness, 'to begin immediately with the necessary deep drilling to explore the suitability of the Gorleben salt dome.'[546] Simultaneously, it expressed understanding for the worries of citizens in the affected Lower Saxon county of Lüchow-Dannenberg. In a letter to Federal Chancellor Helmut Schmidt, the Lower Saxon Minister President, Albrecht, wrote on 8 June 1979 that the building site for a waste management centre at Gorleben could not be protected with justifiable police resources, 'as long as there is an overwhelmingly hostile attitude among the population on the ground and strong commitment on the part of broad sections of the population against the nuclear waste management centre.'[547] If the reprocessing plant were to be removed from the planning, there would 'at least be a good chance of being able to drill the deep boreholes.'[548] In his letter, excerpts from which were soon quoted by various print media, Albrecht also pointed out that when he had rejected reprocessing he had used terms that were open to interpretation such as 'for this generation' or 'for a generation of	

[545] Lower Saxon Landtag (1979): Stenographic Record, 9th electoral term, 15th plenary sitting, 16 May 1979, p. 1716.
[546] Press and Information Office of the German Federal Government (1979): Bulletin: Presse- und Informationsamt der Bundesregierung, 16 May 1979.
[547] Letter from the Lower Saxon Minister President, Ernst Albrecht, to Federal Chancellor Helmut Schmidt, 8 June 1979.
[548] Letter from the Lower Saxon Minister President, Ernst Albrecht, to Federal Chancellor Helmut Schmidt, 8 June 1979.

politicians'. Later, in 1982, the Minister President proposed that a reprocessing plant be built 25 kilometres west of Gorleben. However, Deutsche Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen decided in favour of Wackersdorf as the site for this plant in 1985.	
4.1.4.2 Suitability criteria and problems with their application Once Gorleben had been provisionally selected as the site for a disposal facility and this decision confirmed by the German Federal Government, it had initially remained open in 1977 whether the salt dome at the site of the planned nuclear waste management centre would also be able to accommodate high-level radioactive waste alongside low and intermediate-level radioactive waste.[549] Following the abandonment of the plan for a waste management centre in 1979, an interim storage facility and open-ended studies of the salt dome to ascertain its suitability as a disposal facility were still envisaged at Gorleben. However, the decision not to build the waste management centre did not lead to the hoped-for acceptance of deep boreholes being drilled to explore the salt dome. At the beginning of May 1980, for example, about 5,000 opponents of nuclear power occupied a site intended for a deep borehole and set up a camp. The Lower Saxon Land Government deployed 8,000 police officers to clear the camp in June 1980.	**4.1.4.2 Suitability criteria and problems with their application** Once Gorleben had been provisionally selected as the site for a disposal facility and this decision confirmed by the German Federal Government, it had initially remained open in 1977 whether the salt dome at the site of the planned nuclear waste management centre would also be able to accommodate high-level radioactive waste alongside low and intermediate-level radioactive waste.[635] Following the abandonment of the plan for a waste management centre in 1979, an interim storage facility and open-ended studies of the salt dome to ascertain its suitability as a disposal facility were still envisaged at Gorleben.
In the subsequent period, scientific statements about, and assessments of, the Gorleben site became ever more a field of conflict or point of contention; after all, geological findings or their interpretation were supposed to be decisive for the disposal project. When	In the subsequent period, scientific statements about, and assessments of, the Gorleben site became ever more a field of conflict or point of contention; after all, geological findings or their interpretation were supposed to be decisive for the disposal project. When

[549] Cf. 'Bericht der Bundesregierung zur Situation der Entsorgung der Kernkraftwerke in der Bundesrepublik Deutschland (Entsorgungsbericht)', Bundestag Printed Paper 8/1281, 30 November 1977, annex 2, 'Grundsätzliche sicherheitstechnische Realisierbarkeit des Entsorgungszentrums', p. 33.

[635] Cf. 'Bericht der Bundesregierung zur Situation der Entsorgung der Kernkraftwerke in der Bundesrepublik Deutschland (Entsorgungsbericht)', Bundestag Printed Paper 8/1281, 30 November 1977, annex 2, 'Grundsätzliche sicherheitstechnische Realisierbarkeit des Entsorgungszentrums', p. 33.

the exploration of the salt dome began in 1979, however, there were no criteria with which to appraise its suitability that had been specified by bodies or state agencies authorised to do so. Nor were there even generally accepted criteria of any kind. Furthermore, since only one site was explored intensively, it was also not possible to characterise findings by comparing them – for instance, to describe positive findings as particularly advantageous or judge whether deficiencies that were found had to be anticipated or accepted at any location. At the same time as the provisional selection of the Gorleben site by the Lower Saxon Land Government, the Federal Institute for Geosciences and Natural Resources (BGR) drew up a catalogue of suitable geological formations[550] for the long-term storage of radioactive waste for the Commission of the European Communities. The study involved drafting catalogues of geological criteria that salt, clay or granite formations for final disposal were supposed to meet. The criteria were not applied when it came to the provisional selection of the Gorleben salt dome because the study was not published until May 1977, and Lower Saxony was making the provisional selection of the site for a nuclear waste management centre, to which other standards were applied than those for a disposal site. Apart from general selection criteria for suitable disposal formations such as 'sufficient volume', 'great homogeneity', 'sufficient depth', 'low porosity and permeability',[551] and requirements concerning the stability of the formation, the BGR study also listed specific selection criteria for salt, clay and granite	the exploration of the salt dome began in 1979, however, there were no criteria with which to appraise its suitability that had been specified by bodies or state agencies authorised to do so. Such criteria were specified with the 'Safety Criteria' of 1983. The same year, the decision to go ahead with the underground exploration was also taken by the German Federal Government, which took account of the previously issued assessment criteria when it took this step. Since only one site was explored intensively, it was also not possible to characterise findings by comparing them with results from other locations, as is planned today. This was due to the fact that a comparison of sites based on in-depth geological explorations was not the state of the art of science and technology at that time, and nothing of this kind was therefore planned. At the same time as the provisional selection of the Gorleben site by the Lower Saxon Land Government, the Federal Institute for Geosciences and Natural Resources (BGR) drew up a catalogue of suitable geological formations[636] for the long-term storage of radioactive waste for the Commission of the European Communities. The study involved drafting catalogues of geological criteria that salt, clay or granite formations for disposal were supposed to meet. When it came to the provisional selection of the Gorleben salt dome, numerous geoscientific and spatial planning criteria were applied.[637] The catalogue of suitable geological formations was published in May 1977. Apart from general selection criteria for suitable disposal formations such as 'sufficient volume', 'great homogeneity',

550 Federal Institute for Geosciences and Natural Resources (1977): 'Langzeitlagerung radioaktiver Abfälle: Katalog geeigneter geologischer Formationen in der Bundesrepublik Deutschland: Bericht zum Studienvertrag Nr. 025-76-9-WASD der Kommission der Europäischen Gemeinschaften – Generaldirektion Forschung, Wissenschaft und Bildung in Brüssel'.

551 Federal Institute for Geosciences and Natural Resources (1977): 'Langzeitlagerung radioaktiver Abfälle: Katalog geeigneter geologischer Formationen in der Bundesrepublik Deutschland: Bericht zum Studienvertrag Nr. 025-76-9-WASD der Kommission der Europäischen Gemeinschaften – Generaldirektion Forschung, Wissenschaft und Bildung in Brüssel', pp. 7f.

formations. In this context, while ‘taking note of the above-mentioned danger points’, it described bodies of pure rock salt of sufficient thickness ‘as host rock for a disposal facility, in particular very suitable for highly active waste.’[552] According to the study, the danger points for a geological disposal facility in salt included anhydrite beds. This study of the long-term storage of radioactive waste, which was signed by the then President of the Federal Institute for Geosciences and Natural Resources, Friedrich Bender, stated that, ‘bodies of anhydrite are to be avoided during geotechnical exploration.’[553] On account of their fissuring, anhydrite banks were potential aquifers and could, under certain circumstances, allow groundwater to enter a disposal facility in the interior of a salt dome.[554] The exploration of the Gorleben salt dome did not follow this recommendation. When the Gorleben exploratory mine was being constructed, the Hauptanhydrit was cut through not far from the infrastructure zone during the excavation of Exploration Area 1.[555] The largest brine deposits opened when	‘sufficient depth’, ‘low porosity and permeability’,[638] and requirements concerning the stability of the formation, the BGR study also listed specific selection criteria for salt, clay and granite formations. In this context, while ‘taking note of the above-mentioned danger points’, it described bodies of pure rock salt of sufficient thickness ‘as host rock for a disposal facility, in particular very suitable for highly active waste.’[639] According to the study, the danger points for a geological disposal facility in salt included anhydrite beds. This study of the long-term storage of radioactive waste, which was signed by the then President of the Federal Institute for Geosciences and Natural Resources, Friedrich Bender, stated that, ‘bodies of anhydrite are to be avoided during geotechnical exploration.’[640] On account of their fissuring, anhydrite banks were potential aquifers and could, under certain circumstances, allow groundwater to enter a disposal facility in the interior of a salt dome.[641] The subsequent underground exploration of the Gorleben salt dome followed this recommendation. As had been planned,

[636] Federal Institute for Geosciences and Natural Resources (1977): ‘Langzeitlagerung radioaktiver Abfälle: Katalog geeigneter geologischer Formationen in der Bundesrepublik Deutschland: Bericht zum Studienvertrag Nr. 025-76-9-WASD der Kommission der Europäischen Gemeinschaften – Generaldirektion Forschung, Wissenschaft und Bildung in Brüssel’.

[637] Cf. German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), part 3, section A(II)(2)(g), p. 282, ‘Standortauswahlverfahren des IMK’.

[552] Federal Institute for Geosciences and Natural Resources (1977): ‘Langzeitlagerung radioaktiver Abfälle: Katalog geeigneter geologischer Formationen in der Bundesrepublik Deutschland: Bericht zum Studienvertrag Nr. 025-76-9-WASD der Kommission der Europäischen Gemeinschaften – Generaldirektion Forschung, Wissenschaft und Bildung in Brüssel’, p. 16.

[553] Federal Institute for Geosciences and Natural Resources (1977): ‘Langzeitlagerung radioaktiver Abfälle: Katalog geeigneter geologischer Formationen in der Bundesrepublik Deutschland: Bericht zum Studienvertrag Nr. 025-76-9-WASD der Kommission der Europäischen Gemeinschaften – Generaldirektion Forschung, Wissenschaft und Bildung in Brüssel’, p. 13.

[554] Cf. Federal Institute for Geosciences and Natural Resources (BGR) (1977): ‘Langzeitlagerung radioaktiver Abfälle: Katalog geeigneter geologischer Formationen in der Bundesrepublik Deutschland: Bericht zum Studienvertrag Nr. 025-76-9-WASD der Kommission der Europäischen Gemeinschaften – Generaldirektion Forschung, Wissenschaft und Bildung in Brüssel’, p. 13. On this point, the study says, ‘Anhydrite beds also reduce the stability of artificial cavities. On account of their fissuring, anhydrite banks are potential aquifers. For example, Hauptanhydrit, above all if it is drilled into during mining operations, will allow the groundwater of the cap rock area to enter the disposal facility in the interior of the salt dome. Bodies of anhydrite are to be avoided during geotechnical exploration.’ In a comment submitted to the Commission, the BGR related the statements made in this quotation purely to the example under discussion. Cf. K-Drs. 216, p. 4.

[555] Cf., for instance: Gesellschaft für Anlagen- and Reaktorsicherheit (2013): ‘Synthesebericht für die VSG: Bericht zum Arbeitspaket 13’, p. 230.

the salt dome was explored were encountered in the Hauptanhydrit.[556] Experts from Gesellschaft für Reaktorsicherheit (GRS) later considered the isolation of these deposits as not being proven. In their opinion, it remained questionable whether these were isolated brine pockets substantially surrounded by rock and without connections to other joints.[557] While the salt dome was being explored from the surface with boreholes drilled into the salt table, it was found that a potash bed neighbouring the anhydrite was completely 'subroded' 'up to approx. 90-130 metres below the salt table',[558] and further impacts of groundwater on the	when the exploratory mine was constructed at Gorleben, the Hauptanhydrit was cut through just once not far from the infrastructure zone during the excavation of Exploration Area 1.[642] This was unavoidable on account of the natural geological sequence of strata because, to ensure the necessary stability, the shafts were planned in the salt rock strata of the Zechstein 3 and the possible emplacement zones in the homogeneous salt rock strata of the Zechstein 2, and the Hauptanhydrit lies stratigraphically between these geological units throughout. The largest brine deposits opened when the salt dome was explored

[638] Federal Institute for Geosciences and Natural Resources (1977): 'Langzeitlagerung radioaktiver Abfälle: Katalog geeigneter geologischer Formationen in der Bundesrepublik Deutschland: Bericht zum Studienvertrag Nr. 025-76-9-WASD der Kommission der Europäischen Gemeinschaften – Generaldirektion Forschung, Wissenschaft und Bildung in Brüssel', pp. 7f.

[639] Federal Institute for Geosciences and Natural Resources (1977): 'Langzeitlagerung radioaktiver Abfälle: Katalog geeigneter geologischer Formationen in der Bundesrepublik Deutschland: Bericht zum Studienvertrag Nr. 025-76-9-WASD der Kommission der Europäischen Gemeinschaften – Generaldirektion Forschung, Wissenschaft und Bildung in Brüssel', p. 16.

[640] Federal Institute for Geosciences and Natural Resources (1977): 'Langzeitlagerung radioaktiver Abfälle: Katalog geeigneter geologischer Formationen in der Bundesrepublik Deutschland: Bericht zum Studienvertrag Nr. 025-76-9-WASD der Kommission der Europäischen Gemeinschaften – Generaldirektion Forschung, Wissenschaft und Bildung in Brüssel', p. 13.

[641] Cf. Federal Institute for Geosciences and Natural Resources (BGR) (1977): 'Langzeitlagerung radioaktiver Abfälle: Katalog geeigneter geologischer Formationen in der Bundesrepublik Deutschland: Bericht zum Studienvertrag Nr. 025-76-9-WASD der Kommission der Europäischen Gemeinschaften – Generaldirektion Forschung, Wissenschaft und Bildung in Brüssel', p. 13. On this point, the study says, 'Anhydrite beds also reduce the stability of artificial cavities. On account of their fissuring, anhydrite banks are potential aquifers. For example, Hauptanhydrit, above all if it is drilled into during mining operations, will allow the groundwater of the cap rock area to enter the disposal facility in the interior of the salt dome. Bodies of anhydrite are to be avoided during geotechnical exploration.' In a comment submitted to the Commission, the BGR related the statements made in this quotation purely to the example under discussion. Cf. K-Drs. 216, p. 4.

[556] Federal Office for Radiation Protection (BfS) (2002): 'Verzeichnis der Vorkommen salinarer Lösungen im Erkundungsbergwerk Gorleben sowie in einigen Bereichen des Salzstocks Gorleben'. According to this document, the total volume of the solutions that had flowed into the facility up to 2000, not including ingresses during the sinking of the shafts, was 366 cubic metres, of which more than 300 cubic metres had flowed into the structure in the Hauptanhydrit. The BfS calculated the four brine deposits had a further total reservoir volume of between 300 and 7,000 cubic metres. Cf. pp. 102f.

[557] Gesellschaft für Anlagen- and Reaktorsicherheit (GRS) (2011): 'Sichtung und Bewertung der Standortdaten Gorleben: Bericht zum Arbeitspaket 2: Vorläufige Sicherheitsanalyse für den Standort Gorleben'. On page 53, this report says of the pressure levels measured in the brine reservoirs in the anhydrite, 'The pressure levels listed here are far below the lithostatic pressure and, subject to the assumption of a high-density brine, may even reflect levels of hydrostatic pressure. These findings suggest the reservoirs are not "isolated".' By contrast to this, the Federal Institute for Geosciences and Natural Resources pointed out that the pressure in a solution deposit always falls when it is disturbed, 'so that it is only possible to measure yet lower pressure levels after a solution deposit has been drilled into.' Federal Institute for Geosciences and Natural Resources (2016): 'Stellungnahme zur K-Drs. 212/AG4-27 der Kommission Lagerung hoch radioaktiver Abfallstoffe', K-Drs 246, p. 6. GRS's conclusion was therefore not technically verifiable.

[558] See the comments made by Werner Jaritz (Federal Institute for Geosciences and Natural Resources) at the public hearing held by the Committee on the Environment, Nature Conservation and Nuclear Safety on the Gorleben disposal facility, 25 March 1988, Committee Printed Paper 11/5, part I, p. 162.

potash bed were detected as far as 170 metres into the salt dome.[559] Unlike the early Federal Institute for Geosciences and Natural Resources (BGR) study produced in 1977, later plans for a possible disposal facility at Gorleben asserted it was sufficient for there to be a separation distance between the actual emplacement chambers and the anhydrite. In a recent comment, for instance, the BGR described the demand that anhydrite not only be avoided close to the surface but also deep in the interior of the dome as 'inappropriate'.[560] The Gorleben preliminary safety analysis also assumed the anhydrite had been cut through during the excavation of the exploratory mine. During the period when the Gorleben salt dome was being explored from the surface, which lasted from 1979 to 1983, the Reactor Safety Commission (RSK) agreed on 'Safety Criteria for the Permanent Storage of Radioactive Waste in a Mine'.[561] This RSK Recommendation was adopted in September 1982 and published in the *Federal Gazette* in January 1983. It was the first time binding criteria 'for the selection and exploration of a site, and the planning and operation of a geological disposal facility'[562] had been developed in Germany. The 'Safety Criteria' attached great significance to the choice of the site for long-term safety. They recommended a combination of multiple natural or technical barriers to safely seal the	were encountered in the Hauptanhydrit.[643] The results of the exploration work showed that 'solution inflows' occurred 'for a limited period of time' and were 'associated with isolated cavities or fissure systems that emptied after penetration by the exploration activity.'[644] Experts from Gesellschaft für Reaktorsicherheit (GRS) later considered the isolation of these deposits as not being proven. In their opinion, it remained questionable whether these were isolated brine pockets substantially surrounded by rock and without connections to other joints.[645] While the salt dome was being explored from the surface with boreholes drilled into the salt table, it was found that a potash bed neighbouring the anhydrite was completely 'subroded' 'up to approx. 90-130 metres below the salt table',[646] and further impacts of groundwater on the potash bed were detected as far as 170 metres into the salt dome. The evaluation of the results from the exploration of the shafts found, however, that 'neither water from the overburden nor formation water has entered the Gorleben salt dome in the sampled area 250 m below the salt table during geological time periods.'[647] For the development of disposal concepts, the Gorleben preliminary safety analysis prescribed a separation distance of 50 metres between the actual emplacement chambers and the Hauptanhydrit. The size of the separation distance already makes allowances for uncertainties with

[642] Cf., for instance, Gesellschaft für Anlagen- and Reaktorsicherheit (2013): 'Synthesebericht für die VSG: Bericht zum Arbeitspaket 13', p. 230.

[559] Cf. the comments made by Werner Jaritz (Federal Institute for Geosciences and Natural Resources) at the public hearing held by the Committee on the Environment, Nature Conservation and Nuclear Safety on the Gorleben disposal facility, 25 March 1988, Committee Printed Paper 11/5, part I, p. 163.

[560] Cf. Federal Institute for Geosciences and Natural Resources (BGR) (2016): 'Stellungnahme zur K-Drs. 212/AG4-27 der Kommission Lagerung hoch radioaktiver Abfallstoffe', K-Drs 246, p. 5. According to the BGR, the infrastructure zone of the exploratory mine was consciously located in salt with a lower creep rate, and this was why the Hauptanhydrit had been cut through.

[561] Federal Minister of the Interior (1983): 'Bekanntmachung der Empfehlung der Reaktorsicherheitskommission vom 17. Dezember 1982: Sicherheitskriterien für die Endlagerung radioaktiver Abfallstoffe in einem Bergwerk', Federal Gazette, 5 January 1983.

[562] Federal Minister of the Interior (1983): 'Bekanntmachung der Empfehlung der Reaktorsicherheitskommission vom 17. Dezember 1982: Sicherheitskriterien für die Endlagerung radioaktiver Abfallstoffe in einem Bergwerk', Federal Gazette, 5 January 1983, section 1, 'Einführung'.

disposal facility from the biosphere. Furthermore, the 'Safety Criteria' required evidence to be provided of the safety of an underground disposal facility by means of a site-specific safety analysis focussed on compliance with relevant limits that took account of the overall system made up of the geology, the underground disposal facility and the waste packages.[563] Accordingly, the 'Safety Criteria' included only a few clear geological requirements concerning the site. One requirement related to its overburden: 'If radionuclides are released from the underground disposal facility, the overburden and adjoining rock must help to ensure that impermissible concentrations are prevented in the biosphere. Consequently, a high capacity for the sorption of radionuclides is advantageous for the performance of the barrier function by the overburden and adjoining rock.'[564] The site should also	regard to the detection of geological strata boundaries, the possible existence of joints on the periphery of the salt and the extent of the loosening zone around the underground workings. The need to cut through the anhydrite during the excavation of the exploratory mine was also taken into account in the preliminary safety analysis. During the period when the Gorleben salt dome was being explored from the surface, which lasted from 1979 to 1983, the Reactor Safety Commission (RSK) agreed on 'Safety Criteria for the Permanent Storage of Radioactive Waste in a Mine'.[648] This RSK Recommendation was adopted in September 1982 and published in the *Federal Gazette* in January 1983. It was the first time binding criteria 'for the selection and exploration of a site, and the planning and operation of a geological disposal facility' had been developed in Germany.

[643] Federal Office for Radiation Protection (2002): 'Verzeichnis der Vorkommen salinarer Lösungen im Erkundungsbergwerk Gorleben sowie in einigen Bereichen des Salzstocks Gorleben'. According to this document, the total volume of the solutions that had flowed into the facility up to 2000, not including ingresses during the sinking of the shafts, was 366 cubic metres, of which more than 300 cubic metres had flowed into the structure in the Hauptanhydrit. The BfS calculated the four brine deposits had a further total reservoir volume of between 300 and 7,000 cubic metres. Cf. pp. 102f.

[644] Bornemann, O., Behlau, J., Fischbeck, R., Hammer, J., Jaritz, W., Keller, S., Mingerzahn, G., Schramm, M. (2000): Description of the Gorleben Site: Part 3: Results of the geological surface and underground exploration of the salt formation, Hanover, p. 187.

[645] Gesellschaft für Anlagen- and Reaktorsicherheit (GRS) (2011): 'Sichtung und Bewertung der Standortdaten Gorleben: Bericht zum Arbeitspaket 2: Vorläufige Sicherheitsanalyse für den Standort Gorleben'. On page 53, this report says of the pressure levels measured in the brine reservoirs in the anhydrite, 'The pressure levels listed here are far below the lithostatic pressure and, subject to the assumption of a high-density brine, may even reflect levels of hydrostatic pressure. These findings suggest the reservoirs are not "isolated".' By contrast to this, the Federal Institute for Geosciences and Natural Resources pointed out that the pressure in a solution deposit always falls when it is disturbed, 'so that it is only possible to measure yet lower pressure levels after a solution deposit has been drilled into.' Federal Institute for Geosciences and Natural Resources (2016): 'Stellungnahme zur K-Drs. 212/AG4-27 der Kommission Lagerung hoch radioaktiver Abfallstoffe', K-Drs 246, p. 6. GRS's conclusion was therefore not technically verifiable.

[646] See the comments made by Werner Jaritz (Federal Institute for Geosciences and Natural Resources) at the public hearing held by the Committee on the Environment, Nature Conservation and Nuclear Safety on the Gorleben disposal facility, 25 March 1988, Committee Printed Paper 11/5, part I, p. 162.

[647] Bornemann, O., Behlau, J., Fischbeck, R., Hammer, J., Jaritz, W., Keller, S., Mingerzahn, G., Schramm, M. (2000): Description of the Gorleben Site: Part 3: Results of the geological surface and underground exploration of the salt formation, p. 176.

[563] Federal Minister of the Interior (1983): 'Bekanntmachung der Empfehlung der Reaktorsicherheitskommission vom 17. Dezember 1982: Sicherheitskriterien für die Endlagerung radioaktiver Abfallstoffe in einem Bergwerk', Federal Gazette, 5 January 1983, section 1, 'Einführung'.

[564] Federal Minister of the Interior (1983): 'Bekanntmachung der Empfehlung der Reaktorsicherheitskommission vom 17. Dezember 1982: Sicherheitskriterien für die Endlagerung radioaktiver Abfallstoffe in einem Bergwerk', Federal Gazette, 5 January 1983, section 4.4, 'Endlagerformation, Deckgebirge und Nebengestein'.

'be distinguished by its low levels of tectonic activity.' Furthermore, the 'Safety Criteria' advocated formations 'that react visco-plastically under stress.'[565] In connection with the surface exploration of the Gorleben salt dome, a controversy developed among scientists about the structure of the overburden above the salt dome, and later about the necessity of an overburden with a strong retention function above any disposal facility. Instead of the undisturbed overburden above the salt dome that had initially been anticipated, it became apparent there was a channel that measured 7.5 square kilometres and was filled with sand and detritus from the Ice Age, while some parts of this channel extended down into the salt.[566]
'Above the central part of the salt dome, for a length of approx. 6 km and a surface of approx. 7.5 km^2, the Tertiary beds were completely eroded, so sediments of the Elsterian Glaciation lie on the cap rock and in some areas directly on the salt formation,' the Federal Institute for Geosciences and Natural Resources subsequently stated in its *Description of the Gorleben Site*.[567]
In the early days, it was also scientifically disputed whether the site was actually characterised by low levels of tectonic activity. Even before the beginning of the underground exploration, the geomorphologist Eckhard Grimmel articulated the opinion that there was a large basement fault under the Gorleben salt dome. In view of an earthquake documented 70 kilometres

As far as the choice of site is concerned, the 'Safety Criteria' state that, 'The choice of the site is not just of significance for the construction and operation of the geological disposal facility, but above all its long-term safety. In this respect, the disposal formation is decisive in conjunction with the overall geological system.'[649] They recommended a combination of multiple natural or technical barriers to safely seal the disposal facility from the biosphere. Furthermore, the 'Safety Criteria' required evidence to be provided of the safety of an underground disposal facility by means of a site-specific safety analysis focussed on compliance with relevant limits that took account of the overall system made up of the geology, the underground disposal facility and the waste packages.[650] At that time, a reference period of 10,000 years was taken as the basis for the long-term safety analysis, which meant future possible glaciation did not have to be considered. The 'Safety Criteria' included several clear geological requirements concerning the site. One requirement related to its overburden: 'If radionuclides are released from the underground disposal facility, the overburden and adjoining rock must help to ensure that impermissible concentrations are prevented in the biosphere. Consequently, a high capacity for the sorption of radionuclides is advantageous for the performance of the barrier function by the overburden and adjoining rock.'[651] The site should also

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648 Federal Minister of the Interior (1983): 'Bekanntmachung der Empfehlung der Reaktorsicherheitskommission vom 17. Dezember 1982: Sicherheitskriterien für die Endlagerung radioaktiver Abfallstoffe in einem Bergwerk', Federal Gazette, 5 January 1983.

565 Federal Minister of the Interior (1983): 'Bekanntmachung der Empfehlung der Reaktorsicherheitskommission vom 17. Dezember 1982: Sicherheitskriterien für die Endlagerung radioaktiver Abfallstoffe in einem Bergwerk', Federal Gazette, 5 January 1983, section 4.4, 'Endlagerformation, Deckgebirge und Nebengestein'.

566 Cf., for instance, the remarks made by Klaus Duphorn before the Environment Committee of the German Bundestag: German Bundestag Committee on the Environment, Nature Conservation and Nuclear Safety (1988): Committee Printed Paper 11/5, Bonn, 25 March 1988, part I, pp. 18f.

567 Köthe, Angelika, Hoffman, Norbert, Krull, Paul, Zirngast, Max, Zwirner, Rainer (2007): Standortbeschreibung Gorleben: Teil 2: Die Geologie des Deck- und Nebengebirges des Salzstocks Gorleben, p. 186; English translation: Description of the Gorleben site: Part 2: Geology of the overburden and adjoining rock of the Gorleben salt dome, p. 196.

to the east, he believed the location was at risk: 'The threat of earthquakes in the Gorleben-Rambow region is relatively great in the context of northern Germany.'[568] An expert opinion published in 2011 by the geologist Ulrich Kleemann traced the controversy that had followed this early characterisation of the site by Grimmel.[569] 'The substrate is by no means quiet. It is located on a bulge in the Earth's mantle, the cause of which is unknown. The bulge in the mantle is tectonically limited. The salt dome is found at the intersection of several significant faults.'[570] By contrast, the Federal Institute for Geosciences and Natural Resources notes in its *Description of the Gorleben Site* that there is 'a stable tectonic situation in the study area nowadays'.[571] When the Gorleben site was provisionally selected, the Lower Saxon Land Cabinet already assumed there was a 'great probability' that 'gas is located under the Gorleben salt dome at a depth of about 3,500 metres.'[572] Consequently, there would be 'a potential threat to the disposal facility if gas were to be extracted.'[573] Subsidence might occur in the area	'be distinguished by its low levels of tectonic activity.' Furthermore, the 'Safety Criteria' advocated formations 'that react visco-plastically under stress.'[652] In connection with the surface exploration of the Gorleben salt dome, a controversy developed among scientists about the structure of the overburden above the salt dome, and later about the necessity of an overburden with a strong retention function above any disposal facility. A possible fault zone under the salt dome and possible gas deposits were among the other topics about which there were disputes. The Gorleben channel had already been known about before the site was selected.[653] The exploration then revealed that above the salt dome there was a channel that measured 7.5 square kilometres and was filled with sand and detritus from the Ice Age, while some parts of this channel extended down into the salt.[654] 'Above the central part of the salt dome, for a length of approx. 6 km and a surface of approx. 7.5 km^2, the Tertiary beds were completely eroded, so sediments of the Elsterian Glaciation lie on the cap rock and in some areas directly on the salt formation,' the

[649] Federal Minister of the Interior (1983): 'Bekanntmachung der Empfehlung der Reaktorsicherheitskommission vom 17. Dezember 1982: Sicherheitskriterien für die Endlagerung radioaktiver Abfallstoffe in einem Bergwerk', Federal Gazette, 5 January 1983, section 1, 'Einführung'.

[650] Federal Minister of the Interior (1983): 'Bekanntmachung der Empfehlung der Reaktorsicherheitskommission vom 17. Dezember 1982: Sicherheitskriterien für die Endlagerung radioaktiver Abfallstoffe in einem Bergwerk', Federal Gazette, 5 January 1983, section 1, 'Einführung'.

[651] Federal Minister of the Interior (1983): 'Bekanntmachung der Empfehlung der Reaktorsicherheitskommission vom 17. Dezember 1982: Sicherheitskriterien für die Endlagerung radioaktiver Abfallstoffe in einem Bergwerk', Federal Gazette, 5 January 1983, section 4.4, 'Endlagerformation, Deckgebirge und Nebengestein'.

[568] Grimmel, Eckhard (1978): Ist der Salzstock Gorleben zur Einlagerung radioaktiver Abfälle geeignet?, p. 25.

[569] Kleemann, Ulrich (2011): 'Bewertung des Endlager-Standortes Gorleben: Geologische Probleme und offene Fragen im Zusammenhang mit einer Vorläufigen Sicherheitsanalyse Gorleben (VSG)'.

[570] Kleemann, Ulrich (2011): 'Bewertung des Endlager-Standortes Gorleben: Geologische Probleme und offene Fragen im Zusammenhang mit einer Vorläufigen Sicherheitsanalyse Gorleben (VSG)', p. 8.

[571] Köthe, Angelika, Hoffman, Norbert, Krull, Paul, Zirngast, Max, Zwirner, Rainer (2007): Description of the Gorleben Site: Part 2: Geology of the overburden and adjoining rock of the Gorleben salt dome, p. 5. On this issue, cf. also: Federal Institute for Geosciences and Natural Resources (BGR) (2016): 'Stellungnahme zur K-Drs. 212/AG4-27 der Kommission Lagerung hoch radioaktiver Abfallstoffe', K-Drs 246, pp. 7f. In this comment, the BGR contradicts once again the opinion put forward by Kleemann, who was appointed to the Commission as a geologist.

[572] Lower Saxon Minister for Economics and Transport (1977): 'Entsorgungszentrum für bestrahlte Kernbrennstoffe: Vorlage für die Kabinettsitzung am 8. Februar 1977', p. 2.

[573] Lower Saxon Minister for Economics and Transport (1977): 'Entsorgungszentrum für bestrahlte Kernbrennstoffe: Vorlage für die Kabinettssitzung am 8. February 1977', p. 2.

around the salt dome. Kleemann later pointed out that gas had been encountered several times during the preliminary drilling work for the two shafts of the Gorleben exploratory mine.[574] 'Under the Zechstein salt of the Gorleben-Rambow salt dome, Rotliegend sandstones are found that are gas-bearing to the south and north of the Gorleben site. Irrespective of the question of preventing human intrusion for the exploration of raw materials, such a gas deposit represents a potential threat to the disposal facility that it is necessary to avoid.'[575] In contrast to this, the Federal Institute for Geosciences and Natural Resources denied there was a threat to the site from potentially gas-bearing rocks. The 'presence of a gas deposit' could 'not be concluded merely from the presence of potential reservoir rocks'.[576] Furthermore, in its extensive study of the salt dome, the Federal Institute for Geosciences and Natural Resources described properties that would be positive for disposal. According to the *Description of the Gorleben site*, it will for instance only be necessary to expect low rates of subrosion of the salt dome in future.[577] 'As predicted on the basis of the evaluation of the surface exploration boreholes, the unjointed and undisturbed	Federal Institute for Geosciences and Natural Resources subsequently stated in its *Description of the Gorleben Site*.[655] In the early days, it was also scientifically disputed whether the site was actually characterised by low levels of tectonic activity. Even before the beginning of the underground exploration, the geomorphologist Eckhard Grimmel articulated the opinion that there was a large basement fault under the Gorleben salt dome. In view of an earthquake documented 70 kilometres to the east, he believed the location was at risk: 'The threat of earthquakes in the Gorleben-Rambow region is relatively great in the context of northern Germany.'[656] An expert opinion published in 2011 by the geologist Ulrich Kleemann traced the controversy that followed this early characterisation of the site by Grimmel.[657] 'The substrate is by no means quiet. It is located on a bulge in the Earth's mantle, the cause of which is unknown. The bulge in the mantle is tectonically limited. The salt dome is found at the intersection of several significant faults.'[658] By contrast, in its *Description of the Gorleben Site*, which summarises the 30-year exploration of the salt dome, the Federal Institute for Geosciences and Natural Resources notes there is 'a stable

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[652] Federal Minister of the Interior (1983): 'Bekanntmachung der Empfehlung der Reaktorsicherheitskommission vom 17. Dezember 1982: Sicherheitskriterien für die Endlagerung radioaktiver Abfallstoffe in einem Bergwerk', Federal Gazette, 5 January 1983, section 4.4, 'Endlagerformation, Deckgebirge und Nebengestein'.

[653] German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013, p. 308, footnote 2316.

[654] Cf., for instance, the remarks made by Klaus Duphorn before the Environment Committee of the German Bundestag: German Bundestag Committee on the Environment, Nature Conservation and Nuclear Safety (1988): Committee Printed Paper 11/5, Bonn, 25 March 1988, part I, pp. 18f.

[574] Kleemann, Ulrich (2011): 'Bewertung des Endlager-Standortes Gorleben: Geologische Probleme und offene Fragen im Zusammenhang mit einer Vorläufigen Sicherheitsanalyse Gorleben (VSG)', p. 10.

[575] Kleemann, Ulrich (2011): 'Bewertung des Endlager-Standortes Gorleben: Geologische Probleme und offene Fragen im Zusammenhang mit einer Vorläufigen Sicherheitsanalyse Gorleben (VSG)', p. 19.

[576] Federal Institute for Geosciences and Natural Resources (2016): 'Stellungnahme zur K-Drs. 212/AG4-27 der Kommission Lagerung hoch radioaktiver Abfallstoffe', K-Drs 246, p. 6.

[577] Köthe, Angelika, Hoffman, Norbert, Krull, Paul, Zirngast, Max, Zwirner, Rainer (2007): Description of the Gorleben Site: Part 2: Geology of the overburden and adjoining rock of the Gorleben salt dome, p. 5. Very much higher subrosion rates were felt to be possible by Appel, Detlef, Habler, Walter (1993): 'Berechnung nacheiszeitlicher Subrosionsraten für den Salzstock Gorleben anhand von Lageveränderungen holsteinzeitlicher Ablagerungen'.

Hauptsalz body of the Stassfurt sequence is sufficiently large to act as a potential host rock for the disposal of radioactive waste.'[578] The investigation of the salt formation had not produced any information that conflicted with the suitability of the Gorleben salt dome for disposal from the perspective of its long-term safety. In 1995, however, in a 'study and assessment of salt formations', the Federal Institute for Geosciences and Natural Resources had formulated assessment criteria for the 'disposal of strongly heat-generating radioactive waste in Germany's deep geological formations' that also accorded the geological conditions above the salt considerable significance with regard to sites' suitability.[579] In this respect, cap rock covered with quaternary sediments and quaternary channels that cut deep into superimposed sediments were viewed as negative properties.[580] The Gorleben salt dome, the overburden of which would presumably have displayed these negative characteristics, was not covered by the study. The Committee on a Site Selection Procedure for Repository Sites, which formulated selection criterion not only for salt, but for various types of rock, also assigned the overburden a lesser function. 'Host rock, adjoining rock and overburden shall assume the	tectonic situation in the study area nowadays'.[659] Several hundred boreholes were drilled and extensive quaternary geological studies conducted during the geological exploration of the Gorleben site. They found no evidence of tectonic weakness zones reactivated during the quaternary as a result of deep-seated fault zones, what were referred to as 'endogenous-tectonic basement faults'. Deep seismic measurements conducted at the Gorleben site revealed that basement faults with a net displacement of more than 50 metres below the salt dome could be ruled out.[660] When the Gorleben site was provisionally selected, the Lower Saxon Land Cabinet already assumed there was a 'great probability' that 'gas is located under the Gorleben salt dome at a depth of about 3,500 metres.'[661] Consequently, there would be 'a potential threat to the disposal facility if gas were to be extracted.'[662] Subsidence might then occur in the area around the salt dome. Kleemann later pointed out that gas had been encountered several times during the preliminary drilling work for the two shafts of the Gorleben exploratory mine.[663] 'Under the Zechstein salt of the Gorleben-Rambow salt dome, Rotliegend sandstones are found that are gas-bearing to the south and north of the Gorleben site. Irrespective of the question of preventing human intrusion for the exploration of

[655] Köthe, Angelika, Hoffman, Norbert, Krull, Paul, Zirngast, Max, Zwirner, Rainer (2007): Description of the Gorleben site: Part 2: Geology of the overburden and adjoining rock of the Gorleben salt dome, p. 196.
[656] Grimmel, Eckhard (1978): Ist der Salzstock Gorleben zur Einlagerung radioaktiver Abfälle geeignet?, p. 25.
[657] Kleemann, Ulrich (2011): 'Bewertung des Endlager-Standortes Gorleben: Geologische Probleme und offene Fragen im Zusammenhang mit einer Vorläufigen Sicherheitsanalyse Gorleben (VSG)'.
[658] Kleemann, Ulrich (2011): 'Bewertung des Endlager-Standortes Gorleben: Geologische Probleme und offene Fragen im Zusammenhang mit einer Vorläufigen Sicherheitsanalyse Gorleben (VSG)', p. 8.
[578] Bornemann, Otto, Behlau, Joachim, Fischbeck, Reinhard, Hammer, Jörg, Jaritz, Werner, Keller, Siegfried, Mingerzahn, Gerhard, Schramm, Michael (2008): Standortbeschreibung Gorleben: Teil 3: Ergebnisse der über- und untertägigen Erkundung des Salinars, p. 6; English translation: Description of the Gorleben Site: Part 3: Results of the geological surface and underground exploration of the salt formation, p. 5.
[579] Federal Institute for Geosciences and Natural Resources (1995): 'Endlagerung stark wärmeentwickelnder radioaktiver Abfälle in tiefen geologischen Formationen: Untersuchung und Bewertung von Salzformationen'.
[580] Federal Institute for Geosciences and Natural Resources (1995): 'Endlagerung stark wärmeentwickelnder radioaktiver Abfälle in tiefen geologischen Formationen: Untersuchung und Bewertung von Salzformationen', p. 37.

function of natural barriers in a multi-barrier system,' the Committee's report may have stated,[581] but the properties of the overburden were not even mentioned in the proposed selection criteria. The same applied for the 'Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste', which the Federal Environment Ministry published in September 2010. The term 'overburden' was only mentioned in the glossary of technical terms attached to the 'Safety Requirements'.[582] In summary, it is possible to make the following statements: Until its discontinuation, the exploration of the Gorleben salt dome delivered findings that were interpreted in various ways. 34 years passed between the beginning of the exploration and its discontinuation. During this period, the criteria by which disposal sites were assessed in Germany changed several times. In the course of the exploration of the	raw materials, such a gas deposit represents a potential threat to the disposal facility that it is necessary to avoid.'[664] In contrast to this, the Federal Institute for Geosciences and Natural Resources denied there was a threat to the site from potentially gas-bearing rocks. The 'presence of a gas deposit' could 'not be concluded merely from the presence of potential reservoir rocks'.[665] Furthermore, in its extensive study of the salt dome, the Federal Institute for Geosciences and Natural Resources described properties that would be positive for disposal. For instance, it will only be necessary to expect low rates of subrosion of the salt dome in future.[666] 'As predicted on the basis of the evaluation of the surface exploration boreholes, the unjointed and undisturbed Hauptsalz body of the Stassfurt sequence is sufficiently large to act as a potential host rock for the disposal of radioactive waste.'[667] The investigation of the salt formation had not produced any information that conflicted with the

[659] Köthe, Angelika, Hoffman, Norbert, Krull, Paul, Zirngast, Max, Zwirner, Rainer (2007): Description of the Gorleben Site: Part 2: Geology of the overburden and adjoining rock of the Gorleben salt dome, p. 5. On this issue, cf. also: Federal Institute for Geosciences and Natural Resources (2016): 'Stellungnahme zur K-Drs. 212/AG4-27 der Kommission Lagerung hoch radioaktiver Abfallstoffe', K-Drs 246, pp. 7f. In this comment, the Federal Institute for Geosciences and Natural Resources contradicts once again the opinion put forward by Kleemann, who was appointed to the Commission as a geologist.

[660] Federal Institute for Geosciences and Natural Resources (2016): 'Stellungnahme zur K-Drs. 212/AG4-27 der Kommission Lagerung hoch radioaktiver Abfallstoffe', K-Drs 216, p. 8.

[661] Lower Saxon Minister for Economics and Transport (1977): 'Entsorgungszentrum für bestrahlte Kernbrennstoffe: Vorlage für die Kabinettsitzung am 8. Februar 1977', p. 2.

[662] Lower Saxon Minister for Economics and Transport (1977): 'Entsorgungszentrum für bestrahlte Kernbrennstoffe: Vorlage für die Kabinettssitzung am 8. February 1977', p. 2.

663 Kleemann, Ulrich (2011): 'Bewertung des Endlager-Standortes Gorleben: Geologische Probleme und offene Fragen im Zusammenhang mit einer Vorläufigen Sicherheitsanalyse Gorleben (VSG)', p. 10.

[581] Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', Commission Material K-MAT 1, p. 53.

[582] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2010): 'Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste'.

664 Kleemann, Ulrich (2011): 'Bewertung des Endlager-Standortes Gorleben: Geologische Probleme und offene Fragen im Zusammenhang mit einer Vorläufigen Sicherheitsanalyse Gorleben (VSG)', p. 19.

[665] Federal Institute for Geosciences and Natural Resources (2016): 'Stellungnahme zur K-Drs. 212/AG4-27 der Kommission Lagerung hoch radioaktiver Abfallstoffe', K-Drs 246, p. 6.

[666] Köthe, Angelika, Hoffman, Norbert, Krull, Paul, Zirngast, Max, Zwirner, Rainer (2007): Description of the Gorleben Site: Part 2: Geology of the overburden and adjoining rock of the Gorleben salt dome, p. 5. Very much higher subrosion rates were felt to be possible by Appel, Detlef, Habler, Walter (1993): 'Berechnung nacheiszeitlicher Subrosionsraten für den Salzstock Gorleben anhand von Lageveränderungen holsteinzeitlicher Ablagerungen'.

[667] Bornemann, Otto, Behlau, Joachim, Fischbeck, Reinhard, Hammer, Jörg, Jaritz, Werner, Keller, Siegfried, Mingerzahn, Gerhard, Schramm, Michael (2008): Description of the Gorleben Site: Part 3: Results of the geological surface and underground exploration of the salt formation, p. 5.

Gorleben salt dome, two camps formed within the specialist scientific community, who looked on each other with mutual distrust. Opponents of nuclear power made attacks on scientists from state institutions for their lack of independence. Critical scientists were accused of tailoring their expert opinions to the requirements of clients in the environmental movement. It was a rapprochement between these camps that made it possible for them to work together on the Committee on a Site Selection Procedure for Repository Sites. The discontinuation of the exploration activities at Gorleben was logical in view of the decision to carry out an open-ended exploration process, under which the site was not to be assessed until the end of the licensing procedure for the disposal facility. The conclusion of the exploration work at Gorleben would consequently have delivered a scientific result, but not one that was accepted.	suitability of the Gorleben salt dome for disposal from the perspective of its long-term safety. In 1995, however, in a ‘study and assessment of salt formations’, the Federal Institute for Geosciences and Natural Resources had formulated assessment criteria for the ‘disposal of strongly heat-generating radioactive waste in Germany’s deep geological formations’ that also accorded the geological conditions above the salt considerable significance with regard to sites’ suitability.[668] In this respect, cap rock covered with quaternary sediments and quaternary channels that cut deep into superimposed sediments were viewed as negative properties.[669] This conclusion was reached against the background of the 10,000-year reference period because no ice age that would overprint the area was to be expected during this length of time. The Committee on a Site Selection Procedure for Repository Sites, which formulated selection criterion not only for salt, but also for claystone, accorded the overburden a minor safety function on account of further developments in science and technology – the ‘isolating rock zone’. In summary, it is found that: Until its discontinuation, the exploration of the Gorleben salt dome delivered findings that were interpreted in various ways. 34 years passed between the beginning of the exploration and its discontinuation. During this period, the criteria by which disposal sites were assessed in Germany changed. In the course of the exploration of the Gorleben salt dome, two camps formed within the specialist scientific community, who looked on each other with mutual distrust. Opponents of

[668] Federal Institute for Geosciences and Natural Resources (1995): ‘Endlagerung stark wärmeentwickelnder radioaktiver Abfälle in tiefen geologischen Formationen: Untersuchung und Bewertung von Salzformationen’.

[669] Federal Institute for Geosciences and Natural Resources (1995): ‘Endlagerung stark wärmeentwickelnder radioaktiver Abfälle in tiefen geologischen Formationen: Untersuchung und Bewertung von Salzformationen’, p. 37.

	nuclear power made attacks on scientists from state institutions for their lack of independence. Critical scientists were accused of tailoring their expert opinions to the requirements of clients in the environmental movement. It was a rapprochement between these camps that made it possible for them to work together on the Committee on a Site Selection Procedure for Repository Sites.
4.1.4.3 Scientific or political decisions It already became clear when the surface exploration of the site was concluded that the distribution of roles between politics and science had not been clarified while the Gorleben salt dome was being assessed. In 1983, the National Metrology Institute of Germany (PTB), initially wished to join forces with the scientists involved in the surface exploration in recommending that other potential sites also be studied in parallel to the further underground exploration of the Gorleben site: 'Many statements and results in the report are affected by uncertainties because they have still not been confirmed by underground exploration. The risk that is inherent in this with regard to the type and volume of disposable radioactive waste may be reduced by means of precautionary exploration measures at other sites (back-up sites). Ongoing surface exploration measures at other sites in parallel with the sinking of the shafts will therefore preclude particular action having to be taken in response to practical constraints when this disposal facility is implemented. It would also increase acceptance for the Gorleben site.'[583] This recommendation, which takes up the German Federal Government's first	**4.1.4.3 Scientific and political decisions** In 1983, on grounds of waste management policy, the National Metrology Institute of Germany (PTB) considered joining forces with the scientists involved in the surface exploration with the aim of also exploring other potential sites underground in parallel to the further underground exploration of the Gorleben site. The idea was to do this in case the Gorleben salt dome proved to be unsuitable in the course of its further exploration: 'Many statements and results in the report are affected by uncertainties because they have still not been confirmed by underground exploration. The risk that is inherent in this with regard to the type and volume of disposable radioactive waste may be reduced by means of precautionary exploration measures at other sites (back-up sites). Ongoing surface exploration measures at other sites in parallel with the sinking of the shafts will therefore preclude particular action having to be taken in response to practical constraints when this disposal facility is implemented. It would also increase acceptance for the Gorleben site.'[670] This recommendation, which takes up the German Federal Government's first

[583] Draft of the section 'Zusammenfassung und Bewertung der Ergebnisse' for the report 'Zusammenfassender Bericht der PTB über bisherige Ergebnisse der Standortuntersuchung in Gorleben', enclosed with a letter from Heinrich Illi to the contributors to the drafting of the report, 6 May 1977, p. 8. The draft interim report concluded with the paragraph that is quoted here.

[670] Draft of the section 'Zusammenfassung und Bewertung der Ergebnisse' for the report 'Zusammenfassender Bericht der PTB über bisherige Ergebnisse der Standortuntersuchung in Gorleben', enclosed with a letter from Heinrich Illi to the contributors to the drafting of the report, 6 May 1977, p. 8. The draft interim report concluded with the paragraph that is quoted here.

decision on the site again, was not included in the interim report that was published a short while later. Representatives of the German Federal Government raised objections to the recommendations on 11 May in discussions at the National Metrology Institute of Germany. The majority on the Bundestag's committee of inquiry on Gorleben later found that, 'the German Federal Government did not exert any influence on the specialist/technical content of the interim report.'[584] They believed, however, that the recommendation concerning the exploration of other sites had related to a waste management policy issue that had fallen 'within the competence of the German Federal Government'.[585] By contrast to this, the opposition parliamentary groups on the committee of inquiry articulated the opinion that political influence had been exerted by the German Federal Government when the report was being drawn up: 'The report was amended in response to an instruction.'[586] In the National Metrology Institute's interim report, the passage that summarised the findings on the overburden remained unchanged: 'A first assessment of the overburden with regard to its barrier function for potentially contaminated groundwater shows the clayey sediments that occur over the central areas of the Gorleben salt dome are not thick enough and of such consistent distribution that they would be in a position to retain contamination permanently away from the biosphere.'[587]	decision on the site again, was not included in the interim report that was published by the National Metrology Institute of Germany (PTB) a short while later. Representatives of the German Federal Government raised objections to the recommendations on 11 May in discussions at the PTB. The majority on the Bundestag's committee of inquiry on Gorleben later found that, 'the German Federal Government did not exert any influence on the specialist/technical content of the interim report.'[671] They believed, however, that the recommendation concerning the exploration of other sites had related to a waste management policy issue that had fallen 'within the competence of the German Federal Government'.[672] By contrast to this, the opposition parliamentary groups on the committee of inquiry articulated the opinion that political influence had been exerted by the German Federal Government when the report was being drawn up: 'The report was amended in response to an instruction.'[673] In the National Metrology Institute's interim report, the passage that summarised its findings on the overburden remained unchanged: 'A first assessment of the overburden with regard to its barrier function for potentially contaminated groundwater shows the clayey sediments that occur over the central areas of the Gorleben salt dome are not thick enough and of such consistent distribution that they would be in a position to retain contamination permanently away from the biosphere.'[674]

[584] German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013, p. 148.

[585] German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013, p. 148.

[586] German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013, p. 514.

[587] National Metrology Institute of Germany (1983): 'Zusammenfassender Zwischenbericht über bisherige Ergebnisse der Standortuntersuchung in Gorleben', p. 141.

Even before the Federal Cabinet took the decision about the underground exploration of the salt dome on 13 July 1983, the German Federation and the Land Lower Saxony had agreed that no plan approval procedure would be required for the construction of the exploratory mine.[588] According to the cabinet submission that was adopted, 'The legal precondition for underground exploration is an approval under mining law. There is no need for public participation in a plan approval procedure under nuclear law for these exploratory measures.'[589] On account of the potential suitability of the Gorleben salt dome, it was argued that the exploration of other salt domes was not required at that time. Furthermore, the decision about the suitability of the salt dome was to be taken during the plan approval procedure, the institution of which the National Metrology Institute of Germany had applied for on 28 July 1977. 'Underground exploration is indispensable in order to be able to provide evidence of the Gorleben disposal facility's suitability during the plan approval procedure,'[590] the cabinet decision stated. Only a safety analysis carried out on the basis of an underground exploration that included major accident analyses would 'allow final statements to be made about	The decision about the suitability of the salt dome was to be taken during the plan approval procedure, the institution of which the National Metrology Institute of Germany had applied for on 28 July 1977. 'Underground exploration is indispensable in order to be able to provide evidence of the Gorleben disposal facility's suitability during the plan approval procedure,'[675] the cabinet decision stated. A safety analysis carried out on the basis of an underground exploration that included major accident analyses would 'allow final statements to be made about whether, and to what extent, the Gorleben salt dome can be used as a disposal facility.'[676] 'The legal precondition for underground exploration is an approval under mining law. There is no need for public participation in a plan approval procedure under nuclear law for these exploratory measures,' the cabinet submission that was adopted stated.[677] On account of the potential suitability of the Gorleben salt dome, it was argued that the exploration of other salt domes was not required at that time.

[671] German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013, p. 148.

[672] German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013, p. 148.

[673] German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013, p. 514.

[674] National Metrology Institute of Germany (1983): 'Zusammenfassender Zwischenbericht über bisherige Ergebnisse der Standortuntersuchung in Gorleben', p. 141.

[588] Cf. 'Vorlage des Bundeskanzleramts zur Entscheidung über die untertägige Erkundung des Salzstocks Gorleben', 22 June 1983, p. 4.

[589] The submission is documented in: German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013, p. 152.

[590] Quoted in: German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013, p. 151.

whether, and to what extent, the Gorleben salt dome can be used as a disposal facility.’[591]	
Due to the exploration of the salt dome under mining law, however, the plan approval procedure was only conducted with a limited scope. There was internal coordination between the various authorities, but no formal public procedure.[592] The decision in favour of exploration under mining law without formal public participation especially faced criticism from opponents of nuclear power. Since the design for the exploratory mine was already oriented towards the requirements of a possible later disposal facility, they criticised the exploration work as the construction of the eventual disposal facility without the necessary licence.[593] However, legal action against the exploration of the site under mining law was dismissed.	Due to the exploration of the salt dome under mining law, however, the plan approval procedure was only conducted with a limited scope. There was internal coordination between the various authorities. The decision in favour of exploration under mining law without formal public participation especially faced criticism from opponents of nuclear power. Since, in the case of the diameter of the two shafts to be sunk into the ground by the freezing method, the design for the exploratory mine was oriented towards the requirements of a possible later disposal facility, they criticised the exploration work as the construction of the eventual disposal facility without the necessary licence.[678] However, legal action against the exploration of the site under mining law was dismissed by the Federal Administrative Court on 9 March 1990 in what was known as the ‘first Gorleben decision’.
In an appellate judgement on points of law handed down in March 1990, the Federal Administrative Court saw ‘no reasons to suggest that the respondent is in truth no longer exploring the suitability of the salt dome, but already engaged in the construction of a disposal facility or parts of a disposal facility.’[594] On its own, the objection that the step	In an appellate judgement on points of law handed down on 9 March 1990, the Federal Administrative Court saw ‘no reasons to suggest that the respondent is in truth no longer exploring the suitability of the salt dome, but already engaged in the construction of a disposal facility or parts of a disposal facility.’[679] On its own, the objection that the step

[675] Cf. ‘Vorlage des Bundeskanzleramts zur Entscheidung über die untertägige Erkundung des Salzstocks Gorleben’, 22 June 1983, p. 4.

[676] The submission is documented in: German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013, p. 152.

[677] Quoted in: German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013, p. 152.

[591] Quoted in: German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013, p. 151.

[592] However, talks were held regularly between the applicant, the National Metrology Institute of Germany (subsequently, the Federal Office for Radiation Protection), and the Lower Saxon Environment Ministry as the licensing authority. The Lower Saxon Geological Survey also regularly produced reports on the project.

[593] Cf., for instance: Fritzen, Marianne (1999): ‘Atomrecht, Bergrecht, Unrecht’, in: Lüchow-Dannenberg Citizens’ Initiative for Environmental Protection: Zur Sache 8: Endlager Gorleben.

[594] Appellate judgement on points of law of the Federal Administrative Court of 9 March 1990, Entscheidungen des Bundesverwaltungsgerichts (BVerwGE) 85, 54, p. 10.

from exploration to the construction of a disposal facility could easily be taken at an underground facility did not justify the insinuation that the exploratory mine was already subject to nuclear law.[595] The actual sinking of the shafts for the geological disposal facility began in September 1986[596] and was suspended for 18 months in August 1987 after a serious accident in Shaft I.	from exploration to the construction of a disposal facility could easily be taken at an underground facility did not yet justify placing the exploratory mine under nuclear law.[680] The actual sinking of the shafts for the geological disposal facility began in September 1986[681] and was suspended for 18 months in August 1987 after a serious accident in Shaft I.
With the agreement of 14 June 2000 between the German Federal Government and the energy utilities on the orderly phasing-out of power generation from nuclear energy, both sides also agreed to suspend the exploration of the Gorleben salt dome 'until the clarification of conceptual and safety questions, for at least three, but at the longest ten years'.[597]	With the agreement of 14 June 2000 between the German Federal Government and the energy utilities on the orderly phasing-out of power generation from nuclear energy, both sides also agreed to suspend the exploration of the Gorleben salt dome 'until the clarification of conceptual and safety questions, for at least three, but at the longest ten years'.[682]
In Annex 4 to the agreement, the German Federation delivered a declaration on the exploration of the salt dome at Gorleben, which summarised the main geological results of the exploratory work that had been done: 'In the course of the exploration of Exploration Area 1 (EB 1), the extent of the Älteres Steinsalz that is envisaged for the emplacement of high-level radioactive waste has proven to be greater than originally assumed. However, Exploration Area 1 is not sufficient for the predicted volume of waste. The analytically determined uplift rates of the salt dome give rise to the expectation that, in view of the levels of uplift that are also possible over very long time horizons (of the order of magnitude of one million years), it is not	In Annex 4 to the agreement, the German Federation delivered a declaration on the exploration of the salt dome at Gorleben, which summarised the main geological results of the exploratory work that had been done: 'In the course of the exploration of Exploration Area 1 (EB 1), the extent of the Älteres Steinsalz that is envisaged for the emplacement of high-level radioactive waste has proven to be greater than originally assumed. However, Exploration Area 1 is not sufficient for the predicted volume of waste. The analytically determined uplift rates of the salt dome give rise to the expectation that, in view of the levels of uplift that are also possible over very long time horizons (of the order of magnitude of one million years), it is not

678 Cf., for instance: Fritzen, Marianne (1999): 'Atomrecht, Bergrecht, Unrecht', in: Lüchow-Dannenberg Citizens' Initiative for Environmental Protection: Zur Sache 8: Endlager Gorleben.

679 Appellate judgement on points of law of the Federal Administrative Court of 9 March 1990, BVerwGE 85, 54, p. 10.

595 Cf. the appellate judgement on points of law of the Federal Administrative Court of 9 March 1990, BVerwGE 85, 54, p. 12.

596 Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe mbH (DBE) (1990): Gorleben: Erkundung eines Salzstocks, p. 23.

597 Agreement between the German Federal Government and the energy utilities of 14 June 2000, p. 9.

680 Cf. the appellate judgement on points of law of the Federal Administrative Court of 9 March 1990, BVerwGE 85, 54, p. 12.

681 Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe mbH (DBE) (1990): Gorleben: Erkundung eines Salzstocks, p. 23.

682 Agreement between the German Federal Government and the energy utilities of 14 June 2000, p. 9.

to be expected that this will cause any hazards. No noteworthy solution, gas and condensate pockets have been found in the Älteres Steinsalz. The information gained to date about the impermeability of the rock and therefore the barrier function of the salt has been confirmed positively. The geological findings reached to date therefore do not conflict with the potential suitability of the Gorleben salt dome.’[598] However, the German Federal Government saw a need ‘to further develop the suitability criteria for a disposal facility and revise the conception for the disposal of radioactive waste.’ There had been significant further developments in risk assessment: ‘this has consequences with regard to the further exploration of the salt dome at Gorleben. Above all, the following questions give grounds for doubt.’ After this, the agreement mentioned ‘gas generation in impermeable salt rock,’ ‘retrievability’, the ‘suitability of salt’ in comparison to other host rocks and further issues.[599] The exploration of the salt dome was suspended from 1 October 2000 to 1 October 2010 on the basis of the agreement that had been reached. After this, the Federal Office for Radiation Protection (BfS) wished to resume it on a new, transparent foundation. When uncertain issues were dealt with, the BfS came to the conclusion that, among other things, all the host rocks that were suitable in principle had advantages and disadvantages, which could only be clarified in the course of exploration work. The exploration of the Gorleben salt dome was suspended again in November 2012 and ended on 27 July 2013 when the Site Selection Act entered	to be expected that this will cause any hazards. No noteworthy solution, gas and condensate pockets have been found in the Älteres Steinsalz. The information gained to date about the impermeability of the rock and therefore the barrier function of the salt has been confirmed positively. The geological findings reached to date therefore do not conflict with the potential suitability of the Gorleben salt dome.’[683] However, the German Federal Government saw a need ‘to further develop the suitability criteria for a disposal facility and revise the conception for the disposal of radioactive waste.’ There had been significant further developments in risk assessment: ‘this has consequences with regard to the further exploration of the salt dome at Gorleben. Above all, the following questions, which relate generally to final disposal, give grounds for doubt.’ After this, the agreement mentioned ‘gas generation in impermeable salt rock,’ ‘retrievability’, the ‘suitability of salt’ in comparison to other host rocks and further issues.[684] These ‘uncertain issues’ were cleared up with a synthesis report issued by the Federal Office for Radiation Protection in 2005: ‘The studies found that no essential gaps in knowledge could be identified at the generic level. The open questions identified are either to be clarified by regulatory means or are not regarded as of such relevance that they are fundamentally to be clarified before further decisions are taken about the approach to the disposal of waste.’[685] On the basis of the agreement that had been reached, the exploration of the salt dome was then also suspended from 1 October 2000 until the latest possible

[598] Agreement between the German Federal Government and the energy utilities of 14 June 2000, Annex 4.
[599] Agreement between the German Federal Government and the energy utilities of 14 June 2000, Annex 4.
[683] Agreement between the German Federal Government and the energy utilities of 14 June 2000, Annex 4.
[684] Agreement between the German Federal Government and the energy utilities of 14 June 2000, Annex 4.
[685] Federal Office for Radiation Protection (2005): ‘Konzeptionelle und sicherheitstechnische Fragen der Endlagerung radioaktiver Abfälle: Wirtsgesteine im Vergleich: Synthesebericht des Bundesamtes für Strahlenschutz’, Salzgitter, 4 November 2005, p. 149, para. 4

into force. Since the decision on the underground exploration of the salt dome in 1983, merely one of the nine exploration areas that were initially planned had been largely investigated. The interim results of the exploration, which the German Federal Government set out in 2000 in its consensual agreement with the energy utilities, related exclusively to Exploration Area 1 and therefore about one ninth of the part of the salt dome that was to be explored. The licensing procedure, which was supposed to clarify the suitability of the salt dome and also involve affected local residents, was never carried out. There was no possibility of an agreement under private law between the German Federal Government and the energy utilities prejudicing a decision about the site's suitability. All later attempts[600] to reinterpret the statement that 'the geological findings obtained to date do not conflict with the potential suitability of the Gorleben salt dome' as a statement about its 'suitability', were fruitless. In July 2014, the German Federation and the Land Lower Saxony declared the plan approval procedure on the construction of a disposal facility in the Gorleben salt dome instituted by the National Metrology Institute of Germany in 1977 to be closed.[601] Furthermore, they agreed to end operations in Exploration Area 1, which had been engineered within the salt dome, remove all installations from the area and close it off. Only the shafts of the exploratory mine and parts of the infrastructure zone necessary for the ventilation systems and escape routes are still continuing to be maintained in stand-by operation. The installations above ground have also	date, i.e. 1 October 2010, although it had already been possible for the 'uncertain issues' to be clarified five years previously. After this, the Federal Office for Radiation Protection (BfS) wished to resume the exploration work on a new, transparent basis. When these uncertain issues were dealt with, the BfS came to the conclusion that, among other things, all the host rocks that were suitable in principle had advantages and disadvantages. However, the exploration of the Gorleben salt dome was suspended again in November 2012 and ended on 27 July 2013 when the Site Selection Act entered into force. Since the decision on the underground exploration of the salt dome in 1983, merely one of the nine exploration areas that were initially planned had been largely investigated. It was accordingly only possible for the interim results of the exploration, which the German Federal Government set out in 2000 in its consensual agreement with the energy utilities, to relate to Exploration Area 1. In July 2014, the German Federation and the Land Lower Saxony declared the plan approval procedure on the construction of a disposal facility in the Gorleben salt dome instituted by the National Metrology Institute of Germany in 1977 to be closed.[686] Furthermore, they agreed to end operations in Exploration Area 1, which had been engineered within the salt dome, remove all installations from the area and close it off. Only the shafts of the exploratory mine and parts of the infrastructure zone necessary for the ventilation systems and escape routes are still continuing to be maintained in stand-by operation. The installations above ground have also

[600] For instance, the two terms are equated in the expert opinion by Freshfields Bruckhaus Deringer (2015): 'Stilllegung Entsorgung Kernenergie', p. 21: 'Despite the "potential suitability" of the Gorleben site, i.e. despite its suitability for final disposal, no final exploration is being conducted there.'

[601] Cf. the joint press release of the Federal Environment Ministry, the Lower Saxon Environment Ministry and the Federal Office for Radiation Protection, 29 July 2014.

been adapted to the ongoing stand-by operations.[602] **4.1.4.4 Learning from Gorleben** Under the Site Selection Act, the exploration of the salt dome could only be resumed again if other sites, where the disadvantages found at Gorleben or other disadvantages are not to be anticipated, do not prove to be better suited during the new comparative site selection procedure that the Commission has prepared. According to the comparative study of salt domes carried out by the Federal Institute for Geosciences and Natural Resources,[603] for instance, there were well founded hopes for more suitable sites under the criteria for salt as a host rock that were applied at the time when it was produced. Furthermore, it has to be noted that the assessment of these matters also remained extremely controversial within the German Bundestag's committee of inquiry on Gorleben. The parliamentary groups of the Social Democratic Party of Germany (SPD), the Greens and The Left Party came to the conclusion that, 'Gorleben was not selected as the site through a scientifically verifiable selection process, but as the result of an arbitrary, political decision.'[604] By contrast, the governing parliamentary groups of the Christian Democratic Union/Christian Social Union (CDU/CSU) and the Free Democratic Party (FDP) articulated the opinion that, 'the results of 30 years of Gorleben exploration have never given occasion to doubt the potential suitability of the	been adapted to the ongoing stand-by operations.[687] **4.1.4.4 Learning from Gorleben** Under the Site Selection Act, the exploration of the salt dome could be resumed again if other sites prove to be less well suited during the new comparative site selection procedure that the Commission has prepared. In the light of the principle of consensus postulated in the Site Selection Act, the controversial history that has destroyed trust in the region is an obstacle to the further process, even though the Commission was asked to formulate its criteria for, and requirements concerning, the site that guarantees the best-possible safety without looking at the Gorleben salt dome. In April 2015, the Commission on the Storage of High-Level Radioactive Materials asked the German Federal Government to draw up statutory provisions, 'that make it possible for early action to be taken to secure siting regions and planning zones for potential disposal sites.'[688] The background to this is that the continuing special status of the Gorleben salt dome under the temporary moratorium on development that is in place is due to be ended by the adoption of general provisions. In June 2015, the Bundesrat only gave its consent to the extension of the temporary moratorium on development at Gorleben subject to the proviso that it would expire on 31 March 2017, by which time a statutory foundation would be put in place that would make it possible for early action to

[686] Cf. the joint press release of the Federal Environment Ministry, the Lower Saxon Environment Ministry and the Federal Office for Radiation Protection, 29 July 2014.
[602] Cf. the joint press release of the Federal Environment Ministry, the Lower Saxon Environment Ministry and the Federal Office for Radiation Protection, 29 July 2014.
[603] Federal Institute for Geosciences and Natural Resources (1995): 'Endlagerung stark wärmeentwickelnder radioaktiver Abfälle in tiefen geologischen Formationen: Untersuchung und Bewertung von Salzformationen'.
[604] German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013, p. 592.

Gorleben salt dome for a disposal facility for all types of radioactive waste.'[605] In the light of the principle of consensus postulated in the Site Selection Act, the controversial history that has destroyed trust in the region is an obstacle to the further process, even though the Commission was asked to formulate its criteria for, and requirements concerning, the site that guarantees the best-possible safety without looking at the Gorleben salt dome. It has not allowed itself be influenced by findings that are already available for particular sites, above all in relation to the requirements placed on the overburden as a second geological barrier. Political and scientific decisions cannot be separated from societal experiences, particularly as trust and broad understanding are fundamental preconditions for the best-possible solution. This means 'learning from Gorleben'. Seeing this connection is a central lesson from the exploration of Gorleben, where transparent suitability criteria, formal community participation and a site comparison process that would have complied with contemporary requirements were lacking. The disposal facility for which the Commission has prepared the site selection procedure is to accommodate the contents of approximately 1,900 transport and storage containers of high-level radioactive waste and, under certain circumstances, up to 300,000 cubic metres of low and intermediate-level active waste. At present, there are 113 containers of high-level radioactive waste at the Gorleben transport cask storage facility. During the 13 Castor transports with which these containers were transferred to the interim storage	be taken to secure siting regions and planning zones for potential disposal sites. It was, above all, the Commission's task to draw up scientifically based criteria for the selection of a disposal site with the aim of guaranteeing the best-possible safety without making reference to a particular site. An appraisal of the possible suitability of the Gorleben salt dome as a disposal site was not a component of its statutory mandate. As far as Gorleben is concerned, it can only be a question of learning from the conflicts about this site and avoiding the repetition of previous errors.

[687] Cf. the joint press release of the Federal Environment Ministry, the Lower Saxon Environment Ministry and the Federal Office for Radiation Protection, 29 July 2014.

[688] Commission on the Storage of High-Level Radioactive Materials (2015): 'Beschluss der Kommission vom 20. April 2015', K-Drs. 102 neu.

[605] German Bundestag (2013): Recommendation for a Decision and Report of the 1st Committee of Inquiry pursuant to Article 44 of the German Basic Law (GG), Bundestag Printed Paper 17/13700, 23 May 2013, p. 257.

facility, the Land Lower Saxony had to deploy a total of 154,000 police officers to escort the convoys in the region around the site. The Land estimated the actual additional costs due to these deployments, which do not even include the regular salaries of the forces deployed and the costs of the deployment of the Federal Police, at 352 million euros.[606] When the Lower Saxon Minister President, Ernst Albrecht, distanced himself from the construction of a nuclear waste management centre at Gorleben in May 1979, he noted in the Landtag, ‘that the attitude of the immediately affected population is accorded particular weight.’[607] A reprocessing plant could not be built at Gorleben, ‘as long as it has not been possible to convince broad strata of the population of the necessity and safety acceptability of the installation.’[608] This requirement must also apply today and for all sites.	

4.1.5 Assessment of the experience gained

The Site Selection Act gave the Commission the mandate to propose a scientifically based procedure for the selection of the site for the storage of high-level radioactive waste that would be able to guarantee the best-possible safety and, when doing so, to also assess the experience of the handling of radioactive waste gained in the past, as well as the decisions taken and specifications adopted in this field.

With the Site Selection Act, consequences were drawn from the difficulties encountered by the disposal projects that had been undertaken in Germany. The Act has halted the geotechnical exploration of the Gorleben salt dome and requires a new search to find a site for the disposal of, in particular, high-level radioactive waste. The Commission has learned lessons from the previous German disposal projects, reflected on the cultural and societal background to any new understanding that will be reached, and taken account of the further development of science and technology in the field of disposal.

The open-ended, multistage procedure for the selection of the disposal site that guarantees the best-possible safety is the logical and most important consequence

[606] Information provided by the Lower Saxon Ministry of Internal Affairs to the Secretariat of the Commission, 23 March 2016.

[607] Lower Saxon Landtag (1979): Stenographic Record, 9th electoral term, 15th plenary sitting, 16 May 1979, p. p1715.

[608] Lower Saxon Landtag (1979): Stenographic Record, 9th electoral term, 15th plenary sitting, 16 May 1979, p. 1715.

drawn from the conflict-laden German disposal projects that have been undertaken to date. It offers an opportunity to overcome old conflicts and arrive at a new understanding. Such a selection procedure will prevent the premature specification of one site before the exploration work has been concluded. Until the final decision is taken, various sites will be studied in parallel with increasing intensity until, at the end, a choice is to be made between them from safety points of view. This means the exploration activities will be open-ended and will not be tainted by the suspicion they are only intended to confirm prior assumptions about the disposal site and rubber stamp a political decision to specify a particular site.

The comparative selection procedure will be guided by the geoscientific criteria the Commission has drawn up in the present report,[689] which means the criteria with which the site with the best-possible safety is to be found will have been established before the beginning of the selection procedure. This too is a lesson from the history of Gorleben.

Accusations were frequently made that the decision to select the Gorleben salt dome had been politically motivated. Politics will play an important role in the new procedure as well. After every step in the multistage search, the Site Selection Act provides for a decision to be taken by the German Bundestag that will be intended to confirm each selection decision that is proposed has been based on the correct application of the criteria and the public has been consulted. Following a public debate, Germany’s parliament will approve and affirm the results of a scientifically based selection procedure. This is not comparable with an internally prepared cabinet decision of the kind that led to the designation of the site at Gorleben.

The search for the site with the best-possible safety will start by looking at the whole territory of the Federal Republic of Germany. It will ensure all potentially suitable types of rock and sites are looked at during the selection process, and will avoid prior specifications that could be interpreted as being motivated by extraneous concerns. The Commission has formulated selection criteria without looking at concrete sites. In so far as this is possible, the criteria are valid for all types of rock in which disposal is, in principle, feasible. No site will be selected on the basis of what is politically opportune.

During the exploration of the Gorleben salt dome, formal participation of citizens was not provided for until the plan approval procedure that has to be conducted for all major projects, which was supposed to have followed the positive conclusion of the exploration work. This encouraged critics to suspect the intention was to present the communities who would be affected with a *fait accompli*. By contrast to this, the Commission recommends a selection procedure under which citizens will have the right to comprehensive opportunities for participation and involvement at an early stage. With this in mind, it has drawn up a comprehensive concept for public participation in the selection of the disposal site that describes participation rights, participation formats and options to obtain legal redress in detail.[690]

New forms of participation and influence for the population will also demand changes in the authorities’ behaviour. They will have to involve critical or protesting citizens and always deal with them respectfully. The selection of the

[689] Cf. section B 6.5 of the present report, ‘Decision-making criteria for the selection procedure’.
[690] Cf. section B 7 of the present report, ‘Site selection in dialogue with the regions’.

new disposal site will only be successful if all the actors are capable of learning, and willing to conduct themselves in such a way that new trust is built up and it is possible to talk about all problems openly. The participating authorities will also have to contribute to this by ensuring transparency, which will mean always disclosing the reasons for planned decisions comprehensively and in good time, while engaging with citizens' criticisms at an early stage. Criticism of the authorities' actions is an opportunity to eliminate weaknesses.

Nevertheless, the Commission does not believe the disposal of high-level radioactive waste is to be implemented without friction in future. It has drawn up rules and recommendations for the handling of conflicts.[691] Furthermore, it is convinced that a far-reaching future ethics will have to be anchored in politics and society.[692]

In the opinion of the Commission, there must be clarity about the purpose of the site that is being sought before the selection procedure begins. The Commission has consciously focussed its selection criteria on the requirements of the best-possible storage of high-level radioactive waste. It believes the storage of low and intermediate-level radioactive waste at the same site will only be possible if negative interactions with the high-level radioactive waste are ruled out.[693] However, it recommends that this possibility be taken into account from the outset in the community participation process.[694]

For the population must know from the beginning what might be in store for it. Two years after Gorleben was designated a nuclear waste management centre site, the German Federation and the Land Lower Saxony agreed to alter its main purpose to that of a site to be explored as a disposal facility for radioactive waste.

In the opinion of the Commission, the failure of the disposal of radioactive waste at Asse II also entails consequences for the treatment of divergent scientific opinions. Early warnings about inflows of water into the Asse II mine were not acted upon at the time and even had negative consequences for the scientists who raised them. It would have been possible to correct the misguided course embarked upon at Asse II earlier if critical voices had been taken seriously. The later an error is recognised, the more expensive it becomes to correct. Furthermore, the history of the underground facility at Asse II shows how indispensable it is to obtain opinions from experts who are independent of operators.

At the same time, important experience has been gained with the Asse 2 Monitoring Group and should also be exploited for community participation in major projects.[695] From a contemporary point of view, the Commission recommends that the whole disposal process be designed as a self-interrogating

[691] Cf. section B 2.4 of the present report, 'Principles for the handling of conflicts during the participative search procedure'.

[692] Cf. section B 3 of the present report, 'The imperative of responsibility'.

[693] Cf. section B 6.6 of the present report, 'Requirements on emplacement of additional radioactive waste'.

[694] Cf. section B 7 of the present report, 'Site selection in dialogue with the regions'.

[695] The Asse 2 monitoring process is a collective approach under which various state, political and civil society bodies play differentiated roles with the aims of guaranteeing regional and civil society involvement in the statutorily prescribed retrieval of atomic waste materials from the Asse II site, a former mine in Wolfenbüttel County, and designing the process by which this is done transparently. The monitoring process has, in particular, been designed by the Asse 2 Monitoring Group (a2b). The monitoring process is financed with funds from the Federal Ministry for the Environment, Conservation, Building and Nuclear Safety (BMUB).

system, with errors and undesirable developments being prevented, if possible, by means of continual process monitoring.[696]

The Commission on the Storage of High-Level Radioactive Waste recommends that the consequences it highlights be drawn from the experience of disposal projects in Germany so it is possible to arrive at a new understanding, which will allow a fair, transparent solution that is as safe as possible to be achieved in an open-ended procedure.

4.2 International experience

4.2.1 Selection of disposal sites in other countries

Under the Site Selection Act, the analysis of the international experience of disposal projects was one of the Commission's tasks. It was also to draw on this experience to derive recommendations for a storage concept.[697] Members of the Commission therefore travelled to Switzerland from 31 May to 2 June 2015,[698] to Sweden from 25 to 27 October 2015 and to Finland from 27 to 30 October 2015 in order to inform themselves on the ground about site selection procedures and disposal projects. On these trips, the technical/scientific requirements for the sites taken as the basis for decision-making in each country and the parties' experience of organising community participation were of particular interest to the Commission.

Apart from this, the Commission has conducted hearings with international experts.[699] The following hearings are to be highlighted here in particular:

- the hearing of 5 December 2014 on 'International Experience',[700] at which the Commission gathered information about, in particular, geological barriers, safety requirements, long-term safety and public participation, and
- the hearing of 2 October 2015 on 'Retrieval/Retrievability of High-Level Radioactive Waste from a Disposal Facility, Reversibility of Decisions',[701] which served in particular to look at these topics in depth.

4.2.2 Switzerland

At present, Switzerland is operating five nuclear power plants, at which about 75 tonnes of spent nuclear fuels accumulate each year. These five nuclear power plants were commissioned during the years from 1969 to 1984, and each has a planned operating life of 50 years. Depending on the operating life of each

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[696] On this issue, cf. section B 6.4 of the present report, 'Process design as a self-interrogating system'.
[697] Cf. Section 4(2) of the Site Selection Act.
[698] Cf. 'Reisebericht Schweiz', K-Drs. 129.
[699] Dr. Michael Aebersold (K-Drs. 73), Prof. Dr. Anne Bergmans (K-Drs. 71), Dr. Klaus Fischer-Appelt (K-Drs. 64), Dr. Thomas Flüeler (K-Drs. 63), Prof. Dr. Reto Gieré (K-Drs. 79), Beate Kallenbach-Herbert (K-Drs. 72), Prof. Dr. Hans-Joachim Kümpel (K-Drs. 78), Dr. Jörg Mönig (K-Drs. 80), Prof. Dr. Klaus-Jürgen Röhlig (K-Drs. 62), Prof. Dr. Miranda Schreurs (K-Drs. 65), Dr. Walter Steininger (K-Drs. 74), Prof. Dr. Dr. Jean-Claude Duplessy (K-Drs. 130c), Dr. Stanislas Pommeret, Erik Setzman (K-Drs. 130b and 130d), Prof. Dr. Simon Löw (K-Drs. 130a and 130e), Wilhelm Bollingerfehr (K-Drs. 130g), Dr. Jörg Tietze (K-Drs. 130f and 130i) and Prof. Dr. Jürgen Manemann (K-Drs. 130h).
[700] Cf. the 6th meeting of the Commission, minutes, pp. 16 ff.
[701] Cf. the 16th meeting of the Commission, minutes, pp. 19 ff.; and 'Zusammenfassung der mündlichen Anhörung vom 2. Oktober 2015', K-Drs. 136.

specific plant, this means the quantity of waste to be stored will be up to 4,300 tonnes, which – once packed in underground storage containers – would require a storage volume of approx. 7,300 cubic metres. In addition to this, there will be another roughly 92,000 cubic metres of low and intermediate-level radioactive waste, of which approximately 59,000 cubic metres will be attributable to the dismantling of the nuclear power plants.[702] Switzerland is concentrating on argilliferous rocks as potential host rocks for a geological disposal facility.

4.2.2.1 Conduct of the disposal site selection procedure

In Switzerland, the responsibility for the preparation of the disposal of radioactive waste lies with the National Cooperative for the Disposal of Radioactive Waste (NAGRA);[703] its proposals are examined and assessed[704] by the Swiss Federal Office of Energy (SFOE)[705] and the Swiss Federal Nuclear Safety Inspectorate (ENSI).[706] NAGRA is owned and funded by the Swiss Confederation, which is responsible for the management of radioactive waste from medicine, industry and research, and the nuclear power plant operators.[707] NAGRA has the task of identifying where there are potential sites in Switzerland for a geological disposal facility to be constructed and operated in accordance with the latest advances in technology that will fulfil all the requirements specified by the authorities concerning long-term safety. The 'demonstration of disposal feasibility' required by the legislation was approved for low and intermediate-level radioactive waste as long ago as 1988.

The Wellenberg, a mountain in the Canton of Nidwalden, was discussed as a possible site for a disposal facility from 1993 on. In 1994, the Cooperative for Nuclear Waste Management Wellenberg (GNW) submitted a framework application for a disposal facility for low and intermediate-level radioactive waste, but this was rejected by a referendum in 1995. The application for an exploratory drift submitted in 2002 was also rejected by a referendum.

The demonstration of feasibility for high-level radioactive and particularly long-lived, intermediate-level radioactive waste was submitted in 2002, and approved by the Swiss Federal Council in June 2006; this demonstration of feasibility related to the use of the opalinus clay in the Zurich Weinland as the host rock for a disposal facility.

As a consequence of the applications for the Wellenberg that were rejected in 1995 and 2002, the statutory parameters were revised in Switzerland. Since February 2005, the Nuclear Energy Act and Nuclear Energy Ordinance have stipulated the 'sectoral plan procedure' as the instrument for the selection of disposal sites.[708] The lead role in the conduct of the sectoral plan procedure was assigned to the Swiss Federal Office of Energy (SFOE).

The new concept provides for the disposal site selection procedure to be broken down into three stages.[709] The current objective is to put a deep geological

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702 Cf. http://www.nagra.ch/en/volumesen.htm, last accessed: 6 January 2016.
703 See http://www.nagra.ch/en.
704 Cf. http://www.bfe.admin.ch/radioaktiveabfaelle/01277/05193/index.html?lang=en.
705 See http://www.bfe.admin.ch/.
706 See https://www.ensi.ch/en/?noredirect=en_US.
707 Cf. http://www.nagra.ch/en/company.htm.
708 Cf. http://www.bfe.admin.ch/radioaktiveabfaelle/01275/01290/index.html?lang=en.
709 Cf. http://www.bfe.admin.ch/radioaktiveabfaelle/01277/05192/index.html?lang=en.

repository[710] for low and intermediate-level radioactive waste into operation as of 2050 and a disposal facility for high-level radioactive waste as of 2060.[711] The Sectoral Plan for Deep Geological Repositories,[712] which is authoritative as far as these measures are concerned, consists of a conceptual part[713] and an implementation part. Procedural rules for the search for a disposal site are specified in the conceptual part, which was drawn up with the participation of Swiss and foreign stakeholders,[714] and adopted by the Swiss Federal Council in 2008. The procedure is divided into the following stages:

- The selection of geological siting regions.
- The selection of at least two potential sites for each category of waste.
- The selection of the site(s) and the licensing procedure under the Nuclear Energy Act.

Ultimately, this procedure is being used to seek a suitable, accepted site for the disposal facility that does not necessarily have to be the best site in comparison with other locations.[715]

The potential regions for sites approved by the Swiss Federal Office of Energy in November 2008, which are suitable according to a geoscientific screening carried out by the National Cooperative for the Disposal of Radioactive Waste (NAGRA) for deep geological repositories for radioactive waste, include six siting regions[716] for low and intermediate-level radioactive waste. Of these regions, three are also identified as siting regions for the storage of high-level radioactive waste. This means Zurich Nordost in the Cantons of Zurich and Thurgau, Nördlich Lägern in the Cantons of Zurich and Aargau, and Jura Ost in the Canton of Aargau would be suitable regions for the storage of all types of radioactive waste. The other chosen siting regions are Südranden in the Canton of Schaffhausen, Jura-Südfuss in the Cantons of Solothurn and Aargau, and the Wellenberg in the Canton of Nidwalden. The specification of these regions allows for the option of constructing just one disposal facility that would be able to accommodate low and intermediate-level radioactive waste, as well as high-level radioactive waste.

In 2011, the Swiss Federal Council decided that all the chosen siting regions would continue to be covered by the selection procedure. Provisional safety analyses, spatial development analyses and socio-economic studies are being conducted for these regions. In 2012, 20 possible sites for surface installations in the chosen siting regions were presented by the Federal Office of Energy.

Stage 2 of the site selection procedure for low, intermediate and high-level radioactive waste was concluded in December 2014. Zurich Nordost and Jura-Ost were presented as potential regions for a disposal facility. Both offer the option of storing low and intermediate-level radioactive waste, as well as high-level radioactive waste.

When it issued its technical review, however, the Swiss Federal Nuclear Safety Inspectorate (ENSI) criticised the National Cooperative for the Disposal of Radioactive Waste (NAGRA) for supplying inadequate and, in some cases,

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[710] Cf. https://www.ensi.ch/en/waste-disposal/deep-geological-repository/?noredirect=en_US.
[711] Cf. http://www.bfe.admin.ch/radioaktiveabfaelle/01277/01308/index.html?lang=en.
[712] Cf. https://www.ensi.ch/en/waste-disposal/deep-geological-repository/sectoral-plan-for-deep-geological-repositories-sgt/?noredirect=en_US.
[713] Cf. http://www.bfe.admin.ch/radioaktiveabfaelle/01277/05191/index.html?lang=en.
[714] Cf. Aebersold, Michael, 6th meeting of the Commission, minutes, pp. 57 and 61.
[715] Cf. Mönig, Jörg, 6th meeting of the Commission, minutes, pp. 68f.
[716] Cf. http://www.bfe.admin.ch/radioaktiveabfaelle/05182/index.html?lang=en.

unverifiable data in its technical/scientific report. It could not conclusively be appraised on this basis whether NAGRA had correctly excluded the Nördlich Lägern region from the rest of the procedure.[717] The broad-based hearing planned for 2016, which is to give cantons, organisations and the population the opportunity to comment on these proposals within a three-month period before the Federal Council decides on the approval of the concrete regions proposed in mid-2017, is expected to be delayed by six to twelve months as a result of ENSI's criticism of the report from NAGRA.

In the subsequent, third stage, the remaining sites, Zurich Nordost and Jura-Ost, are then to be investigated even more thoroughly. In order to obtain comparable levels of scientific knowledge, it will now also be possible for boreholes to be drilled from the surface and further geophysical investigations – such as 3D seismic studies, gravimetric studies, geoelectric studies and geological mapping – to be conducted. When this is done, intensive field work is to gather data that will then be incorporated into a comparison of the sites from a safety perspective; by contrast, underground exploration activities are not provided for during the selection process. Another task for the third stage is the elaboration of foundations for suitable compensatory measures, as well as foundations for the systematic surveying and observation of societal, economic and ecological impacts. Furthermore, the drafting of a site-specific long-term safety case is an essential element of this stage.

The provisional selection of the sites for which 'general licence applications' will be drawn up is to be made in 2020; the conclusive decision on the site or sites and the granting of a general licence are anticipated for 2027. The Federal Council and, subsequently, the Swiss parliament will decide on the granting of the general licence. Finally, it will be possible for a national plebiscite on the general licensing decision to be demanded by 50,000 eligible voters or eight cantons.

The financial aspects of nuclear waste management are regulated in the Swiss Nuclear Energy Act and, in addition to this, the Federal Ordinance on the Decommissioning Fund and the Waste Disposal Fund. Among other things, these instruments provide for the application of the polluter-pays principle, the establishment of public funds to finance decommissioning and waste disposal, an obligation for waste producers to pay additional contributions into these funds to cover any shortfalls and a duty to set aside reserves to finance other waste management costs. The contributions to the funds are calculated on the basis of cost estimates that are updated every five years. The most recent amendments to the Act introduced a safety margin of 30 per cent to be added to the estimated costs, and adjusted the parameters for the quantitative financial calculations to take account of current conditions. The two funds serve primarily to ensure the necessary financial resources will be available when they are required; furthermore, the moneys and/or claims to their repayment from the funds stay on the energy utilities' balance sheets. Ultimate supervision over both funds is exercised by the Federal Council. 8.4 billion Swiss francs are to be amassed in the Waste Disposal Fund, of which 4.1 billion have already been paid in; 2.9 billion Swiss francs are budgeted for in the Decommissioning Fund, of which 1.9 billion have been paid in at present.

[717] Cf. http://www.ensi.ch/de/2015/11/09/das-ensi-konkretisiert-die-nachforderung-an-die-nagra-fuer-eine-bessere-beurteilungsgrundlage-der-standortgebiete/, last accessed: 6 January 2016.

4.2.2.2 Disposal concept

The storage concept[718] for high-level radioactive waste provides for an argilliferous host rock – probably opalinus clay – at a depth of 500 to 700 metres accessed via shafts and ramps, and a main storage facility with horizontal emplacement tunnels. The concept envisages horizontally lying containers being positioned on pedestals that consist of bentonite in the storage tunnels and the cavities around the disposal containers being backfilled with bentonite granulate. The requirements concerning the observation phase and sealing still have to be specified in concrete terms. The Act demands retrievability 'without undue effort' until the disposal facility is sealed,[719] which will depend in particular on the type of backfilling materials used and the stability of the cavities.[720] Scientific experiments on the host rock and to develop the storage concept are being conducted both at the Grimsel rock laboratory operated by the National Cooperative for the Disposal of Radioactive Waste (NAGRA)[721] and at the Mont Terri rock laboratory[722] operated by the Swiss Federal Office of Topography (SWISSTOPO).[723]

4.2.2.3 Community participation

The central bodies concerned with regional involvement in the disposal site selection procedure are the regional conferences that were formed in 2011, in which representatives of interested circles, in particular regional authorities, organisations and private individuals, actively oversee the process. German municipalities close to the border are also able to participate directly in these regional conferences.[724] The regional conferences are coordinated by the Swiss Federal Office of Energy as the authority in charge of the procedure, so that the project-delivery organisation is not forced to perform a double function.[725] The make-up of the regional conferences was not decided according to a predetermined proportional scheme or by means of a fixed election procedure, but was negotiated locally on the ground in some cases. In the view of the Commission, this flexibility has not caused credibility or acceptance problems because the prevailing understanding of the state in Switzerland differs significantly from that found in Germany, and the country's population has a higher degree of fundamental trust in the actions of public institutions.[726]
The function of the regional conferences is to draw up demands and recommendations, in particular on spatial planning concerns, safety provisions and possible socio-economic or ecological impacts, that then feed into the decision-making process. For example, the regions and cantons are deliberating in cooperation with the National Cooperative for the Disposal of Radioactive Waste (NAGRA) on the layout of surface installations, how they should be embedded into the landscape, rail and road links, and the siting of buildings.

[718] Cf. http://www.bfe.admin.ch/radioaktiveabfaelle/01274/01280/01286/index.html?lang=en.
[719] Cf. Fischer-Appelt, Klaus, 6th meeting of the Commission, minutes, p. 28.
[720] Cf. 'Zusammenfassung der mündlichen Anhörung vom 2. Oktober 2015', K-Drs. 136, p. 2.
[721] See http://www.grimsel.com/.
[722] See http://www.mont-terri.ch/.
[723] See http://www.swisstopo.admin.ch/.
[724] Cf. Kallenbach-Herbert, Beate, 6th meeting of the Commission, minutes, p. 34.
[725] Cf. Kallenbach-Herbert, Beate, 6th meeting of the Commission, minutes, p. 34.
[726] Cf. 'Reisebericht Schweiz', K-Drs. 129, pp. 11f.

In April 2014, the Swiss Federal Office of Energy announced that the conclusion of the disposal site selection procedure for a deep geological repository would be delayed by what is expected to be about ten years on account of the intensive public participation and demands from the regions for more time.

4.2.3 Sweden

The two oldest Swedish reactors, Oskarshamn 1 and 2, were connected to the grid in 1972 and 1974, and are to be operated for 50 years. The other Swedish nuclear power plants were commissioned between 1975 and 1985, and are expected to have operating lives of 50 to 60 years.
In Sweden, the responsibility for the management and disposal of fuel elements lies with the operators of the nuclear power plants. For this purpose, the four Swedish nuclear power plant operators set up a limited company, Swedish Nuclear Fuel and Waste Management Company (SKB), which is also responsible for transports and interim storage. Twelve per cent of its shares are held by Sydkraft Nuclear, 36 per cent by Vattenfall AB, 30 per cent by Forsmark Kraftgrupp AB and 22 per cent by OKG Aktienbolag. At present, SKB employs about 500 employees, 30 of them just in the field of communications.
SKB has already been operating a near-surface disposal facility for low and intermediate-level radioactive waste from the Swedish nuclear power plants in crystalline rock close to the Forsmark nuclear power plant since 1988. This disposal facility offers space for 63,000 cubic metres of radioactive waste. By contrast, spent fuel elements have been kept at the Central Interim Storage Facility (Clab) close to the Oskarshamn nuclear power plant since 1985. The Clab has capacity for 8,000 tonnes of waste, and currently holds 5,800 tonnes. Approximately 200 tonnes of waste is added each year. At present, an increase in its permitted storage capacity is being sought to a total of 12,000 tonnes in approximately 6,000 containers.
Only crystalline rock is available as a potential host rock for deep geological repositories in Sweden.

4.2.3.1 Conduct of the disposal site selection procedure

SKB began the search for a disposal site as long ago as 1977. After municipalities and local populations were not involved in the process at the beginning, many municipalities initially rejected the construction of a disposal facility in their areas. Eventually, however, a number of municipalities then responded to the invitation to put themselves forward as sites for the construction of a disposal facility. From 1993 to 2000, SKB conducted feasibility studies for eight potential sites. The precondition for any potential site was the consent in principle of the population that lived in the area, the municipality where the site was located and the county administration.
It was not possible for either relevant advantages for the interior of the country or relevant differences between northern and southern Sweden to be identified in the preliminary geological studies. All the potential sites had crystalline host rock; no suitable sites with rock salt or claystone are available in Sweden. The levels of acceptance among the population were therefore decisive for the selection of the potential sites. Despite this, two of the potential sites, Storuman and Malä, later

dropped out on account of municipal referendums that went against the plans in 1995 and 1997. Of the other six potential sites – Östhammar, Nyköping, Tierp, Oskarshamn, Hultsfred and Älvkarleby –, five seemed suitable from SKB's point of view. Of them, SKB put Östhammar near Forsmark, Oskarshamn and Tierp on the shortlist. The municipal councils of Östhammar and Oskarshamn approved the conduct of exploratory drilling; Tierp turned it down by a narrow majority. The exploratory drilling work was begun in 2002. In June 2009, SKB decided in favour of the Forsmark site because the rock there displayed higher thermal conductivity than the rock at Oskarshamn. This meant that decay heat would be conducted away from the waste more effectively. In addition to this, the rock at Forsmark was more impermeable and had fewer joints, and therefore gave rise to the expectation that less water would flow into the facility.
In March 2011, SKB submitted an application for the construction of a disposal facility for high-level radioactive waste at the Forsmark site to the Swedish supervisory authorities. For the time being, this application is the subject of a regulatory review that is looking at its radiation protection and nature conservation aspects. The review will then inform an opinion that will be delivered to the government. Not only that, the consent of the municipality will be required. The fundamental decision about the disposal facility will then be taken by the government, following which the licence will be formally granted. The expectation is that the application submitted in 2011 will be decided on between 2018 and 2020; the construction of the disposal facility is then to be concluded in 2025. Trial operations are initially envisaged, then regular emplacement during the period up to 2075. The facility is to be sealed between 2085 and 2095. A new application will be required for each operational phase.

4.2.3.2 Disposal concept

SKB launched its work on a disposal concept as long as go as 1977. For this purpose, a research facility for waste disposal technology was set up at the closed Stripa mine. In 1983, SKB published a report in which it presented its concept for the permanent encapsulation of spent fuel elements. The starting point for this concept are natural barriers in the shape of rock formations. However, these formations will only guarantee the disposal facility's mechanical stability, not its water resistance. Additionally, technical barriers such as bentonite rings and several-centimetre-thick copper canisters are provided for to guarantee water resistance. Since 1995, the research has been continued at the Äspö Hard Rock Laboratory near Oskarshamn. Apart from this, an experimental project on the horizontal emplacement of containers is being carried out at Forsmark.
At Äspö, tests are being conducted at a depth of 450 metres to find out how emplacement containers with a five-centimetre-thick copper casing behave in crystalline rock. Additionally, the copper canisters are to be embedded in a layer of bentonite. This clay-like material swells if it comes into contact with water. In its swollen state, the bentonite is to retain any radioactive pollutants that may be released. If the copper canisters were to corrode, this bentonite buffer would be the only barrier that would prevent the dispersal of radioactive pollutants. On account of the joints that are found in it, the surrounding crystalline rock itself is not able to contribute significantly to the retention of leaking radionuclides.

To this end, 500-metre-long drifts are first to be driven into the crystalline host rock at the future disposal site. Welded into up to 25-tonne copper canisters and surrounded by bentonite buffer, the spent fuel is to be stored safely there for at least 100,000 years. At present, questions are thrown up primarily by the water ingress that was visibly noticeable on a visit to the disposal facility for low and intermediate-level radioactive waste at Forsmark, which SKB quantifies at approximately 360 litres a minute, the equivalent of 22 cubic metres an hour or 518 cubic metres a day. Against this background, the permanent corrosion-resistance of the planned copper canisters has recently been the subject of controversial discussions among the specialist community.

The safety criteria will be examined by the Radiation Safety Authority in the course of the licensing procedure; this body is both a scientific authority and, simultaneously, a supervisory authority, employs approximately 300 staff and has an annual budget of about 400 million Swedish krona. By contrast, the environmental impact assessment will be carried out by another authority. Following the conduct of a consultation procedure, the first task for the authorities will be to present the government with an expert recommendation concerning the fundamental decision that is to be taken. The government will consult the municipality in question and then take its decision as a collegiate body. The actual licencing – and the imposition of any conditions that may be necessary – will then be a matter for the authorities again.

It is evident from this procedure that the authorities in Sweden will not examine various sites on the basis of selection criteria, but the site selected by the nuclear power plant operators who have a duty to manage radioactive waste, and that the planned disposal facility will be examined using scientific, technical and legal suitability criteria. In order to guarantee the success of this approach, the overall project has been intensively overseen by the Swedish authorities for 40 years and relevant expertise built up. This expertise relates, in particular, to the methodology of the safety analyses for the different materials (copper, cast iron and bentonite), and the exploration of the geological and hydrogeological situation.

Evidence concerning the emplacement method, the selection of the site and all relevant safety factors will be required for it to be licensed. In this respect, a detailed assessment of all relevant aspects and influential factors over a period of up to 1,000 years, and a less exhaustive assessment for up to 100,000 years will be required; in the future, the disposal facility’s safety will be assessed for a period of up to a million years. The safety of the copper canisters will be assessed for a period of 100,000 years, with a particular focus on pressure resistance and corrosion, which will at least require evidence of fault-free fabrication. By contrast, retrieveability is only demanded on an optional basis; in so far as this is the case, decisions about retrieveability will be a matter for the applicant and the licensing authority.[727]

SKB has quoted a figure of 136 billion Swedish krona for the total costs of the concept. Of this sum, 39 billion krona have already been invested, 56 billion krona are held by a publicly administered fund established to finance the disposal of the waste, and the nuclear power plant operators have provided the fund with guarantees for another 41 billion krona. The disposal of spent fuel will incur costs of about 37 billion Swedish krona, of which approximately eight billion krona

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[727] Cf. Fischer-Appelt, Klaus, 6th meeting of the Commission, minutes, pp. 28f.

will be spent on the canister factory for the copper capsules, five billion krona on the encapsulation plant and about 24 billion krona on the actual disposal facility. The Fund is financed with a fee levied at a rate of 0.04 Swedish krona per kilowatt hour, which is to be paid on power supplied from nuclear power plants in Sweden.

4.2.3.3 Community participation

Throughout the process, the Swedish Government will be advised by an independent scientific body, the National Council for Nuclear Waste. The Council consists of twelve members and employs five staff in its secretariat, including two experts in the field. The Council's functions include the independent assessment of SKB's research programme, the production of reports on recent advances in waste management and the state of the art of the technology, the observation of international developments, and the holding of seminars and public hearings.
Apart from this, the project is being monitored by various regional and supraregional community groups and associations. These organisations overwhelmingly do not see it as their job to stop the disposal project, but rather to oversee it critically and seek to ensure all the decisions taken are as transparent as possible. The vast majority of the community groups whose protests were essentially aimed at preventing the disposal facility have now broken up again. Another interesting detail of the Swedish procedure is the fact that resources have also been made available to environmental groups and other NGOs from the power plant operators' Waste Disposal Fund, allowing them to take part actively in public debates and the scrutiny of the Swedish waste management concept.[728] In comparison to other countries, trade unions and churches have not played prominent roles in the public discussion of the disposal question.

4.2.4 Finland

As in Sweden, the responsibility for the selection of a disposal site and the implementation of disposal in Finland lies exclusively in the hands of legally liable private companies; in this field, the state is only active in its supervisory function, which it exercises through the Radiation and Nuclear Safety Authority, and the Ministry of Economic Affairs and Employment. Disposal facilities for low and intermediate-level radioactive waste are also in operation at the Loviisa and Olkiluoto power plant sites. Waste has been emplaced at Olkiluoto since 1992 and at Loviisa since 1998.
Special vehicles are used to carry the low and intermediate-level radioactive packages from an interim storage facility over 300 metres of public road to the disposal facility, where they are driven via a ramp into a hall at a depth of 60 metres. In total, the disposal facility at Olkiluoto has sufficient capacity to be able to accommodate all Finland's low and intermediate-level radioactive waste until 60 years after the commissioning of Olkiluoto 3.
As in Sweden, only crystalline rock is available as a potential host rock for deep geological repositories in Finland.

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[728] Cf. Schreurs, Miranda, 6th meeting of the Commission, minutes, p. 44.

4.2.4.1 Conduct of the disposal site selection procedure

With regard to the construction of a disposal facility for high-level radioactive waste, the Finnish Nuclear Energy Act prescribes a staged approach. The first decision was the political determination by the Council of State that a disposal facility for radioactive waste would be constructed in Finland. As far as the subsequent process for finding a site is concerned, the Finnish Nuclear Energy Act requires the involvement of the affected municipalities, as well as regional and supraregional administrations and organisations. Once their various comments have been received, a public hearing is to be organised. The conclusive decision on the disposal site taken by the Council of State will have to be ratified by Parliament. The final construction licence and the operating permit will then be granted by the Council of State and presented in Parliament.

The crucial public actors in the field of final disposal are the Ministry of Economic Affairs and Employment – which conducts relevant research and legislative work, acts as the licensing authority for the disposal facility and leads the supervision of the fund that administers the necessary financial resources –, and the Radiation and Nuclear Safety Authority – which is technically independent, equipped with a right of veto, and acts equally as a specialist supervisory authority and as a scientific authority. The Radiation and Nuclear Safety Authority's task is, in particular, to specify safety requirements concerning the population's possible exposure to radiation.

The private company Posiva Oy was established to take charge of the operative implementation of a central disposal facility for spent fuel. The nuclear power plant operators together hold 100 per cent of the shares in Posiva Oy, which currently has approximately 100 employees.

On the basis of a government decision, Posiva Oy investigated the first potential sites for a disposal facility from 1986 to 1992. The studies looked at the geological properties of the host rock at the potential sites and their environmental factors. Of these potential sites, four were explored in detail in the years from 1993 to 2000, both from above ground and via various boreholes, including the two nuclear power plant sites Loviisa and Olkiluoto, at which the existing interim storage facilities are also located.

After all four sites had proven to be fundamentally suitable, Posiva Oy selected Olkiluoto in order to minimise the transports that would be required.[729] There are two nuclear power plants at this location, and a third is currently under construction. Furthermore, a disposal facility for low and intermediate-level radioactive waste staffed with approximately 300 personnel is already in operation there. According to information from Posiva Oy, only about 40 litres of water penetrate into the existing disposal facility a minute, which is equivalent to 2.4 cubic metres an hour or 58 cubic metres a day and is therefore indicative of a relatively impermeable formation for crystalline rock.

The decision in favour of Olkiluoto was supported by a large majority on the local municipal council; a survey among the local population also found about 60 per cent approval. The government approved the choice of the site in December 2000. Parliament ratified this government decision almost unanimously in May 2001.

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[729] Cf. http://www.grs.de/sites/default/files/pdf/grs-247_anhg05_endlagerstandorte.pdf, last accessed: 7 March 2016.

The application to build a disposal facility at Olkiluoto was submitted at the end of 2012 and has now been approved. The operating company expects the planning phase to last a further two years before the construction work can begin. In the mean time, it will remain possible for the plans to be revised at any time; hitherto, however, the basic assumptions have proved to be accurate. In November 2015, the Finnish Government approved the construction of a disposal facility at Olkiluoto and granted Posiva a licence tied to this approval. The construction work is to commence in 2023; prior to this, however, Posiva will have to review the disposal facility's environmental impacts once more.

4.2.4.2 Disposal concept

Like Sweden, Finland too intends to emplace copper canisters surrounded by a bentonite barrier in crystalline rock. The current planning assumes 3,250 copper canisters with a total of about 6,000 tonnes of spent nuclear fuel. As a matter of principle, retrievability will only be guaranteed during the emplacement phase, and would require the removal of the bentonite and the development of suitable retrieval equipment. Following the conclusion of the emplacement phase, which is expected to take approximately 100 years, the disposal facility is then to be sealed in such a way that unauthorised retrieval is made as unfeasible as possible. Authorised retrieval of emplaced waste once the disposal facility has been sealed is no longer provided for under the current concept either.[730]

The waste is not actually to be emplaced until after the end of its decay time, which is given by the operators at 20 to 40 years. Work would therefore continue to be possible in the galleries during the emplacement phase. Once the facility has been sealed as planned in 2120, the operators do not anticipate any detectable elevated levels of background radiation at the surface to be caused by the waste that has been emplaced.

Decisions will only be taken about the ultimate suitability of individual boreholes for the embedding of the copper canisters in the course of the emplacement work; in particular, the formation of fissures, water ingress, the distance from faults in the rock and the quality of the crystalline rock will be crucial here. It is currently still not certain what the final capacity of the disposal facility will be once unsuitable areas have had to be diverted around; if the rock is of good quality, it is envisaged the individual boreholes will be about ten metres apart.

The requirements concerning the construction licence for the disposal facility are equivalent to those for the construction of a nuclear power plant and also include an examination of the safety of the technical emplacement solution. In so far as this is the case, the applicant is subject to a duty to demonstrate the facility's safety for a period of at least 100,000 to one million years.

Given the nuclear power plants that are licensed at present in Finland, the costs for the disposal of the waste are estimated at six billion euros; of this sum, about 3.5 billion euros will be spent on the disposal facility for high-level radioactive waste. The remaining 2.5 billion euros will be split between the disposal of low and intermediate-level radioactive waste, and the dismantling of the nuclear power plants. These costs form the basis for the calculation of the fees that are collected as a surcharge on power supplied from nuclear plants and bring in 67

[730] Cf. Fischer-Appelt, Klaus, 6th meeting of the Commission, minutes, p. 28.

million euros a year for the Finnish Nuclear Waste Management Fund. The legislation demands that there must always be enough money available in the Fund at the end of the year to cover the total costs from this point onward. At present, approximately two billion euros are held in the Fund. The operating company's operational expenditure is directly financed by its shareholders and not from the Fund.

4.2.4.3 Community participation

The dominant aspect of Finnish energy policy is the aspiration to independence from energy supplied by Russia. The overwhelmingly held opinion there is that this can best be guaranteed by the country's own nuclear power plants. The particularly export-relevant Finnish paper, metal and chemicals industries consume a great deal of energy, so that *per capita* power consumption is about twice as high in Finland as it is in Germany. Against this background, the prevailing fundamental consensus in Finland is that nuclear power is essential to the country's energy supply and makes it more independent of energy imports. Nuclear power is believed to create jobs and, apart from this, contribute to the attainment of emissions targets. This is also the basis on which the question of the permanently safe disposal of high-level radioactive waste is discussed.
The participation of third parties (churches, trade unions, non-governmental organisations, civil society) in the licensing procedure for a disposal facility will mainly be guaranteed by holding hearings; further to this, there will of course be comprehensive options for legal redress before the Finnish courts, although it will only be possible for legal action to be taken against a concrete disposal facility licence.
Objections from residents who live near the disposal site are, however, hardly to be anticipated at Olkiluoto – despite or maybe especially because of the municipalities' right of veto;[731] 90 per cent of the 900-hectare peninsula on which the disposal facility will take up about two square kilometres is owned by the operating company. Furthermore, the public interest in the disposal of radioactive waste has also declined generally since the government took this fundamental decision. However, it could revive when the construction licence for the disposal facility is presented in Parliament. Against this background, the crucial actors in the administration are pursuing a strategy of not always having to get involved in every discussion, but making sure they can always be consulted when this is necessary. Specifically, the Radiation and Nuclear Safety Authority is not taking part in the political process, and is instead focussed on gaining and keeping public trust with transparency and reliable information.

4.2.5 Other countries

Apart from Switzerland, Sweden and Finland, experience from France, the UK, Canada and the USA was also brought together, and discussed during the Commission's hearings.

[731] Cf. Schreurs, Miranda, 6th meeting of the Commission, minutes, pp. 44f.

4.2.5.1 France

58 nuclear power plants are currently in operation in France, between them supplying 73 per cent of the country's energy demand; twelve reactors have been permanently shut down, and one is under construction.[732] Back in the 1970s and 1980s, several attempts were made by the French government to investigate potentially suitable sites for a disposal facility for high-level radioactive waste in claystone, schist, rock salt and crystalline rock. At the moment, France is concentrating on argilliferous rocks as potential host rocks for a deep geological repository.

In 1990, the government halted the search for a disposal site and mandated a parliamentary commission chaired by Christian Bataille, a member of the National Assembly, to draw up a proposal for the further action to be taken. The outcome was legislation that was unanimously adopted in December 1991. This act delayed the decision about the future disposal concept until 2006 and defined a research programme that would be focussed on the new concept.

Following the adoption of the legislation, municipalities were sought that would declare their agreement in principle to the construction of an underground laboratory. In all, 30 municipalities announced they were willing to host such a laboratory. In December 1998, the government licensed the construction of an underground laboratory in a 160-million-year-old clay formation near Bure, on the border between the départements of Meuse and Haute-Marne.

The Planning Act Concerning the Sustainable Management of Radioactive Materials and Waste[733] was then adopted in June 2006. This legislation governs the further research that is being done at Bure as part of the search for a site and the work on the disposal concept. Since it is to be ensured that the disposal site displays geological parameters that can be compared with those at Bure, a 'zone of interest for detailed survey' measuring 250 square kilometres was initially designated in the Bure region.

In 2012, the French Government announced that a deep geological repository for high-level and long-lived intermediate-level radioactive waste was to be created in a zone to the north of the underground laboratory at Bure that still remained to be explored in detail. This 30-square-kilometre zone is located within the designated, 250-square-kilometre 'zone of interest for detailed survey' in the north east of France, on the border between the départements of Meuse and Haute Marne, about 120 kilometres away from the German border, in the geological structure of the Paris Basin.[734] The planned disposal facility is to be constructed in the middle of an approximately 140-metre-thick, Callovo-Oxfordian claystone formation, at a depth of about 500 metres.[735] The concept provides for separate areas for intermediate and high-level radioactive waste, which will both be transported into the underground facility via a ramp. In addition to this, shafts are planned for personnel access and ventilation systems. Retrieveability will have to

[732] Cf. http://www.iaea.org/PRIS/CountryStatistics/CountryDetails.aspx?current=FR, last accessed: 7 March 2016.

[733] Cf. http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000000240700&dateTexte=&categorieLien=id, last accessed: 7 March 2016.

[734] Cf. http://cigeo.org/en/site-of-the-facilities.

[735] Cf. Küppers, Christian, Alt, Stefan (2013): 'Wissenschaftliche Beratung und Bewertung grenzüberschreitender Aspekte des französischen Endlagervorhabens „Cigéo" in den Nachbarländern Rheinland-Pfalz, Saarland und Großherzogtum Luxemburg', p. 5.

be guaranteed until the disposal facility is permanently sealed, but for at least 100 years.[736] The details are to be decided on by legislation in 2016.

The concept exclusively provides for the emplacement of waste from reprocessed fuel in the area reserved for high-level radioactive waste. The direct storage of spent fuel has not been envisaged since 2007. Vitrified reprocessing waste will be poured into primary packages made of stainless steel, which will be welded watertight with a lid. After this, they will be packed in disposal packages made of non-alloy steel, which will be intended to protect against contact with water and may also achieve greater heat dissipation. The disposal packages are to protect the waste for a period of approximately 1,000 years, during which the activity from short and medium-lived radionuclides will be dominant. They will be 1.60 metres long, have a diameter of 0.6 metres and walls 55 millimetres thick; to allow for the option of retrievability, they will be equipped with ceramic runners. The disposal packages are to be inserted into horizontal cells about 40 metres long with a diameter of 0.7 metres. The emplacement section at the rear of each cell will be lined completely with an impermeable sleeve. After the end of the operating phase, the head of the cell at the front will be sealed with metallic, bentonite and concrete plugs. The distance between the disposal cells will be between 8.5 and 13.5 metres, depending on the heat output from the packages. The licensing procedure for the disposal facility is to be concluded by 2018; the emplacement of the waste could then be begun in 2025. Initially, just five per cent of the high-level radioactive waste is to be emplaced and observed for approximately 50 years before further waste is emplaced.

When the Growth and Economic Activity Act (*Loi Macron*) was passed on 9 July 2015, an article was also adopted at the same time concerning the disposal of high-level radioactive waste. This article specified that the safety of the disposal facility was first to be examined during a pilot phase. Furthermore, the waste was to be emplaced in such a way that retrieval would remain possible for at least 100 years. This was to ensure future generations had the option of reversing the emplacement of the waste in case an alternative solution for the management of radioactive waste was subsequently found. The development of the disposal facility was to be monitored for 100 years. The final sealing of the disposal facility was planned once 100 years had passed.

On 6 August 2015, the French Constitutional Council found fault with this article on the grounds that it had not been adopted in conformity with the constitution. In response, the French Ministry of the Economy and Finance announced it would be presenting a new bill in the first six months of 2016.

Even though a specific site is not mentioned in the Act, it is to be assumed that a licensing application for the Cigéo Project[737] in the Bure region will be submitted because this is the only site in France for the disposal of high-level radioactive waste that has been investigated underground. Very recently, however, following a fatal accident at the Bure underground research laboratory,[738] doubts about the 'stability of the whole rock formation in this region'[739] have been expressed again.

[736] Cf. Fischer-Appelt, Klaus, 6th meeting of the Commission, minutes, pp. 28f.
[737] Cf. 'Zusammenfassung der mündlichen Anhörung vom 2. Oktober 2015', K-Drs. 136, p. 2
[738] Cf. Balmer, Rudolf, 'Frankreich hat keinen Plan B', Die Tageszeitung, 28 January 2016, p. 8.
[739] 'Kritik am geplanten Atommüllendlager Bure', Saarbrücker Zeitung, 28 January 2016, p. B2.

4.2.5.2 UK

At present, the UK is operating 15 nuclear reactors for energy generation; 30 further reactors have been permanently shut down.[740] Nuclear waste has been accumulating in the UK ever since the 1940s; to the present day, however, just one disposal facility for short-lived, low-level radioactive waste is available at Drigg, Cumbria. Currently, there are only decentralised storage facilities at more than 30 sites for the remainder of what will in total be about 4.72 million cubic metres of existing and arising radioactive waste.[741]

In the 1980s, the Nuclear Industry Radioactive Waste Executive (Nirex), a consortium of producers of radioactive waste established in 1982 by the British Government, proposed various sites for a disposal facility for high-level radioactive waste, but these locations were not pursued any further in view of resistance from the population. Up to 1997, the search for a disposal site continued to be dominated by expert bodies whose members came from politics, business and the authorities, and which attempted to specify potential sites without convincing public participation. In 1997, the last of these attempts failed when Nirex's application for an underground laboratory in the Lake District (Cumbria) was turned down on account of public opposition.

In 1999, the British Government responded by announcing a reorientation of the search for a disposal site, which was no longer to be organised purely as a scientifically founded process from this point on, but was above all to be conducted openly and transparently.[742] Accordingly, the development of an overall strategy for the disposal of radioactive waste was only to move ahead with comprehensive stakeholder engagement, while the decision on the site for a long-term storage facility was to be prepared in partnership by the government and the communities that came into question.

In 2001, the British Government launched a programme of action with its Managing Radioactive Waste Safely (MRWS) consultation document. Under this programme, an independent Committee on Radioactive Waste Management (CoRWM) was founded in 2003, since when it has acted as an independent advisory body to the British Government on all questions relating to repositories. In 2006, the Committee delivered official recommendations that proposed the disposal of higher activity radioactive waste in deep geological strata as the preferred waste management concept for disposal in the UK, coupled with the safe interim storage of waste until such time as they were emplaced. These recommendations were accepted by the British Government in October 2006. It was on this basis that, in 2008, as part of the Managing Radioactive Waste Safely programme, the Government published a white paper on its Framework for Implementing Geological Disposal, which puts in place the parameters for the management of radioactive waste to be implemented in a deep geological

[740] Cf. http://www.iaea.org/PRIS/CountryStatistics/CountryDetails.aspx?current=GB, last accessed: 7 March 2016.

[741] Cf. http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/479225/Overview_of_Higher_Activity _Waste_November_2015.pdf, last accessed: 7 March 2016.

[742] Cf. http://webarchive.nationalarchives.gov.uk/20150817115932/http://www.nda.gov.uk/publication/transcript-history-of-work-in-the-uk-towards-a-policy-for-dealing-with-radioactive-waste/, last accessed: 7 March 2016.

repository, and provides for a staged process that is founded on voluntarism and partnership.

Based on this new approach to the selection of a disposal site, it was hoped that a site would be selected and explored by 2040.[743] The first phase of this selection procedure was launched in 2008 with a call for voluntary expressions of interest in the selection process from local authorities. However, the devolved region of Wales distanced itself from this initiative and urged Welsh local authorities not to take part in the process; at the same time, the devolved Scottish Government ruled out the acceptance of a deep geological repository on its territory by the Scottish Parliament.[744]

Up until 2009, just two borough councils, both in West Cumbria, and one county council (Cumbria) had agreed to join the process. As a result of this, the concept of local authorities' voluntary participation in the selection of the disposal site was questioned once more by British public opinion.[745] By 2013, Cumbria County Council had also withdrawn from the process.[746] Since the county council's approval would have been necessary for the borough councils located in the county of Cumbria, Allerdale and Copeland, to be able to carry on taking part in the search for a disposal site, the site selection process was consequently suspended in 2013 without having reached a result.[747] After this, the Department of Energy and Climate Change (DECC), which is responsible for making and implementing nuclear policy in the UK, announced a revision and subsequent resumption of the disposal site selection procedure in 2014.[748]

This revised strategy was published as a white paper by the Department of Energy and Climate Change in July 2014.[749] Drawing on the experience of the previous, failed attempt to select a site, the new disposal site selection procedure no longer foresees interested local authorities volunteering as the first step, but a national geological 'screening' of Wales, England and Northern Ireland in order to select areas with favourable geological structures. The screening is to begin in 2016 and will be conducted by the Nuclear Decommissioning Authority in close collaboration with an independent review panel. No particular host rock is prescribed in the white paper; the search will cover salt, claystone and crystalline formations. Potential sites that are found by this first screening are to be announced in 2016. The second step will be the participation of local authorities on the basis of the favourable regions identified by the screening. As previously, this is to be founded on a voluntarist approach, and it will also begin in 2016.

As a precaution, however, in the course of the new selection process, a legislative amendment was also passed by the UK Parliament at the beginning of 2015 that defines a geological disposal facility and the work involved in its development as a 'nationally significant infrastructure project'. This deprived local and county councils of their right of veto, and transferred the ultimate power to take

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743 Cf. http://www.bgs.ac.uk/downloads/start.cfm?id=1822.

744 Cf. http://news.bbc.co.uk/2/hi/science/nature/7450479.stm, last accessed: 7 March 2016.

745 Cf. http://news.bbc.co.uk/2/hi/europe/8155601.stm.

746 Cf. Kallenbach-Herbert, Beate, 6th meeting of the Commission, minutes, pp. 35f.

747 Cf. http://www.allerdale.gov.uk/environment-and-waste/nuclear-geological-disposal-fa/mrws-background.aspx, last accessed: 7 March 2016.

748 Cf. http://www.bbc.com/news/uk-england-cumbria-25041302, last accessed: 7 March 2016.

749 Cf. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/332890/GDF_White_Paper_FINAL.pdf, last accessed: 7 March 2016.

decisions about the siting and construction of a geological disposal facility to central government.[750]

4.2.5.3 Canada

Canada has a more than 60-year history of using nuclear energy and is the second-largest producer of uranium in the world. Supplying approximately 15 per cent of its total energy consumption, nuclear energy has an important place in the country's energy supply. At present, 19 nuclear power plants are in operation in the provinces of Ontario, Quebec and New Brunswick, while six reactors have been permanently shut down.[751] Canada's approach to the storage of high-level radioactive waste involves final disposal in deep geological formations with the option of retrieveability. Crystalline and sedimentary rocks are being studied as host rocks.

In 2002, the Nuclear Fuel Waste Act was passed in Canada.[752] In 2005, it formed the foundation for the elaboration of an adaptive, stepped process for the search for a disposal site that was approved by the Canadian Government in June 2007. This nine-step process was to be preceded by the publication of a concept for the selection of a site.

It was in this context that Canada's energy utilities established the Nuclear Waste Management Organisation (NWMO),[753] which is overseen by an Advisory Council. The NWMO is the organisation responsible for the disposal of low, intermediate and high-level radioactive waste. It is a not-for-profit organisation financed through trust funds in which the energy utilities have been depositing money since 2002. The state regulatory authority is the Canadian Nuclear Safety Commission (CNSC). The CNSC acts pursuant to the provisions and guidelines set out in the Nuclear Safety and Control Act (NSCA), which lays down the parameters for the disposal of waste from the perspectives of health, safety and the environment.[754]

Following a national dialogue process held in the years from 2002 to 2005, Adaptive Phased Management (APM) was launched in 2007 at the proposal of the Nuclear Waste Management Organisation and the Canadian Government. APM represents a commitment to the safe long-term storage of high-level radioactive waste in deep geological formations. It involves a nine-step plan that defines various activities, divides them into individual phases and takes account of the advances made as more is learned during each phase.[755] Retrieval is to be possible for a particular period of time so that the waste can be reached again if new technologies come on stream. There is exclusive reliance on the voluntary participation of communities and an open, fair selection procedure. With each further step, interested communities will be involved more deeply in the selection

[750] Cf. http://www.theguardian.com/environment/2015/apr/05/law-changed-so-nuclear-waste-dumps-can-be-forced-on-local-communities, last accessed: 7 March 2016.
[751] Cf. http://www.iaea.org/PRIS/CountryStatistics/CountryDetails.aspx?current=CA, last accessed: 7 March 2016.
[752] Cf. http://www.nwmo.ca/~/media/Site/Files/PDFs/2015/11/04/17/35/1962_backgrounder_regulatoryoversightapm2012.ashx, last accessed: 7 March 2016.
[753] See http://www.nwmo.ca/.
[754] See http://nuclearsafety.gc.ca/.
[755] Cf. http://www.nwmo.ca/~/media/Site/Files/PDFs/2015/11/04/17/34/1543_overview_brochure_en.ashx, last accessed: 7 March 2016.

procedure together with the Nuclear Waste Management Organisation and will have the option of withdrawing from it up to Step 5. The initiative to take part in the further steps must come from the communities themselves. In particular, the presentation of the plans for the disposal of waste to regional groups and indigenous peoples is a high priority under this concept.
The other essential components of APM include the concept for the underground facility and the storage of the waste using a multibarrier system[756] made up of containers, bentonite clay as a geotechnical barrier and the host rock. Boreholes, tunnels and drifts are envisaged as storage options. Exclusively Canadian waste is to be emplaced.
Two different types of container for high-level radioactive substances have been developed. Both types consist of an inner container made of steel and an outer coating made of copper. The containers are intended for deployment in both crystalline and sedimentary rocks. Materials based on bentonite are to be deployed in various combinations as buffers.
Interested communities had until March 2011 to inform themselves about the search for a disposal site and express their interest in possibly hosting a site. These expressions of interest were followed by initial screenings of the proposed regions on the basis of uniform criteria. If all the criteria are met, the community receives a positive response about its suitability as a potential disposal site. The community is then once again able decide whether it wishes to continue to take part in the site selection process. If this is the case, a detailed study of the site will next be conducted that looks at technical and socio-economic factors. This process is to take between seven and ten years.
In November 2013, a preliminary assessment of the 22 interested potential host communities was carried out. Nine of them had withdrawn by the end of 2014; the remainder are undergoing further examination.
To this end, feasibility studies were initially conducted in order to ascertain whether each community met the preconditions for a subsequent site. These preconditions included, in particular, the area’s geoscientific suitability, which represents the most important precondition for the selection of a disposal site. All available data sources, such as geological maps, geophysical studies, technical reports and geoscientific databases, were used to assess the potential host communities when this was being done. In 2014, in-depth investigations then began in the communities of Creighton (Saskatchewan), Hornepayne (Ontario), Ignace (Ontario) and Schreiber (Ontario). These investigations included, among other things, geological field studies and high-resolution geophysical data surveys.
The commissioning of a disposal facility is foreseen for 2035. Until that point, spent fuel will be held at various interim storage facilities. There are nine interim storage facilities across Canada in all, six of them at nuclear power plant sites and three at laboratories.

[756] Cf. https://www.nwmo.ca/~/media/Site/Files/PDFs/2015/11/04/17/35/1961_backgrounder_multiplebarriersystem2012.ashx, last accessed: 7 March 2016.

4.2.5.4 USA

The USA meets about 20 per cent of its national energy demand with nuclear energy. At present, there are 99 reactors in operation, five reactors have been under construction since 2013, and 33 reactors have been permanently shut down.[757] Since 1982, there has been a statutory basis in the USA for the search to find a suitable site for a disposal facility with a capacity of 70,000 tonnes of heat-generating waste.
In the USA, the state's function of managing radioactive waste is regulated by law in the Nuclear Waste Policy Act (NWPA), which was adopted in 1982. The provisions set out in the NWPA concerning the selection of a disposal site relate both to scientific and safety requirements for the selection of the site, and the institutional framework within which it will be selected. The authority responsible for the disposal of high-level radioactive waste is the Department of Energy (DOE). The supervisory and licensing authority is the Nuclear Regulatory Commission (NRC).[758]
In 1983, the US Department of Energy selected nine sites in six states for preliminary studies. In 1985, following the conclusion of the preliminary studies, three sites were selected for more extensive scientific investigations: Hanford in Washington, Deaf Smith County in Texas and Yucca Mountain in Nevada. Without waiting for the results of these comparative investigations, Congress amended the Nuclear Waste Policy Act in 1987, mandating the Government to concentrate on one potential site, Yucca Mountain.[759] The ridge foreseen for the disposal facility consists of tertiary volcanic tuffs and is located on a site previously used by the military close to a former nuclear weapons testing range. The host rock is a consolidated, volcanic, welded tuff. The volume of waste that could be emplaced in the installation was set at 140,000 tonnes. The disposal facility was to be excavated approximately 200 to 425 metres below the surface, but still above the groundwater table.
From 1994 to 1997, an underground laboratory was constructed at Yucca Mountain to carry out detailed geological and hydrogeological studies. In 1998, the US Government was presented with a study about the feasibility of a disposal facility at the Yucca Mountain site.
In July 2002, President George W. Bush confirmed the suitability of Yucca Mountain and announced a disposal facility would be constructed at this site. The House of Representatives and the Senate approved this intention, thus overruling the objections raised by the State of Nevada.
In 2002, the licensing procedure for the construction of the disposal facility was commenced. In 2004, it was decided by the courts that the compliance period was to be set at one million rather than 10,000 years. In June 2008, the US Department of Energy then officially applied for authorisation to construct the disposal facility which, according to the plans made at the time, was to open at the end of 2011 and in which the emplacement of waste was to begin in 2017.

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[757] Cf. http://www.iaea.org/PRIS/CountryStatistics/CountryDetails.aspx?current=US, last accessed: 7 March 2016.
[758] Cf. http://www.bfs.de/DE/themen/ne/endlager/standortauswahl/international/endlagerung-international.html, last accessed: 7 March 2016.
[759] Cf. http://www.grs.de/sites/default/files/pdf/grs-247_anhg05_endlagerstandorte.pdf, last accessed: 7 March 2016.

As a consequence of doubts in the new administration under Barack Obama, in particular concerning the suitability of consolidated, welded tuff as a geological barrier, the budget for Yucca Mountain was cut significantly in March 2009. The Yucca Mountain site still continued to be studied until 2011, the year in which the programme was finally closed down by the US Government. A draft technical safety evaluation report begun in 2008 was completed at the order of a federal court and presented in January 2015. In it, the Nuclear Regulatory Commission (NRC) came to the conclusion that, from a technical point of view, a disposal facility at Yucca Mountain based on the designs that had been drawn up would be suitable for the disposal of waste.

In parallel to this, the USA has been preparing a new political strategy for the management of radioactive waste since 2009. For this purpose, it set up a 'blue ribbon commission' made up of high-ranking politicians and experts, which drafted recommendations concerning a new legal framework for the management of high-level radioactive waste with the participation of the public.

In its final report,[760] which was presented in January 2012, the Blue Ribbon Commission recommends a new disposal site selection procedure be conducted with public participation, a disposal site only specified with the consent of the affected states and communities, the responsibility for seeking a disposal site given to a new, independent authority and consolidated storage facilities constructed. In order to secure its finances, a separate fund is to be established. In November 2015, the Nuclear Waste Technical Review Board (NWTRB) submitted a report to Congress and the Department of Energy on the design of the site selection procedure for a deep geological repository for high-level radioactive waste.[761]

A disposal facility for non-heat-generating, long-lived radioactive transuranic waste from research facilities and, in particular, the production of nuclear weapons has already been in operation in the USA since 1999: the Waste Isolation Pilot Plant (WIPP), which is located at a depth of 650 metres in a salt rock formation near Carlsbad, New Mexico.[762] The first disposal facility in the world for high-level radioactive waste, it has a floor area of 0.5 square kilometres and consists of eight 'panels', each of which has seven rooms. WIPP exclusively accepts non-heat-generating waste from military uses, usually in facilities where nuclear weapons are produced. High-level radioactive waste is not permitted at WIPP by law. According to some reports, the decision to emplace exclusively non-heat-generating, transuranic waste from military uses at WIPP taken under the then US administration was the result of political negotiations with the states and the parties concerned. The parties would only agree to the site under this condition. By contrast, the German weekly newspaper *Die Zeit* reported in 1988 that scientists at the University of New Mexico had described crystallisation water being released in 'unexpectedly large quantities' during 'brine-migration tests'[763] in rock salt at WIPP. The plant's licensed capacity is approximately 175,000 cubic metres; emplacement operations are planned until 2034. Up to February 2014, about 90,800 cubic metres of radioactive waste had been

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[760] Cf. http://energy.gov/sites/prod/files/2013/04/f0/brc_finalreport_jan2012.pdf, last accessed: 7 March 2016.

[761] Cf. http://www.nwtrb.gov/reports/siting_report_analysis.pdf, last accessed: 4 March 2016.

[762] Cf. http://www.grs.de/sites/default/files/pdf/grs-247_anhg05_endlagerstandorte.pdf, last accessed: 7 March 2016.

[763] These tests simulate and study processes caused by the input of heat due to radioactive decay. The input of heat is accompanied by, among other things, the migration of solutions in salt rock.

emplaced at a depth of 650 metres. In February 2014, two unconnected accidents occurred in short succession:[764] a truck that was being used underground caught fire and radioactivity was released from an emplaced barrel, resulting in the contamination of underground installations. These events revealed serious deficiencies in the geological disposal facility's organisation. On the one hand, there were serious deficiencies in the safety management underground at both the conceptual and practical levels; this is why it was possible for the truck to catch fire. On the other hand, there were serious deficiencies in the conditioning and control of the waste packages; these deficiencies led to the release of radioactivity from the barrel. In addition to this, there are further conceptual deficiencies, among other things when it comes to the structure of the ventilation system for the geological disposal facility. Further emplacement activities in the installation have been suspended for the time being.

4.2.6 Assessment of experience

In view of their different geological and societal baseline conditions, the experience gained in various countries during the search for suitable sites for the permanently safe storage of radioactive waste cannot be applied one to one to Germany.

While the issue of the suitability of different host rocks does not even arise in some states on account of their overall geological situation (and, as for example in Sweden and Finland, questions about technical barrier concepts therefore tend to be prominent), this issue is devoted a great deal of attention in Germany. Against this background, technical/scientific information from various disposal projects has – where relevant – been incorporated directly into the appropriate sections of the present report.

The individual states have found just as great a diversity of answers to the question of whether the disposal of radioactive waste is a matter for the public sector or the private sector; whereas some states see the responsibility for seeking a disposal site, including public participation, and then constructing and operating that disposal facility as lying solely with the waste producers – and confine themselves to regulation and licensing – the search for a disposal site and disposal are perceived primarily as public functions in other countries. However, what is common to all the approaches is that – no matter how diverse the practical arrangements may be – they are financed in accordance with the polluter-pays principle or are at least to be financed in this way in future.

A generally heterogeneous picture is also apparent as far as the societal baseline conditions are concerned. This heterogeneity is determined by influential factors such as each state's – actual or felt – dependence on nuclear energy, the anchoring of elements of direct democracy in the constitutional order and the population's understanding of its identity, political and regulatory systems, national traditions, in particular with regard to the application of participative processes, or simply the density of settlement in certain places and individual regions' economic prospects for the future.

In particular, although Switzerland has taken over many participative and procedural elements from the German Committee on a Site Selection Procedure

[764] Cf. http://www.wipp.energy.gov/wipprecovery/accident_desc.html, last accessed: 6 January 2016.

for Repository Sites, and has already made a great deal of progress in its disposal site selection procedure, the Commission has come to the conclusion that – despite the valuable guidance and experience to be found there – the Swiss search procedure is not in turn transferrable to German conditions. Under the community participation that is taking place there, for instance, the Swiss regional conferences are, at least at present, merely looking at the location and layout of the surface installations, but not the safety of the underground storage facility. The selection criteria will only be quantified in the course of the search procedure, and no underground exploration is provided for before the final decision on a site is taken.

These contrasts are rooted in a significantly different understanding of the state in Switzerland. It is far more natural for its citizens to feel they have a stake in public decisions and will be called upon to contribute to decision-making. The system of direct democracy, in which important questions may be presented to the electorate once again for it to take the ultimate decision, strengthens citizens' willingness to give the actors involved the benefit of the doubt.

Despite this, it is possible in retrospect to recognise certain elements of common ground in the individual countries' experiences that permit at least some fundamental conclusions to be drawn. Lessons for the further action to be taken in Germany can be derived from their errors and setbacks.

To date, for instance, there is nowhere in the world where the search for a disposal site has been successful if it has been based solely on technical considerations and followed the 'decide-announce-defend' principle, i.e. been conducted more or less in accordance with the rules of a classic administrative procedure. Rather, the international experience makes it clear that, when it comes to the search for a disposal site, in which a single region has to assume what is actually a responsibility for the whole of society, even a procedure that is in conformity with the legislation, follows rule-of-law principles and is democratically legitimated is not always sufficient for the final outcome to be perceived as fair and therefore acceptable.

Even in states where the concrete site is ultimately specified by a decision that selects from among several interested local or regional authorities – and it has therefore been possible to achieve a high level of acceptance in the local population –, this development has not usually been achievable at the first attempt, but has demanded the transition from a procedure initially dominated by technical/administrative considerations to a transparent, participative procedure that is consequently felt to be fair.

At the same time, however, it is to be noted that such transitions have also been quite overwhelmingly associated with appropriately adapted fundamental concepts for the search for a site; instead of finding the best single site from safety points of view, the site selection procedures that have been successful up until now have concentrated on selecting the site with the highest levels of acceptance among the affected population out of several that are fundamentally suitable.

This is remarkable given that, in the German discussion, the selection of the best site, in particular from safety points of view, in a comparative procedure is usually viewed as a particularly important precondition for the later acceptance of this site. At the same time, the question of appropriate economic compensation for the eventually selected siting region is discussed far more critically in Germany than in many other states.

Both tendencies must be rooted in the particular history of the search for a disposal site in Germany and the many years of conflicts over the phasing-out of nuclear energy, but make it strikingly clear once again that, in isolation, the success of a particular selection procedure in another state does not by any means guarantee that it can be transferred to German conditions.
The international experience of granting veto rights to affected local and regional authorities in disposal site selection procedures has been highly diverse; although they have sometimes helped to clearly promote acceptance in selected communities, in other states they have also led to the forced abandonment of disposal site selection procedures. Against this background, especially in systems where there are several levels of local government, it is to be examined closely what level is to be granted absolute rights, and the extent to which these rights are required and suitable as means of ensuring transparency.
Practically all the states that are actively working on a disposal facility of their own for radioactive waste are now engaging with questions of retrieveability as well – even if this is manifested in different ways. In particular, the timeframe for assured retrieveability taken into consideration varies in each case. While retrieveability is sometimes only to be guaranteed until the disposal facility has been sealed, thought has also been given to markedly longer periods of time – depending of whether the discussion has placed greater emphasis on relieving later generations of the burden of monitoring and caring for waste or on ensuring future generations have the freedom to take their own decisions.
With regard to the conditions under which a population as a whole and, in particular, the selected siting region will feel a selection procedure is ultimately fair, the international experience that is available therefore does not permit any conclusions to be applied directly to Germany. However, it is to be noted that transparency and opportunities for active involvement have always been necessary, if not always sufficient, elements of successful selection procedures.

5 WASTE MANAGEMENT OPTIONS AND THEIR ASSESSMENT

5.1 Aims and approach

The new beginning in the efforts to resolve the question of the safe, equitable, peaceful management of (in particular, high-level) radioactive waste that is associated with the Site Selection Act consists not only in a fresh approach to the selection of a disposal site. Rather, it is also a matter of thinking in fundamentally new ways about how this waste is handled and transported. This also means, in particular, analysing possible options other than the transfer of the waste to an underground facility in a deep geological formation, the solution that has been favoured in Germany to date.
The aim of the present section is to set out the options that have played, or still are playing, a role in the international debate about the handling of radioactive waste. Initially, it will look at the full range of such options that has been discussed. Then, on the basis of the current level of knowledge and readily understandable criteria, it will move on to identify the option or options that could potentially be of significance as alternatives alongside the Commission’s

preferred solution as the process continues. The process by which the ultimately recommended option has been selected is to be presented transparently in this way.

Having been prepared by Working Group 3, this selection process was conducted by the Commission in several fully and transparently documented steps. During its deliberations, external expertise was drawn upon in the following forms:

- Federal Institute for Geosciences and Natural Resources (BGR): report on 'Category C' waste management pathways: levels of knowledge and crucial aspects of the grounds for their categorisation (K-Drs. AG3-75)
- Hearing held by Working Group 3 on 'Deep Boreholes', 8 June 2015 (K-Drs. AG3-24, K-Drs. AG3-25 and K-Drs. AG3-26)
- Two expert opinions on transmutation (K-MAT 45 and K-MAT 48)
- Nuclear Waste Management Commission (ESK) discussion paper on partitioning and transmutation (K-MAT 35)
- Expert opinion on long-term interim storage (K-MAT 44)
- Brief comment by the German Association for Repository Research (DAEF) on deep borehole disposal (K-MAT 27)
- US Nuclear Waste Technical Review Board (US-NWTRB) report on deep borehole emplacement (K-MAT 50)
- Expert opinion on deep boreholes (K-MAT 52)

5.2 Overview of waste management options and their categorisation

Radioactive waste has to be managed in such a way that no dangers are posed to humans and the environment over the short, medium and long term. As a consequence of some radionuclides' long half-lives, the safety of these materials is to be guaranteed for one million years. The extremely long time horizon of the challenge of keeping radioactive waste away from the inhabited surface of the Earth will dominate the search for responsible waste management options.

In the early days of nuclear energy, little attention was paid to the problem of managing high-level radioactive waste. The prevailing mood was one of optimism that a solution would be found when the time came.[765] Early contributions to the discussion about waste management options also disseminated ideas that, from a contemporary point of view, appear extremely inadequate to the challenges faced in this field. The thinking about radioactive waste was dominated by notions such as placing them in underground caverns, dissolving them so they would be diluted in the water of the oceans and confidence in technological progress, which was expected to resolve the problems by technical means. It was only with the passing of time that it became clear how great the challenges – scientific and technical, but also societal – of dealing safely, equitably and peacefully with this issue would be.

The aim of keeping radioactive waste away from the inhabited surface of the Earth also inspired ideas about disposing of them in outer space, the depths of the Earth's crust – for instance using deep boreholes that would reach depths of 3,000-5,000 metres –, the deep oceans or the Antarctic and Greenland ice sheets. Another group of options would rely on time as a factor, i.e. interim storage that would continue for several centuries in the expectation that new solutions would be found in the mean time. It is anticipated that transmutation, i.e. the conversion

[765] Cf. Radkau, Joachim, Hahn, Lothar (2013): Aufstieg und Fall der deutschen Atomwirtschaft.

of long-lived radionuclides into less long-lived nuclides, will have the potential to at least simplify the waste management problem. Solutions involving underground facilities in deep geological strata can be distinguished by the degree of reversibility that is envisaged for them, and range from the most rapid possible, practically irreversible sealing to concepts that would ensure the retrievability of the waste over lengthy periods of time and even their recoverability once the disposal facility had been sealed.

On account of their diversity, these options are associated with a great variety of parameters, preconditions, uncertainties and implications. In the present section, the various options will be assigned to the following categories depending on their prospects of contributing to the resolution of the problem:

- **Not to be pursued further**:[766] In view of current and foreseeable levels of knowledge, the Commission recommends that these options not be pursued further, stating its arguments and criteria for this opinion.
- **Conceivable, but not immediately feasible or not advantageous**:[767] Different variants of the options in this category could potentially contribute to the safe disposal of high-level radioactive waste but, in the opinion of the Commission, are not at present sufficiently technically mature or feasible for a strategy to be built on them for the handling of high-level radioactive waste. Apart from this, they do not currently offer any apparent advantages over the waste management option prioritised by the Commission.
- **Promising**:[768] These options (this family of options) seem(s) promising in the light of the current levels of scientific/technological knowledge. They are to be pursued further in a proactive fashion, elaborated in detail and recommended to the German Bundestag for implementation.

In the sections below, the Commission assigns the various options to these categories in accordance with the following parameters, exclusion criteria, estimations and assessments:

- Prospects of the successful achievement of the aim of permanently isolating radioactive waste from the inhabited surface of the Earth
- Manageability of technologies and procedures, in particular risks and catastrophic incidents
- Valid agreements under international law

This approach will take account of current and foreseeable advances in science and technology, as well as societal parameters, e.g. legal specifications, in order to develop a transparent line of argument for the option and/or options that are regarded as promising.

The terminology of the permanent storage, indefinite storage and disposal of radioactive waste is of significance when the waste management options delineated below are assessed. The uses of these terms in this context and how they relate to one another are therefore to be defined at this point:

- **Permanent storage:** 'Permanent storage', used in contrast to interim storage, may be regarded as a generic term for the safest-possible storage of radioactive waste for unlimited periods of time. In this superordinate sense, it encompasses both indefinite storage on or close to the surface of the earth and options for disposal in geological formations.

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766 Described in section B 5.3.
767 Described in section B 5.4.
768 Described in section B 5.5.

- **Indefinite storage:** As one aspect of permanent storage, this term denotes constantly controllable and controlled storage for unlimited periods under the active custody of the generation that is alive at the time, and is also described as the ‘guardianship concept’. Technically, ‘indefinite storage’ is closely related to interim storage, but explicitly does not pursue the aim of putting waste into a passive, safe long-term state after a particular period. Instead, safety is to be guaranteed by means of permanent, proactive monitoring with opportunities for intervention.
- **Disposal:** As one aspect of permanent storage, used in contrast to indefinite storage, ‘disposal’ denotes the placement of radioactive waste in geological formations with the aim that the waste will remain at the location where it has been emplaced and will be safely isolated from the biosphere there for an unlimited period. The ultimate aim is a passive state that is safe over the long term. This includes options such as disposal in an underground facility without planned opportunities for the correction of errors, disposal in an underground facility with planned opportunities for the correction of errors and deep borehole disposal.

The disposal of radioactive waste in outer space, inland ice sheets, and the different strategies for waste disposal in the oceans (which would rely on dilution) and emplacement in unconsolidated sediments or subduction zones are to be analysed individually as different types of waste management options. They cannot be subsumed under the generic term permanent storage and definitely do not constitute disposal in the sense discussed here either.

Transmutation and all waste management strategies that have the interim storage of radioactive waste as their aim are to be regarded as options for the handling of waste that would influence the parameters for its later management or disposal, but are not themselves waste management options. They are therefore not to be associated with the generic term permanent storage either.

The aspect of the capacity to correct errors has had a great deal of attention devoted to it in the current specialist discussion and consequently in the Commission’s work as well. The waste management options examined by the Commission below offer different opportunities for the correction of errors, and some do not offer any opportunities of this kind at all. In this connection, significance attaches to the generic term ‘reversability’ and, in relation to radioactive waste, its subordinate terms ‘retrievability’ and ‘recoverability’:

- **Reversability:** As a generic term, reversability denotes the planned capacity to reverse decisions as a means of correcting errors that have been identified or undesirable developments. It may already be taken into account at an early stage in planning, and has effects throughout the process: when methods or procedures are selected, when sites are selected for installations, when installations are being operated and during the post-operational phase. Of course, it presupposes adequate measures for the identification of errors.
- **Retrievability:** When a waste management option is pursued and/or an installation operated for this purpose, the generic term reversability involves a focus on the ‘retrievability’ of the waste. In a general sense, this means action to seize waste when errors are identified and return it to an interim storage facility.
- **Recoverability:** During the post-operational phase, i.e. following the conclusion of the actual waste management measure, the waste that is being managed should have reached the state sought with the waste management option (e.g. their position in the disposal facility or indefinite storage facility). When

errors occur and/or are identified during the post-operational phase, the recovery of the waste from this state is the furthest-reaching measure for the correction of errors. Here too, the aim is to return the waste to interim storage facilities.
These terms are discussed once again in section 5.5.2 as they relate specifically to the form of final disposal preferred by the Commission.

5.3 Options not to be pursued further

The Commission has gathered information on the international levels of knowledge about the waste management options that are categorised as generally unrealistic by drawing on a survey of the relevant literature compiled by the Federal Institute for Geosciences and Natural Resources (BGR).[769]
Having discussed the information that is available, the Commission has arrived at a differentiated view of the options that are described below, the tenor of which is to reject them. In view of the current and foreseeable levels of knowledge and the clear arguments that it sets out, the waste management options in question will not be pursued further by the Commission. Nor will they be recommended for future observation or active pursuit.

5.3.1 Disposal in outer space

The option of the disposal of radioactive waste in outer space was investigated particularly during the 1970s and 1980s. The lead was taken by scientists at the National Aeronautics and Space Administration (NASA) and the Boeing Aerospace Corporation in the USA. Transporting waste into outer space was mostly looked on as a complementary alternative to disposal on Earth and was to be applied primarily for smaller quantities of waste made up of separated, long-lived nuclides. The transport of large quantities of waste into outer space does not come into question already for reasons of cost.
The concepts investigated vary from sending waste to the Sun and out of the Solar System to disposal on the Moon or in a high Earth orbit. Orbital paths in the inner Solar System (around the Earth and Moon) and incineration in the Sun were assessed less favourably than, e.g., an orbital path around the Sun, disposal on the surface of the Moon or a destination completely outside the Solar System. Although incineration in the Sun would certainly destroy hazardous substances, it would be extremely expensive. Orbital paths around the Earth and the Moon would not be stable enough for long-term disposal.
If waste were to be transported into outer space, key problems relating to safety would have to be resolved. Rescue systems would have to be provided for that could be deployed if mislaunches or other malfunctions occurred when materials were being sent into outer space. Any spreading of radioactive waste in the atmosphere or on the ground as a consequence of accidents would have to be avoided. The waste could be transported in the form of a cermet, a heat-resistant material made of ceramics and sintered metal, in order to minimise the dispersal of

[769] Cf. Federal Institute for Geosciences and Natural Resources (2015): ‘Entsorgungspfade der sogenannten Kategorie C: Wissensstand und maßgebliche Aspekte zur Begründung der Einordnung’, Commission Printed Paper K-Drs./AG3-75.

radionuclides if an accident did occur. It is probably not possible to speak here of options for the 'correction of errors'.
The US National Academy of Sciences (NAS) has concluded that the option of final disposal in outer space is not safe and practical, and probably never will be. It is regarded generally as a high-risk technology. Not only that, the costs would be higher by a factor of ten than those of geological disposal. The probability of a rocket mislaunching ranges between one and ten per cent. It would also have to be taken into account that the separation of long-lived radionuclides is an expensive, time-consuming nuclear procedure with hazardous risks for the personnel deployed. On account of its unfavourable geographical location, Germany could not launch this waste into outer space from its own sovereign territory. Final disposal in outer space would require waste to be transported to a spaceport close to the Equator.
Finally, one sticking point under international law is Article IX of the Outer Space Treaty,[770] in which the signatories commit to ensure that harmful contamination of outer space, including the Moon and other celestial bodies, is avoided in research activities. This agreement entered into force on 10 October 1967 and has been legally binding for the Federal Republic of Germany since 10 February 1971.
Summary: The Commission has come to the opinion that the management of radioactive waste in outer space is associated with an unacceptably high risk of massive radionuclide releases in the biosphere. This alone is reason enough for it to reject any pursuit of this option. The unresolved technical and safety questions, the immense costs that would have to be anticipated, even if the method proved successful, and the implications under international law support and reinforce this view.

5.3.2 Disposal in the Antarctic or Greenland ice sheets

Disposal in ice and permafrost was considered by the US National Academy of Sciences (NAS) as early as 1957. The concept was developed in various studies and subsequently assessed by the US Department of Energy (DoE). Zones were proposed in the Antarctic and Greenland, which are both covered by thick ice caps. Although it is more easily accessible for ship transports and the environmental conditions are less extreme, Greenland was not looked at in greater detail because it belongs to Denmark and has settled areas. In Germany too, thought was given to waste management in the polar ice caps at the end of the 1950s, but this approach was finally rejected at the beginning of 1960 by the then Federal Ministry of Atomic Affairs.
On account of what may be anticipated to be their high transport and conditioning costs, it is primarily high-level radioactive waste that would come into consideration. They would either be placed in a borehole drilled 50-100 metres deep in the ice and then sink as the heat they generated melted the ice, allowing them to sink and 'self-bury' down to the top of the underlying rock, or would have to be held in a particular position by anchors attached on the surface. Concepts for this method have also been patented. In this respect, it was assumed

[770] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies of 10 October 1967, ratified for the Federal Republic of Germany on 10 February 1971.

that the Antarctic would be covered in ice uninterruptedly for 200 million years, even during warmer climate periods. However, doubts about the degree of certainty with which the climatic conditions necessary for safe disposal could be predicted were already being expressed in the 1970s and have also been confirmed in the mean time. Currently, the idea of storage in ice and permafrost is being called strongly into question by persistent global warming, accompanied as it is by melting ice masses, and very sensitive ecological situations in the Arctic and Antarctic. Earlier assumptions about the extent of ice fields that could exist for more than 10,000 years are not tenable in accordance with current levels of knowledge. There are still gaps in what is known, e.g., about the dynamics of glaciers and the (safety) technological preconditions for such schemes. For instance, the effect of a strong heat source in the ice or at its base can only be assessed with difficulty.

The disposal of radioactive waste in the Antarctic has been ruled out by international law to date under Article 5 of the Antarctic Treaty that entered into force on 23 June 1961 and its numerous related agreements. In addition to this, there is the fact that waste would have to be emplaced in ice outside Germany's borders, which would make transports abroad necessary.

Summary: In view of the long reference period, the Commission does not regard the conveyance of high-level radioactive waste to Arctic or Antarctic ice sheet regions as a sufficiently safe form of disposal and rejects it for this reason.

5.3.3 Disposal in the oceans

Oceans were already given consideration as possible locations for the disposal of radioactive waste in the early days of research into nuclear energy. The thinking focussed on (a) the dilution effect in the massive quantities of water, (b) the thick layers of sediment at the bottom of the oceans and (c) the placement of waste in subduction zones. These options will be briefly discussed separately below, following which an account will be given of the legal situation, which is equally relevant to all three methods.

Dilution principle (a): Radioactive waste was first dumped at sea by the USA in 1946. Under provisions adopted by the International Atomic Energy Agency (IAEA), some OECD states that were using nuclear energy were still disposing of primarily low-level radioactive waste in the oceans until the 1980s. Waste packed in containers or barrels was mostly dumped in the North Atlantic and north-eastern and/or western Pacific. The dumping zones were located far from coasts and active plate margins in depths of water of between 2,000 and 4,000 metres. The risks posed by this procedure were still categorised as relatively low for some types of waste in 1985 by a report from the OECD Nuclear Energy Agency (NEA) because it was assumed that the pollutants and their activity were rapidly diluted in the very large volumes of water and distributed across large areas, as a result of which the limits set could be complied with.

A moratorium agreed by the states that had signed the London Dumping Convention[771] ended this practice, and the dumping of low-level radioactive waste has been prohibited since 1994. The dilution principle is contradicted firstly by the fact that it is difficult to state a completely harmless concentration.

[771] London Dumping Convention, Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, LC72.

Secondly, dilution could be cancelled out by various enrichment effects in sediments or the food chain, which could then hardly be corrected because the method is practically irreversible.

Sediment strata below the seabed (b): So far, two procedures have been analysed in greater detail in expert circles as possible methods for disposal in sediment strata below the seabed. In one method, specially fabricated waste containers (penetrators) designed with a streamlined shape and weighing several tonnes would be released from on board a ship and embed themselves up to 30 metres deep in unconsolidated soft sediments under the seabed. This was tested successfully in the 1980s in abyssal areas of the Atlantic.

In another procedure (which has not been tested in practice), the waste would be disposed of in boreholes drilled several hundred metres deep in consolidated or unconsolidated sediments. These boreholes would subsequently have to be sealed with concrete. Studies carried out by the OECD Nuclear Energy Agency (NEA) have led to the publication of a series of reports on the feasibility of the emplacement of high-level radioactive waste in deep sea sediments.

This form of disposal in marine sediment strata is attractive from a technical point of view on account of the relatively low probability of major accidents and the favourable characteristics of deep-sea sediments with their high retention capacities.[772] However, the long transport routes, the higher probability of accidents at sea, the risk of catastrophic incidents and leakage due to the corrosion of the metal containers in a salt water environment, the practical impossibility of correcting errors, and risks to the personnel deployed during the transport and emplacement of the waste are open to criticism. There continue to be large gaps in what is known about the conditions in the deep sea under which the burden of waste management would be shifted onto the international community. In addition to this, there is the fact that major accidents would be unmanageable and a great deal of effort would have to be put into technical development in order to guarantee the method's feasibility. In the estimation of the Committee on a Site Selection Procedure for Repository Sites,[773] there are no tried-and-tested techniques available for the engineering of disposal sites of this kind.

Disposal in subduction zones (c): The idea of disposing of radioactive waste in subduction zones[774] goes back above all to the proposition that waste could be isolated from the biosphere by a tectonic plate sinking into the Earth's mantle. 'Subduction' happens relatively slowly, at a rate of several centimetres a year. However, this is sufficient to exceed the diffusion speed of radionuclides, so their release into the oceans would not have to be expected.

Nevertheless, the tectonic activity encountered along trench zones also raises the probability that the safety of a disposal facility of this kind could be compromised and radionuclides released early on before the waste had penetrated into the Earth's mantle. This uncertainty implicit in the prediction of the geological processes and therefore the pathway the waste would ultimately take represents a problem. After all, steps to correct errors, including the retrieval or

[772] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', Commission Material K-MAT 1.

[773] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1.

[774] Subduction zones are areas in which parts of the Earth's crust are sinking into the Earth's mantle on account of geotectonic movements of the continental sheets at 'active plate margins'.

recovery of the waste if this was necessary, would hardly be imaginable under a procedure of this kind.
The disposal of solid radioactive waste on or in the seabed has now been prohibited by several international agreements. This is motivated by doubts about the ultimate whereabouts of the waste and the realisation that a few countries should not pollute the marine environment that is shared by all. The London Dumping Convention (see above) has been in force since 1975. Thanks to the London Protocol added to it in 1996,[775] it is not only disposal on but also in the seabed and the deeper marine substrate that is prohibited. The only exception would be an area below the seabed that could be accessed from land. This puts clear barriers under international law in the way of the possible disposal of radioactive waste in the oceans in all the forms discussed above – irrespective of the safety concerns that have been mentioned, the lack of technical evidence about these methods and any geological uncertainties. The transport operations that would be required and the need to use international waters militate just as much against these options as the poor or non-existent methods for the correction of errors.
Summary: The Commission is of the opinion that it will not be possible to demonstrate that marine waste management strategies such as dilution, or practically irreversible burial in deep-sea sediments or subduction zones will attain levels of safety comparable with other forms of final disposal. The current international consensus is that they are not acceptable as strategies for the management of high-level radioactive waste. The Commission sees no reason to withdraw from the international bans that apply to these methods and therefore rejects the further development of marine waste management strategies for radioactive waste.

5.3.4 Indefinite storage on or close to the Earth's surface without any intention of final disposal

At present, the near-surface storage of high-level radioactive waste is common practice for interim storage as a stage preliminary to subsequent disposal. In some countries, thought is also being given to long-term, near-surface storage until a suitable method of final disposal is available.[776] The present section, however, only discusses storage options under which no attention would be paid to the waste's subsequent disposal and that are therefore to be referred to as 'indefinite storage'.
If waste were to be stored indefinitely for an unforeseeable period of time at a surface or near-surface storage facility that was to be constantly controlled and controllable, it would not only be necessary to provide for control and monitoring measures for limited periods, as under disposal concepts, but it would have to be possible for the waste to be inspected and easily retrieved at any time. It could only be guaranteed that such a safety concept would be upheld as long as long-term societal control was maintained.
The advantages of this procedure would be the permanent accessibility of the waste, the fact that they could be monitored and the possibility of immediate intervention if major accidents occurred.
If there were to be technical progress in emplacement methods or the treatment of waste, either some of the radioactive substances could be reused or the risk they

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[775] London Protocol: 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (as amended in 2006).
[776] Cf. section B 5.4.1.

posed could be mitigated. Furthermore, opportunities for waste to be directed to more advanced methods in future and the possibility that measures could be taken if major accidents occurred often lead to higher levels of acceptance among the population.

The decisive factor in this respect is, however, the longevity and stability of the monitoring concept, including the institutions entrusted with implementing it. Under the concept known in Switzerland as ‘guardianship’, the responsibility for the monitoring of a surface storage facility would be passed on through the generations. In an approach adapted to Swedish conditions, the waste would be emplaced in dry rock strata just under the Earth’s surface. Neither approach has been pursued further.

Indefinite storage conflicts with the requirement derived from ethical principles that a waste management solution be configured in such a way that it does not force coming generations to take any action, but ensures the waste that is being managed comes to be in a safe final state, provided no decisions are taken to alter the course that has been embarked upon.[777] Further to this, the reliability of the institutions entrusted with waste management over an extremely long span of time represents the biggest source of uncertainty. It is for this reason that the IAEA assumes procedures of this kind are only worth applying for short-lived isotopes.

The Swiss National Cooperative for the Disposal of Radioactive Waste (NAGRA), which contrasts societal stability to geological stability in its discussion of this approach, also tends to follow the same line of argument. Consequently, expeditious disposal is to be preferred to options that involve monitoring because indefinite storage does not have identifiable advantages either in terms of its (long-term) safety or its ethical justifiability. The Swiss Expert Group on Disposal Concepts for Radioactive Wastes comes to the conclusion that long-term safety will not be guaranteed by monitored indefinite storage, but only by geological concepts. It does not appear possible for plausible evidence to be provided of the functioning of societal/institutional protective systems over the requisite period of time. Assuming stable societal conditions for thousands of years or longer runs counter to historical experience, while many geological configurations that could be used as passive protective systems display high levels of stability over time.

Apart from the uncertain nature of forecasts about societal and political developments, further criticisms are the danger of accidents (e.g. as a result of a lack of maintenance) and attacks due to war or terrorism, the danger of proliferation, the great organisational and financial effort future generations would have to make, and climatic imponderables.

Summary: The Commission does not see monitored indefinite storage as a realistic option for the demonstrably safe, long-term handling of radioactive waste. The proactive pursuit of a strategy of this kind is therefore rejected by the Commission.

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[777] See section B 3.5.

5.3.5 Deep geological solution without retrievability

The transfer of radioactive waste into an underground facility in a deep geological formation designed specially for this purpose without opportunities for reversibility is one of the best studied waste management options. It is the technical precursor from which current approaches to disposal allowing diverse options for the correction of errors have been developed.

Most methods envisage a geological disposal facility being constructed at a depth of 500-1,000 metres in a suitable geological formation, the long-term stability of which would have to make by far the greatest contribution to the fulfilment of the safety requirements.[778] In the past, options for the correction of errors in the handling of emplaced waste, i.e. retrievability or recoverability, have not been provided for in the interests of rapid sealing that ensures such materials are in a safe long-term state.

The host rocks that come into question according to the current level of knowledge are salt, claystone and crystalline rocks (e.g. granite). The specific host rock chosen will have impacts on the underground equipment required and the necessary safety cases.

A geological disposal facility is also recommended by the Commission as an option worth pursuing,[779] but with one central difference from the variant that is categorised as not worth pursuing here. This difference lies in the retrievability and/or recoverability of the waste. Admittedly, it may be argued that the retrieval or recovery of waste is merely a matter of effort. It is possible ‘in principle’ in every deep geological configuration. However, the effort and the risks involved in retrieval/recovery can vary massively. Accordingly, it makes a great difference whether aspects of reversability are already provided for from the very outset under particular conditions and for particular periods of time, or whether the aspiration is to seal the disposal facility as quickly as possible without giving any consideration to reversability.

Rapid, conclusive sealing is favoured above all by the argument that no aftercare would be required. Ideally, there would be no requirements concerning the control of the disposal facility over longer periods of time, because the geological formation would guarantee the level of safety that is demanded. Future generations would neither incur costs for aftercare nor bear any burdens attributable to the risks posed by the waste. It would be necessary to pass on knowledge, but this would be limited to about the position of the site so uses that might be associated with a risk of radiological releases would not be envisaged there in later periods.

The criticism of this approach relates above all to the question of whether it is at all possible for its premises to actually be satisfied. The central premise is that a technically/geologically *totally safe* solution is possible, i.e. that safety cases have to be so reliable that it is guaranteed future generations will be protected against any possible harm caused by the waste. This premise is rooted in an ideal of technological/scientific feasibility that has fundamentally been called into doubt as awareness has grown of the ambivalence of technology,[780] in particular

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[778] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): ‘Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites’, K-MAT 1.

[779] See section B 5.5.

[780] Cf. Grunwald, Armin (2010): Technikfolgenabschätzung: Eine Einführung.

when it gives rise to unintended consequences. One ethical analysis even reached the conclusion that disposal without options for reversibility, which is indeed intended to keep future generations free of burdens if possible, could result in them facing particularly great risks.[781]
However, if doubts are raised about the feasibility of a guaranteed safe solution, it must remain possible in principle for coming generations to revise the opinions they inherit from earlier periods, taking account of ethical points of view, and replace such opinions with their own assessments.[782] Precautions must be taken all the more if it is to be possible for unexpected developments to be dealt with responsibly. It is precisely this argument that is behind the requirements that are also set out in the Site Selection Act concerning the possibility of the correction of errors and therefore the exclusion of options that do not provide for such possibilities.
Summary: The Commission is of the opinion that geological disposal without precautions that allow errors to be corrected by retrieving or recovering waste is no longer consonant with contemporary requirements and the need for controllability. The Commission therefore recommends that ideas about final disposal that do not offer such opportunities for the correction of errors not be pursued further.

5.4 Possible alternatives to final disposal in an underground facility

The pathways for deep borehole disposal, transmutation and long-term interim storage have been raised in societal and scientific debates as possible alternatives to disposal in an underground facility. The Commission has therefore taken up these three pathways, gathered information about the recent progress made on each concept and, as the result of its discussions, come to a differentiated opinion on them.
Initially, it is to be noted that, when they are compared, deep borehole disposal, transmutation and long-term interim storage are not equivalent pathways for the resolution of the problems of disposal:

- If it is technically feasible, the placement of high-level radioactive waste in deep boreholes would *de facto* represent a form of disposal and therefore an alternative to disposal in an underground facility.
- By contrast, were they to be pursued, transmutation and long-term interim storage would also continue to require the downsteam disposal of high-level radioactive waste, regardless of the form in which it was implemented. These options could therefore postpone disposal and potentially alter its parameters, but not ultimately replace it.

The Commission has also reached the conclusion that, from a contemporary point of view, none of these three pathways offers safety advantages or would result in the earlier disposal of high-level radioactive waste than the pathway that is preferred by the Commission (disposal in a geological disposal facility with reversability/retrievability/recoverability).[783]

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[781] Cf. Kalinowski, Martin, Borcherding, Katrin (1999): 'Die Langfristlagerung hoch radioaktiver Abfälle als Aufgabe ethischer Urteilsbildung: Teil 1': ETHICA 7, pp. 7-28; 'Die Langfristlagerung hoch radioaktiver Abfälle als Aufgabe ethischer Urteilsbildung: Teil 2': ETHICA 7, pp. 115-142.
[782] See section B 3.5.
[783] See also section B 5.5.

The Commission regards the further pursuit of deep borehole disposal technology and regular observation of future developments in this field as worthwhile in principle.
Under the parameters that prevail in Germany, the Commission does not anticipate any crucial contribution to the resolution of the disposal problem to come from the development of transmutation technology.
Planned long-term interim storage with the aim of resolving the waste management issue by unspecified methods at an unspecified point in the future should not be a strategy to be pursued proactively either. The Commission feels the technical and regulatory issues associated in any case with the interim storage that is foreseeable today over the longer term have been discussed in relation to necessary interim storage,[784] so no additional contribution to developments is to be anticipated here from ideas about long-term interim storage.
The Commission's specific conclusions on the three pathways are set out in greater detail in the following sections

5.4.1 Long-term interim storage

The Commission understands the term 'long-term interim storage' to denote the interim storage of high-level radioactive waste for several hundred years, during which the development of a final waste management solution would be dispensed with for an unspecified period. In so far as this is the case, its time dimension differentiates it from necessary interim storage until waste is emplaced in an operational disposal facility. *De facto*, long-term interim storage is not a real waste management option. Nevertheless, under particular circumstances, it could represent a strategy to be pursued by society beyond the periods of several decades that will probably be necessary.
The Commission is therefore of the opinion that, in view of its relevance to the disposal of high-level radioactive waste, long-term interim storage requires further observation, and has obtained an expert opinion on the issues that are associated with the topic.[785]
The repeated, more or less arbitrary extension of the operation of interim storage facilities is not an acceptable option for the handling of high-level radioactive waste. In consequence, if it is to come into consideration as a conceivable strategy at all, long-term interim storage over several hundred years would require a conscious decision and robust justification. It would postpone the question of disposal into a very far distant future, in which the generation that would then be alive would nonetheless be expected to take decisions about the actual disposal of the high-level radioactive waste in question.

5.4.1.1 Technical influences

As a planned state, the overall system of a long-term interim storage facility would have to be designed for probable developments over several hundred years. The protection targets would be identical to the current ones: the safe

[784] See section B 5.7.
[785] Cf. TÜV Nord EnSys, Öko-Institut e.V. (2015): 'Gutachten zur Langzeitzwischenlagerung abgebrannter Brennelemente und verglaster Abfälle', K-MAT 44.

isolation of radioactive substances, the dissipation of decay heat, the maintenance of subcriticality, the prevention of unnecessary radiation exposure, and the limitation and control of the unavoidable exposure of operating personnel and the population to radiation would also have to be guaranteed without exception in future by long-term interim storage. Purely technically, long-term interim storage appears feasible in principle.

In terms of their robustness, the built installations would have to be designed in such a way that their safety-oriented functions would be retained even if security and/or safety systems were to fail temporarily. Effective ageing management for built structures tailored to the long periods for which they would be used would have to ensure that any damage to such structures was identified, documented and followed up. Taking this forward, repair measures would have to be planned and carried out. In principle, the construction of new buildings and installations might also be necessary, something that might have to be done several times.

With regard to the design of a long-term interim storage facility resistant to exogenous impacts, regulatory foundations would have to be put in place that, despite increasing uncertainties over the long term, laid down practical specifications concerning the type, level and frequency of the impacts on which the design was to be based. Since comprehensive predictions about such impacts cannot be made for several hundred years, the regulatory parameters would have to be formulated in such a way that the impacts to be assumed and their possible consequences were regularly reviewed and backfitting measures implemented as necessary during the operating life of the long-term interim storage facility.

All the realistically conceivable design options for long-term interim storage have advantages and disadvantages. The initially obvious option of continuing to use the existing intermediate storage facilities would have the fundamental disadvantage that these facilities were not designed with operating lives of several hundred years in mind. They therefore do not have the flexibility to cope with assumed loads that, on account of the long periods for which the waste would be stored, would clearly exceed current assumptions, or would be based on impacts that would have to be taken into account additionally. By contrast to this, the requirements regarded as necessary, including tolerances, could be factored in from the outset in newly built structures. However, the technical provisions and regulatory framework this would demand would still have to be developed.

Compared to shallow underground (i.e. near-surface) built structures, long-term interim storage facilities on the surface would offer advantages as far as protection against flooding was concerned, as well as easier access routes and maintenance. By contrast, compared to surface storage facilities, underground storage facilities and tunnel solutions would offer advantages in terms of the security of the installations and protection against exogenous impacts caused by civilisational developments. Possible crash loads could be absorbed by earth covers and/or embankments. Tunnel solutions could avert problems with flooding.

Reinforced concrete structures are regarded today as comparatively durable. However, there is no experience of the ageing behaviour of reinforced concrete over periods of several hundred years. It is highly probable that such concrete structures would therefore have to be refurbished in the course of their operating lives.

The impermeability of the storage containers would have to be permanently monitored using a container monitoring system. Handling facilities such as cranes, materials handling vehicles and similar equipment would have to be available in an operational state for the emplacement and removal of storage containers, as well as measures that might be required to maintain and restore the storage containers throughout their long-term interim storage. A container maintenance station would have to be kept available for the maintenance and repair of the storage containers, in particular their sealing systems. A ‘hot cell’, including handling equipment for repairs to the primary lid sealing system and the operations that would potentially be required to transfer a container’s inventory into a second storage container, would have to be available as well. The availability of the components for the sealing system would also need to be ensured permanently, as would the requisite energy supply.

To uphold the operational readiness of the technical facilities over long periods of time, a maintenance and repair concept would have to be developed that would also provide for the replacement of components that were no longer useable. Since it would not be feasible to stockpile spare parts for the whole duration of long-term interim storage, it would be necessary to retain the capacity to fabricate copies of components and modules that were suffering from ageing when this was necessary throughout the long-term interim storage period. The possibility of the complete replacement of the technical facilities would also have to be taken into account as well, particularly as the evolving state of the art would make backfitting necessary.

The maintenance of the integrity and handleability of the inventories would be an important precondition. On account of the short reference period, some aspects of the matter, e.g. chemical interactions, the embrittlement behaviour of the inventories or hydride reorientation, are disregarded in the analyses carried out under the current approach to the provision of evidence about measures that ensure the integrity of inventories. For the long storage periods that are envisaged, these aspects would have to be reanalysed and subsequently assessed repeatedly. The analytical methods used today to ensure the integrity of inventories would have to be reviewed to ascertain their suitability as a basis for statements about a system’s long-term performance and potentially replaced with new assessment methods, which would first have to be developed. The documentation of the inventories and containers would have to be so comprehensive that a fundamental assessment with basic data would be possible even after a lengthy period. One essential aspect in this respect is the storage and locatability of data over many generations, and the preservation of their legibility.

From a contemporary point of view, it would have to be assumed when long-term interim storage was planned that the requirements concerning the integrity and handleability of spent fuel elements could not be upheld over the whole planned storage period. Concepts would therefore have to be developed (e.g. for the repackaging of fuel elements) that could be put into practice if there was evidence of undesirable damage.

Apart from built and technical security features, securing a long-term interim storage facility against third parties also requires security personnel or state forces. At least the same technical equipment and systems would be required as are deployed to secure the current interim storage facilities. These include passive features (e.g. reinforced walls) and active systems (e.g. electronic monitoring equipment).

Apart from this, the design of the installations to resist impacts consequent upon military conflicts would grow in significance over several hundred years. Independent supplies of media, unmanned operation for limited periods, regular updating of measures against ballistic attack/aircraft crash and a preference for underground forms of storage facility would be the consequences

As early as the planning stage, specific load assumptions that would potentially diverge from current assumptions (including the aims of attack, attacker profiles, equipment and *modus operandi* to be assumed) would have to be newly specified as the design basis on account of the long reference period. This would have to be combined with a commitment on the part of the competent authorities to evaluate these assumptions at regular intervals and when the need do so was identified. Whether the regular upgrading of security measures as a consequence of these evaluations would be technically possible over the long term, so that even attacks with improved or novel weapons and equipment could be coped with, cannot be predicted from a contemporary point of view.

5.4.1.2 Non-technical influences

If high-level radioactive waste were interim stored for several centuries, it is not only questions of technical feasibility and safety that would have to be attended to. Rather, it would also be necessary to take account of the parameters that would influence a society's ability to responsibly perform the tasks associated with the interim storage of radioactive waste in perpetuity and how those parameters might change.

The high degree of specialisation in container technology, the low levels of maintenance needed on the containers themselves and the lack of domestic demand following the phasing-out of the use of nuclear energy could have the result that, in just a few decades time, it would no longer be possible to assume the requisite competences would be preserved in Germany unless action were taken. Much the same is true for the capacity to deal with high-level radioactive waste, whether in the context of container repairs, repackaging or the waste management steps that would follow long-term interim storage all the way through to the implementation of final disposal. The availability of qualified technical, scientific and administrative personnel for what will in future be the niche technology of long-term interim storage could not be regarded as assured. The loss of know-how could, however, entail a decline in the quality of waste material handling. It would therefore be a challenge to maintain the competences required to the necessary standards for several hundred years.

Over the long term, demographic effects such as declines in population and the concentration of the population in urban areas could also influence questions relating to the selection of a storage site and the design of long-term interim storage facilities. Depending on the site, e.g., the effort involved in the maintenance of the requisite external infrastructure (access routes, supplies of media) over the long term would increasingly have to become the responsibility of the storage facility itself, which would be the sole user of the infrastructure under certain circumstances.

From regulatory perspectives, the long-term interim storage of high-level radioactive waste over several hundred years would be incompatible with the current national and European legal framework if a proactive procedure aimed at final disposal were to be dispensed with. A potential decision to take this course would therefore have to entail a far-reaching revision of the foundations for the procedure and its administration that are regulated in the Atomic Energy Act, including the relevant sublegislative provisions, in conjunction with a fundamental reorientation of the safety philosophy for the handling of high-level radioactive waste. New concepts would be required for the licence and its maintenance that would be suitable as ways of dealing with objections to the award of licences raised on account of influences on the safety and security concept that could not be predicted over the long term.

It would be sensible for the implementation of long-term interim storage to be a responsibility of the state in order to ensure the requisite continuity. As far as the functions associated with licensing and supervision are concerned, it would be obvious from a contemporary point of view to concentrate them within the jurisdiction of a single authority at the federal level in order to bundle competences, optimise interfaces and limit costs. If this were done, various changes to the current distribution of competences for interim storage would be required. The diversity of actors involved in and opinions about long-term interim storage would very probably diminish considerably as the facility was operated over the long term so that it would hardly be possible for democratic decision-making processes to be conducted with the participation of the public and stakeholders.

Compared to current practice, the financing of long-term interim storage throws up a series of unanswered questions, e.g. about the term 'safekeeping' (Section 9a of the Atomic Energy Act), the upholding of the polluter-pays principle, retrospective claims for the reimbursement of additional costs from waste producers and the reallocation of financial reserves that have been built up for disposal. The costs for the construction, operation and monitoring of intermediate storage facilities would have to be met in addition to the provision made for a future disposal facility. The current legal framework of the Atomic Energy Act and the Disposal Financing Ordinance would need to be developed further in appropriate ways.

Irrespective of the design option chosen for the long-term interim storage facility, it would take several decades before it was commissioned. It is impossible to quantify how long would be needed to go through the preceding process of societal and political discourse that would initially have to foster a consensus in favour of long-term interim storage, something that would represent a paradigm shift from the current approach to the matter. Under the parameters of licensing law valid at present, however, it is to be assumed that the commissioning of a planned long-term interim storage facility would not be possible during the current operating lives of the existing interim storage facilities.

5.4.1.3 Summary

If a decision were to be taken today in favour of long-term interim storage over several centuries, this would imply an admission that no solution had been found for the permanent management of high-level radioactive waste that was consonant with current safety requirements, current perceptions of risk and current societal parameters, and that decisions about the management of waste would therefore have to be taken by future generations.

Consequently, the Commission rejects long-term interim storage (with disposal in several hundred years).

Although the technical parameters for long-term interim storage can be described in their entirety from a contemporary point of view, their long-term evolution over periods of several centuries is only predictable to a limited extent. Apart from this, some aspects of societal change (e.g. the phasing-out of nuclear power and demographic change) pose challenges to the maintenance of a long-term interim storage facility. Finally, as history teaches, societal stability cannot be presumed over such long periods of time. Sources of instability, such as military conflicts and impacts caused by third parties, would have to be taken into account in the design of a long-term interim storage facility. Nonetheless, it appears difficult to imagine the safe operation of a long-term interim storage facility being guaranteed during phases of severe societal turmoil – e.g. if the current societal order were to collapse.

The planning of long-term interim storage and the maintenance of the capacity to manage it for centuries raise a whole series of questions, and involve uncertainties and therefore risks that, from a contemporary point of view, militate against the active pursuit of such a strategy. Nonetheless, long-term interim storage may be forced on society if it does not prove possible to implement the disposal of waste that is aspired to. The Commission therefore regards it as worthwhile and necessary, in particular, to continue to pay attention to the effects associated with the ageing of containers and inventories, and to make efforts to gain further knowledge in these fields in future as well.[786]

5.4.2 Transmutation

The Commission identified the transmutation procedure as a topic that requires further observation in view of its relevance for the disposal of high-level radioactive waste, and obtained two expert opinions on the questions associated with transmutation.[787]

The aim of transmutation is to first partition the long-lived[788] nuclides of the elements plutonium, neptunium, americium and curium (the ‘transuranic elements’) produced during the operation of nuclear reactors, then convert them into stable or short-lived nuclides. By contrast, the transmutation of the long-lived fission and activation products present in spent fuel as well is hardly being pursued by researchers. In this connection, in line with current advances in science and technology, transmutation is also not suitable for the further treatment of high-level radioactive waste from reprocessing that has already been vitrified. The procedures discussed today are not applicable for fuel elements from research and prototype reactors either, so the procedure would only be applied to fuel elements from power reactors.

Transmutation could lead to a reduction or, in the best case, elimination of the proportion of long-lived transuranic elements in the radionuclide inventory that is to be disposed of. However, it would not be a waste management option for the

[786] Cf., on this section, TÜV Nord ENSYS, Öko-Institut e.V. (2015): ‘Gutachten zur Langzeitzwischenlagerung abgebrannter Brennelemente und verglaster Abfälle’, K-MAT 44.

[787] Cf. Brenk Systemplanung (2015): ‘Gutachten zum Thema „Transmutation“ im Auftrag der Kommission Lagerung hoch radioaktiver Abfallstoffe’, K-MAT 45. Öko-Institut e.V., Carl Friedrich von Weizsäcker Centre for Science and Peace Research at the University of Hamburg (UHH-ZNF) (2015): ‘Gutachten „Transmutation“ im Auftrag der Kommission Lagerung hoch radioaktiver Abfallstoffe’, K-MAT 48.

[788] In the context that is discussed here, long-lived radionuclides are defined as nuclides with half-lives of more than approximately 10,000 years, short-lived nuclides accordingly have markedly shorter half-lives.

long-term handling of high-level radioactive waste because, even if optimistic assumptions were made, high-level radioactive and/or long-lived waste would remain and require disposal.

5.4.2.1 Overall technological system and advances in technical development

The implementation of ‘partitioning and transmutation’, also abbreviated as ‘P&T’, essentially involves three steps: partitioning, fuel manufacture and conversion, i.e. transmutation.

In partitioning, the spent fuel elements are chemically dissolved in a reprocessing plant and the radioactive substances they contain separated into several product streams in a number of process steps. Two processes for the partitioning of transuranic elements are to be distinguished. The hydrometallurgical PUREX process developed for the partitioning of uranium and plutonium from spent uranium oxide fuel elements has its origins in reprocessing. Considerable technical further development will be required if it is also to be possible to partition what are known as the minor actinides, such as neptunium, americium and curium, in future. Researchers have been able to demonstrate the feasibility of partitioning. So far, however, experiments have only been conducted on a laboratory scale. Whether industrial implementation will succeed with the requisite recovery factors of around 99.9 per cent is uncertain from a contemporary point of view. The ‘pyrometallurgical process’ concept based on electrochemical methods at high temperatures in an oxygen-free environment is at a yet earlier stage of development.

The next step would be to manufacture fresh fuel elements from the separated transuranic elements. The development of fuels that contain the minor actinides as well as plutonium – in particular uranium-free fuels for deployment in accelerator-driven reactors – is still at a relatively early stage as well. One set of problems during the manufacture, transport and handling of transmutation fuel elements is posed by the high levels of gamma radiation and neutron radiation which is emitted, in particular from curium. They require massive shielding and remote-controlled handling, and have already inspired ideas about dispensing with the partitioning and transmutation of curium isotopes. Apart from this, as far as uranium-free fuels are concerned, there are still no procedures for the partitioning of fission products from the matrix, so it is not possible to make any statements at present about the volume and characteristics of the resulting waste products.

The fresh fuel elements would ultimately be deployed in suitable transmutation reactors, where they would be irradiated to split the transuranic elements. Internationally, two concepts are being discussed for such transmutation reactors and their fuel. Firstly, there are ‘fast reactors’ with mixed oxide fuels, which represent a further development of the fast breeder. In France, there is currently a concept for a prototype reactor (ASTRID) that would be a fast breeder optimised for transmutation. Secondly, accelerator-driven reactors with uranium-free fuels are being discussed, which would be started up and controlled using an external neutron source. Up until now, such plants have only existed as conceptual studies. The first accelerator-driven experimental reactor (MYRRHA) is to be built in Belgium with significant funding from the European Union. Apart from this, there is a concept for a European prototype (the EFIT reactor).

After transmutation had been completed, the transmuted fuel elements would have to be reprocessed once again so that the cycle could subsequently be repeated. Since only a certain proportion of the transuranic elements could be transmuted in each run-through, this would necessitate a large number of cycles. Furthermore, intermediate storage facilities and transports of various radioactive substances would be required between the different steps. Since the process would not bring about the complete transmutation of the long-lived minor actinides, high-level radioactive waste and considerable volumes of low and intermediate-level radioactive (secondary) waste would still have to be managed.

5.4.2.2 Timeframe and costs

On account of the still very early stage they are at in their evolution, it initially appears from a contemporary point of view that at least four to five decades will be required for the development of all the necessary P&T technologies to industrial maturity, potentially even considerably longer.
As far as the inventory to be found in Germany following the phasing-out of the use of nuclear energy is concerned, if the intention is to reduce the 140 tonnes of transuranic elements it will include to ten per cent of the original figure, an average of between five and seven transmutation reactors and the infrastructure required for reprocessing (partitioning) would subsequently have to be in continuous operation for 150 years. 16 reactors might even be needed to begin with, in which case, on account of the large volume of transuranic elements, three or four reactors would still be required 100 years later. Total operating lives of less than 100 years could only be achieved theoretically with considerably more reactors and/or higher reactor power levels or subject to the optimistic assumption of a higher transmutation efficiency per cycle. If lower reactor power levels were assumed, this might result in the reactors operating for 200-300 years.
With regard to the costs of a P&T system, only very rough estimates with wide margins of error are possible at present. Depending on the concept, 25-60 billion euros would have to be estimated for research and development, and another 40-350 billion euros for the creation of the requisite installations. The electrical energy that could be generated by transmutation plants would merely cover part of these costs.

5.4.2.3 Impacts on the emplacement of radioactive waste in Germany

The influences of a comprehensive P&T strategy on disposal can currently be discussed in qualitative terms at best. For instance, the volume, radionuclide inventory and radiotoxicity of the high-level radioactive waste would be reduced. The floor area required by a disposal facility for such materials could also be cut, although the disposal concept and the heat output from the waste at the time when they were emplaced would have a greater influence on the floor area required than the proportion of transmutable radionuclides. In order to achieve any noteworthy reduction in heat output, the fission products generated by P&T would still have to decay for approximately 300 years in a surface intermediate storage facility after transmutation.

The isolation period necessary for disposal would not be reduced because the potential dose that resulted over the long term from the waste in the disposal facility would not be determined by the transuranic elements but by long-lived fission and activation products that could not be converted by P&T. Transuranic elements are regarded as largely immobile under disposal conditions. By contrast, the total mass of fission products present would increase, and might even roughly double, depending on the transmutation concept. Apart from this, it is significant that the reprocessed waste present in the form of vitrified waste products would determine the long-lived activity inventory of the disposal facility and, from a contemporary point of view, could not be dealt with by transmutation.
The fact that the activity of the inventory placed in the disposal facility would be reduced by P&T might lead to a lowering of potential dose rates under certain scenarios involving human intrusion or rapid releases after improbable developments.
The volume of low and intermediate-level radioactive waste would increase significantly, by an estimated 150,000-170,000 cubic metres, due to the secondary waste produced during P&T (e.g. operational and dismantling waste). This waste would, however, have comparatively short half-lives. There is no disposal pathway for this waste under Germany’s current National Waste Management Programme.
The date when a disposal facility for high-level radioactive waste could be sealed would recede noticeably into the future, whether because it would be commissioned later or kept open for longer. This would be associated with safety consequences and have impacts on the security situation.

5.4.2.4 Safety and risks of proliferation

The development of transmutation reactors that would be safer than contemporary power reactors represents one of the core aims of the current international research and development work that is being done in this field. However, transmutation reactors pose specific risks of causing major accidents that result from the special radioactive inventories in these plants, transmutation fuels’ chemical and physical characteristics and the characteristics of the liquid metals envisaged for cooling. It is therefore uncertain from a contemporary point of view whether transmutation reactors would actually be able to achieve levels of safety higher than contemporary nuclear power plants.
On account of the higher levels of heat generated, the high dose rate and its criticality safety implications, P&T would in some respects impose markedly more rigorous requirements concerning the transport and interim storage of radioactive materials. In comparison to current practice, the expectation must be that several times the amount of fuel element transports and handling steps would be carried out for each tonne of heavy metal deployed, combined with significant radiation protection requirements, in particular for personnel.
If a P&T strategy were to be implemented on an industrial scale in Germany, several tonnes of partitioned transuranic elements would be processed each year during the facilities’ operating lives, of which plutonium in particular, but to a lesser extent neptunium and americium too could be misused to build nuclear weapons. The reprocessing and fuel production plants where these substances would be handled separately would have to be subject to rigorous requirements

concerning both controls on fissile material and the security of the plants, and would remain subject to these requirements continuously for several hundred years (see above). For this reason, the development work is moving in the direction of the joint partitioning of minor actinides. Once transmutation had been completed, the risk of proliferation would accordingly be reduced and/or ruled out.
This stands in contrast to the scenario of the extraction of weapons-grade substances from a disposal facility, which would demand the retrieval or recovery of waste and the subsequent partitioning of the desired fissile materials. These measures would involve significant effort, would probably be impossible for subnational actors to carry out and would be detected by fissile material monitoring systems.
The risks posed by the implementation of a P&T strategy over a period of approx. 150-300 years are to be weighed up against the possible reduction of potential risks to the long-term safety of a geological disposal facility.

5.4.2.5 Societal and social parameters for practical implementation

The implementation of a P&T strategy would rely on the existence of a stable state over the centuries to come, including appropriate infrastructure for the preservation of knowledge, training, operation, research and development. This means a P&T strategy would shift the responsibility for the treatment and disposal of high-level radioactive waste largely onto future generations.
A decision to implement P&T would presuppose acceptance for this technology among the population, and it would also have to be supported by future generations on account of the length of time required for its technical implementation. The contemporary societal consensus that nuclear energy should not be used in Germany would have to be abandoned. The legal parameters laid down in the Atomic Energy Act would have to be adapted, and secondary rules and regulations put in place to permit the industrial use of plutonium on the technological scale associated with a P&T strategy as discussed above.
Furthermore, an understanding about the financing of this approach would be required, with a view to both the rapid development of the technologies and their subsequent implementation. Even the participation of European partner countries, whatever the form in which this was organised, would be associated with significant political, societal and regulatory adjustments. In Europe, it has only been France and EURATOM that have undertaken concrete research and development activities until now.

5.4.2.6 Summary

While it appreciates the aspects of the matter discussed above, the Commission is of the opinion that no arguments for the development of a transmutation technology can be derived from the topics relating to a disposal facility that have been analysed by the Commission. Under the parameters that are in place in Germany, the Commission believes this technology has no advantages for the final disposal of radioactive waste. Consequently, the active pursuit of a P&T strategy is not recommended from a contemporary point of view.[789]

5.4.3 Deep borehole disposal

The Commission identified deep borehole disposal as a possible alternative to final disposal in an underground facility that required more detailed deliberation, and has gathered information by obtaining an expert opinion on recent progress in this field.[790]

The disposal of high-level radioactive waste in boreholes that are up to 5,000 metres deep is a form of deep geological disposal that, on account of the depth at which the waste would be emplaced and the overlying rock strata, is fundamentally conceivable as a safe method of isolating high-level radioactive waste.

In Germany, it has not been analysed in detail to date as an alternative waste management method. Internationally, e.g., the USA and Sweden have been looking at concepts of this kind. No in-depth studies or demonstration projects have been conducted as yet.

5.4.3.1 Technical and safety concept

Deep borehole disposal is intended to make it possible for waste to be isolated extensively from the biosphere, as well as offering opportunities for several (redundant) different (diverse) geological barriers to be used to ensure the safety of disposal. Fundamentally less damage is caused to the host rock and/or the isolating rock zone when boreholes are drilled than when underground facilities are constructed, apart from which the long sealed sections of the boreholes are also fitted with diverse, redundant seals. The great depth at which the waste would be emplaced is seen not least as a feature that would enhance protection against proliferation.[791]

In accordance with current standards, the ambition for deep borehole disposal as a form of disposal of high-level radioactive waste must be for it to comply *mutatis mutandis* with the 'Safety Requirements' issued by the Federal Environment Ministry in 2010,[792] which means it must permanently guarantee safe containment for one million years without the need for aftercare, essentially using geological barriers. At the same time, retrieval during the disposal facility's operation and recovery are to be possible over a period of 500 years after it has been sealed. In the light of these requirements, the expert opinion that was obtained developed a fundamental concept for deep boreholes, on the basis of which the state of the art of the technology and the safety aspects associated with the concept were discussed.

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[789] Literature consulted: Brenk Systemplanung (2015): 'Gutachten zum Thema „Transmutation" im Auftrag der Kommission Lagerung hoch radioaktiver Abfallstoffe', K-MAT 45. Öko-Institut e.V., Carl Friedrich von Weizsäcker Centre for Science and Peace Research at the University of Hamburg (UHH-ZNF) (2015): 'Gutachten „Transmutation" im Auftrag der Kommission Lagerung hoch radioaktiver Abfallstoffe', K-MAT 48.

[790] Cf. Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) (2016): 'Tiefe Bohrlöcher', K-MAT 52.

[791] Cf. Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) (2016): 'Tiefe Bohrlöcher', K-MAT 52, p. 16.

[792] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2010): 'Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste'.

The concept envisages an emplacement zone at a depth of between 3,000 and 5,000 metres in vertical boreholes drilled into crystalline basement rock. Other suitable types of host rock are not to be anticipated in Germany at this depth. At least two independently acting geological barriers, salt and clay for instance, would have to lie on top of the emplacement zone. A collection or trap system would be installed between the depth of emplacement and the salt and clay barriers in order to retain the gases that would be anticipated as corrosion products.
The minimum diameter of the boreholes would depend on the diameter of the disposal capsules (design diameter: 430 millimetres), which would additionally require a stabilising disposal container. The deeper the borehole, the more containers it would be able to accommodate, but the more stable the containers would also have to be on account of the compression force and pressurisation to which they would be subject in the sealed borehole. The requisite stability of the container would be ensured by the thickness of its walls, which would in turn influence the diameter of the borehole. The expert opinion obtained by the Commission analyses a range of variants for these features with the result that a borehole diameter of 900 millimetres is felt to be required for emplacement at a depth of 5,000 metres on account of the dimensions of the container.[793] Smaller diameters would be sufficient for boreholes that were not as deep.
The borehole would need to be fully cased. In the emplacement zone, the borehole would be lined with casing and additionally the annulus filled with cement. Where the borehole passed through barriers made up of salt rock and clay strata, the casing would have to be removed when the borehole was sealed in order not to impair the convergence and self-healing of the geological barriers. For emplacement, the borehole would be filled with a borehole fluid that would contribute to the stability of the borehole and guarantee retrievability. A sealing function when the borehole was closed would be played by backfill materials made of salt grit, bentonite and asphalt/layers of bitumen above the emplaced waste.

5.4.3.2 Latest advances in technology and development work needed

At present, studies on deep borehole disposal as a waste management option are mainly being driven ahead in the USA. Apart from geoscientific research, for instance, the Department of Energy (DOE) is planning a pilot project in which inactive containers with a diameter of 115 millimetres are to be emplaced in crystalline basement rock and retrieved. The pilot project is to help demonstrate the feasibility of a waste management option for strontium containers from research activities, which is also why markedly smaller container and borehole diameters are required in this case. Safety analyses for transport, construction, operation, sealing and long-term safety are currently being drawn up. Various backfilling materials for boreholes are also being discussed in the form of fluid or solid substances.
The possibility of recovery is not envisaged in any of the international projects on deep borehole disposal of which the Commission is aware.

793 Cf. Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) (2016): ‘Tiefe Bohrlöcher’, K-MAT 52, p. 158.

Deep boreholes are used above all in the oil and gas industries. The technologies and procedures developed for these purposes could also be applied for deep borehole disposal. This would, however, require them to be adapted and further developed.
The latest advances in the technology of drilling at great depths are flush drilling procedures. The dry drilling of deep boreholes cannot be presupposed at the required depths. In this respect, the borehole's depth and diameter are decisive, interrelated variables. Normally, a borehole is begun with a larger diameter, which gradually reduces as it is drilled deeper. Today, as a general rule, typical deep boreholes in the oil/gas industry are drilled with a diameter of 311.1 millimetres (12 $^1/_4$ inches) at the bottom. At present, an effective bottom diameter of a maximum of 450 millimetres is regarded as feasible with standard drilling methods at up to 5,000 metres depth. A diameter of 650 millimetres is technically feasible at a depth of 2,000 metres. Boreholes with greater diameters have only been drilled in the past as part of scientific and military projects.
Greater bottom diameters (up to 900 millimetres, see above) would be required for the emplacement of radioactive waste in several-thousand-metre-deep boreholes, so a considerable further development of the equipment and drilling technologies would be necessary in this field. Furthermore, higher standards would have to be placed on the vertical alignment of boreholes for the emplacement of waste than in conventional industrial drilling operations.
Apart from the flush drilling method itself, the vertical boreholes would also need to be filled with fluid to keep them open and stabilise them. The characteristics of the fluid would have to be matched to the surrounding rock (solubility behaviour, high impermeability).
A whole range of tried-and-tested drilling fluids are available, but a specific fluid formulation would have to be developed for each site. Since it would also perform its stabilising function during and after the emplacement of the waste packages, the fluid deployed would remain in the borehole, so the waste containers would be sunk into the fluid and would be surrounded by it at the depth where they were emplaced. In this respect, there is considerable need for research into the interactions between the fluid, the casing and the waste packages, as well as the central questions of the safety of disposal connected with them, e.g. corrosion and gas generation.
The casing would stabilise the borehole and could help to absorb the rock pressure at the depth of emplacement. With a view to retrievability, it would be indispensable for the casing to be capable of resisting this pressure over long periods. Furthermore, the casing would have to be corrosion-resistant under emplacement conditions. No experience of the long-term durability of casing materials is available. Here too, there is a corresponding need for development.
Waste containers for deep borehole disposal would still have to be developed as well. The crucial parameters for the size of the containers would be, on the one hand, the borehole geometry and, on the other hand, the size of the waste to be emplaced. The temperature and pressure conditions in the borehole, and the chemical characteristics of the fluid would be crucial for the selection of the container material. Austenitic steels are categorised as suitable in principle. How stable the container would have to be and therefore the thickness of its walls would also be determined by the compression force of the column of stacked containers.

On account of their limited wall thicknesses, it would not be possible for the waste containers to be self-shielding. Consequently, they would have to be emplaced under radiation protection conditions. Cold tests of emplacement in a borehole under realistic conditions have already been conducted successfully using transfer containers. Not only that, there are various state-of-the-art procedures for automated emplacement operations. No need for further specific development work is seen here. However, this method presupposes the vertical alignment of the borehole with the least possible deviations in its orientation. Salt, clay and bitumen/asphalt have proven to be stable over the long term as materials for borehole seals, e.g. at gasfields and oilfields. The redundant, diverse deployment of materials of these kinds along a sealed section of borehole of over 1,000 metres is categorised as technically feasible.

5.4.3.3 Operational and long-term safety

Given the latest advances in science and technology, the operational and long-term safety of deep borehole disposal cannot yet be assessed. Nor is it possible to estimate whether a disposal method of this kind could actually be put into practice safely in principle over the long term. However, some safety-relevant topics can be identified.
On account of the great depth of the boreholes, it is fundamentally a challenge to produce a safety case that is valid not only for the operational phase and the near field of the borehole, but also for a larger three-dimensional volume such as an isolating rock zone when a long-term safety analysis is conducted. The combination of crystalline basement rock at great depth, overlying geological barriers and the gas traps that would be required would certainly result in a very complex configuration here.
The spectrum of major accidents to be given consideration during the operational phase would also have to be newly developed. The early release of radionuclides from the waste inventory during the first 100 years is to be assessed as a relevant risk. A release could occur on account of damage to a container during emplacement, corrosion processes connected with the borehole fluid or geological processes that compromise the stability of the borehole and the containers. In consequence, a significant release of radionuclides into the borehole fluid is to be expected, which would have consequences for retrievability, in particular. Furthermore, it would have to be assessed whether gas generation caused by corrosion in the fluid in an open borehole could lead to an upwards movement in the fluid and therefore the dispersal of radionuclides at an early stage.
With regard to the long-term safety of a sealed emplacement borehole, the probable and less probable developments to be taken as a basis, and/or the specific features, events and processes relevant for borehole disposal in this respect would also have to be newly developed. As far as this is concerned, it is viewed as probable[794] that relevant corrosion would start after just a few decades as a result of the contact between the container material and the fluid. This means the generation of significant quantities of hydrogen gas would have to be anticipated in the sealed borehole. The impacts of gas migration in deep boreholes and the resulting gas

[794] Cf. Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) (2016): ‘Tiefe Bohrlöcher’, K-MAT 52, section 10.2.

pressure on the sealing system have not been studied. Gaps in knowledge about the geochemical environment in the deep borehole, influenced as it would be by the container and casing materials, borehole fluid, rock and, under certain circumstances, the waste inventory would have to be closed for the safety analysis. Nor is it possible at present, on account of the gaps in what is known, to assess the long-term maintenance of subcriticality in a deep borehole in which numerous containers filled with spent nuclear fuel would be emplaced vertically on top of one other.[795]

5.4.3.4 Retrieval and recovery

Requirements concerning retrieval and recovery would first have to be specified for deep borehole disposal. If the 'Safety Requirements' issued by the Federal Environment Ministry in 2010 were to be applied *mutatis mutandis*, retrieval would be classified as feasible in the sense of the reversibility of the emplacement of a waste container by means of existing procedures up until the point in time at which a borehole was sealed. However, the period during which waste would be emplaced in a single borehole, and the waste packages would therefore be more or less accessible, would only last for three to five years and would consequently not be comparable with the period for which waste could be retrieved from a geological disposal facility. On this issue, the expert opinion obtained by the Commission[796] explains that the experience gathered with conventional drilling technology suggests it is fundamentally possible to operate boreholes for 100 years. According to the opinion, waste could also be retrieved from a borehole that had been kept open over a period of this length.
The requirement that containers be recoverable for 500 years pursuant to the 'Safety Requirements' issued by the Federal Environment Ministry in 2010 is classified as unfeasible in the expert opinion obtained by the Commission in accordance with what is known today. It is true that the emplaced waste could, in principle, be accessed again by overwashing after the borehole had been sealed and recovered as well if necessary. Ultimately, however, it is not possible to make any statements about whether the containers and the structure of the borehole at the depth of disposal would remain sufficiently intact and locatable for the required period of 500 years.[797]

5.4.3.5 Summary

In principle, deep borehole disposal could permit the extensive isolation of waste from the biosphere using redundant, diverse geological barriers and long sections of borehole filled with technical barriers. The great depth of disposal is viewed not least as a feature of enhanced protection against proliferation.
At present, however, the Commission believes the technology for deep borehole disposal is not as mature as that for final disposal in an underground facility.

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[795] Cf. Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) (2016): 'Tiefe Bohrlöcher', K-MAT 52. section 10.3.
[796] Cf. Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) (2016): 'Tiefe Bohrlöcher', K-MAT 52, section 9.
[797] Cf. Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) (2016): 'Tiefe Bohrlöcher', K-MAT 52, p. 217.

Generally, the technology displays a number of problems that are categorised as relevant by the Commission, will require intensive research and development work, and raise doubts about its prospects of feasibility. In this context, mention may be made above all of the emplacement of waste containers in a borehole fluid with the consequences of container and casing corrosion, and the gas generation they would cause. Furthermore, it will be necessary to develop drilling technology for the drilling diameters required at the depth of emplacement, which are not feasible at present (to date: only 430 millimetres), and there is a need for considerable development of the waste containers required for this form of emplacement. A conceivable borehole diameter of 900 millimetres would still only allow containers that would accommodate comparatively small amounts of radioactive material; this means a very large number of containers would be required.

Apart from these considerations, the concept of recoverability would have to be dispensed with because it is categorised as unfeasible according to the current level of knowledge.

The Commission assumes that the technology could be further developed and might then prompt a different assessment of deep borehole disposal. However, it will only be possible for deep boreholes to be considered as an alternative waste management method once the technology is mature and at least as promising as disposal in a geological disposal facility. In particular, the Commission feels deep borehole disposal has no advantages over its preferred solution of an underground facility as far as their time scales are concerned.

The Commission recommends that the developments that are currently taking place in the science and technology, above all in the USA, be observed further and the progress achieved regularly tracked, e.g. as part of the reporting by the project delivery organisation to the regulatory authority and the German Bundestag. Apart from this, the Commission believes it would also be worthwhile for the German authorities to provide appropriate funding for research projects on unanswered questions such as the specific container technology and safety requirements to be applied for borehole disposal. Given the fundamental uncertainty about whether it will be possible for intensive research and development to actually demonstrate the deep borehole disposal pathway represents an option for safe disposal, the search for a site for disposal in an underground facility must not be restricted as a result of this.

5.5 Priority solution: geological disposal facility with reversability/retrievability/recoverability

Having discussed the options for waste management, the Commission has come to the conclusion that the option of a geological disposal facility that has been pursued to date in Germany offers the best opportunity for safe waste management – but with one significant conceptual change. Compared to earlier approaches, which provided for sealing to be carried out as rapidly as possible without particular account being taken of whether the waste would subsequently be retrievable or recoverable, the Commission accords great significance to the reversability of decisions and the retrievability and/or recoverability of waste – unlike under the option described in section B 5.3.5 –, e.g. so that errors can be corrected as required by the Site Selection Act, but also to keep open options for action and scope for decision-making for future generations.

To begin with, the fundamental assumptions and premises of this option are detailed in section B 5.5.1 below. Key terminology is then explained in section B 5.5.2, and a brief account of this option's phases along a time axis is given in section B 5.5.3.
Finally, the central arguments that persuaded the Commission on the Storage of High-Level Radioactive Materials to settle on this option are explained in section B 5.5.5.

5.5.1 Foundations and premises

This option is associated with the ultimate aim of constructing a disposal facility in a deep geological formation in the form of an underground facility that is to be sealed in the (more or less distant) future, and will impose no burdens on the biosphere and future generations. This option is itself multifaceted and may involve very different process pathways. The Commission understands process pathways as clearly stateable steps and processes within the overall process of the search for a site with the best-possible safety, the construction of a geological disposal facility, its filling with waste and its sealing. This includes all observation and evaluation steps, i.e. all the steps involved in process and facility monitoring.[798] All the steps in these process pathways must be set out plausibly at the beginning of the procedure in order to justify the expectation that this pathway will permit a sustainable, responsible, safe solution for the handling of high-level radioactive waste.
As a matter of course, it will remain open to future generations to design the process pathways in detail. This is also true for the specification of important deadlines and arrangements, and even the judgement as to whether the facility is actually to be finally sealed. However, the current aim associated with this option by the Commission is *a safely sealed geological disposal facility*. Only this would satisfy the requirement derived from ethical principles that it will have to be possible for the pathway embarked upon to be followed to its end as long as future generations do nothing to change course and that reversability must only be an *offer* to future generations they will not have to accept in the normal course of events.[799] Decision-making criteria and procedural steps are to be specified in such a way that this aim can be achieved. This is described in detail by section B 6.
The design of process pathways that will lead to a sealed geological disposal facility is to make it possible for a disposal facility to be implemented within a timeframe that complies with the Site Selection Act, and guarantee the greatest possible opportunities to learn and options for reversability. Reversibility, i.e. the capacity to change course during the ongoing procedure, will be required (1) to allow the correction of errors and (2) to keep options for action open for future generations (e.g. to take account of new findings), while (3) it may help to build trust in the process. Concepts for the retrievability or recoverability of waste and/or the reversibility of decisions are central to this approach. Before decisions are taken that will be irreversible or can only be revised with a great deal of effort, transparent, scientifically supported evaluations will have to be carried out at milestones in the process with the participation of the public and the relevant

[798] Cf. section B 6.3.6.
[799] See section B 3.5.

bodies.[800] Forms of monitoring suitable for this purpose will be required if it is actually to be possible for the actors to recognise when there is a need to change course, e.g. to correct errors.[801]

High-level (in particular) radioactive waste is regarded by the Commission as *waste to be managed* that has to be permanently safely disposed of. The retrievability and recoverability of waste are exclusively envisaged in the context of the permanently safe disposal of waste,[802] certainly not with the intention that such materials could possibly be reutilised in future. Admittedly, future generations would be free so take a different view of this matter.

When the site with the best-possible safety is selected,[803] it will in principle not just be the host rock that counts, but also the overall geological situation, and the combination of the host rock and associated technical and organisational disposal concepts tailored to the site in question. It is not possible to state conclusively whether salt, claystone or crystalline rocks are best suited until the particular disposal concept has been specified, a question that does not arise at this level. During the site selection procedure that is expected to commence around 2017, thought will have to be given to all aspects relevant for the possible process pathways that will lead to a sealable geological disposal facility. Apart from the specification of the decision-making criteria and the procedural steps, this will also involve consideration being given to the requirements connected with the retrievability/recoverability of the waste. At the same time, as few decisions as possible are to be taken in advance so that future generations continue to have opportunities open to them to switch to other options. This takes account of the fact that it is not yet possible to conclusively reconcile the different ethical principles that are relevant today, but this remains a long-term task for the time being.[804] Any ideas put forward today about future developments, some of which would be very distant, therefore do not serve the purpose of specifying what should happen in advance, but of exploring all the aspects of the matter that have to be given thought at the beginning of the disposal site selection procedure so that the outcome of the procedure is the selection of the site with the best-possible safety, and showing how the process pathway to get there can be designed from a contemporary point of view.

5.5.2 Reversability, retrievability and recoverability –explanation of terms

The design of the process pathway that will lead to a sealed geological disposal facility is to make it possible for a disposal facility to be implemented within a timeframe that complies with the Site Selection Act, and guarantee the greatest possible opportunities to learn, correct errors and take account of new findings. Concepts for the retrievability or recoverability of waste and/or the reversability of decisions are central to this approach. The following understandings of these terms are taken as the basis for the further remarks that are made:

- *Reversability* of decisions means being able to reverse decisions once they have been taken and switch to different waste management pathways where necessary, e.g. on the basis of new technical options that appear more attractive

[800] On institutional institutional arrangements to ensure these evaluations are carried out, see section B 5.5.4.
[801] Cf., on this issue, section B 6.3.6.
[802] See section B 3.5.
[803] See section B 6.2.
[804] Cf. section B 3.5.

or on account of newly identified problems with the original plan. During the disposal site selection process, this will also include opportunities to return to earlier stages in the procedure. It usually takes some time to reverse decisions, and this incurs certain costs. Such costs are likely to be all the higher, the later the stage at which a decision is reversed.

- *Retrievability* is the capacity to retrieve high-level radioactive waste from a disposal facility again once it has been emplaced there and some of the emplacement galleries and/or boreholes have been finally backfilled and/or technically sealed. Retrieval is the concrete action by which the waste containers would be brought back out of the facility. Retrievability presupposes precautions being taken that – without compromising safety – would facilitate the retrieval of the waste containers and/or guarantee appropriate technologies for this purpose were available, from the infrastructure to the containers.
- *Recoverability* is understood as the possibility of the retrieval of containers of high-level radioactive waste if the geological disposal facility has already been completely sealed. E.g., this could be done by excavating a second underground facility in the vicinity of the original disposal facility, via which the waste would be recovered. The preconditions for this are locatability, i.e. knowledge of the exact location of the waste at the time when they were emplaced, and the intact condition of the containers.

Ensuring reversability during the process, and the retrievability and recoverability of the waste does not mean there is any intention of taking action of this kind at the current point in time. It is purely a matter of keeping options open. It is not necessary or possible to decide today why later generations would maybe wish to retrieve waste. The Commission is concerned to incorporate opportunities for reversability (e.g. to correct errors), retrievability (e.g. to switch to other pathways) and recoverability (in case unforeseen negative developments take place in the sealed disposal facility) into the process in order to make it as adaptive as possible and keep options for action open for future generations in accordance with the requirements that have been derived from ethical principles.[805] To this end, it is necessary to specify when an observation and/or development is interpreted as undesirable and action to correct errors is initiated. It is also necessary to specify which institution has the power to take such action and how appropriate processes can be conducted with the participation of civil society.

5.5.3 Stages of final disposal

Under the parameters that have been described, different concrete ways of implementing this concept are certainly conceivable. The ‘geological disposal facility with reversibility’ option is therefore not a single pathway but a family of pathways. The following account is intended to show how it can be broken down into stages from a contemporary point of view.

Stage 1 Disposal site selection procedure: According to the Site Selection Act, the procedure for the selection of possible disposal sites can potentially be started as of 2017 once a decision has been taken by the German Bundestag. Above all, there will be a need here for clearly scientifically defined, democratically legitimated selection criteria and safety requirements, as well as clear rules on

[805] See section B 3.5.

procedural steps, public participation, the structure of the relevant authorities and decision-making processes. The disposal site will be selected in several steps, during which the eligible regions and/or sites will gradually be narrowed down until the site with the best-possible safety has been determined. As this process unfolds, high-level radioactive waste will continue to be kept at interim storage facilities. If it takes a very long time to select a disposal site or a decision is made to switch to other pathways, safe storage processes that would involve a great deal of technical, economic and institutional effort will possibly have to be initiated, transports to other sites or repackaging in different containers for instance.[806] It will be possible to discontinue the procedure at any time during the selection process and switch to other pathways. The funds already disbursed for the selection of the disposal site will potentially have to be written off. This stage will be concluded with the specification of a disposal site by a decision of the German Bundestag.[807]

Stage 2 Geotechnical engineering of the site: The geotechnical engineering of the site for the emplacement of radioactive waste will initially involve the prior planning and licensing procedure that is required, as well as the provision of the requisite long-term safety cases for the combination of geological barriers and the technical disposal concept. It will then be a matter of constructing the disposal facility with all the necessary technical installations on the surface and underground, including transport routes for the subsequent emplacement of waste. It is likely this stage will be concluded with a 'cold' trial phase, during which the technical functioning of all the emplacement (and monitoring) processes will be tested. The technical preconditions for emplacement must be put in place in advance, e.g. in the form of the containers for the waste and transport routes. During this stage, it will be possible to discontinue the engineering activities at any time and switch to other pathways. The costs would be confined to the writing-off of the funds spent on the selection of the site and the engineering work.[808]

Stage 3 Emplacement of radioactive waste in the geological disposal facility: The emplacement of radioactive waste will commence when the first loaded disposal package is transferred into the prepared geological disposal facility. The disposal packages will be placed in a series of chambers, galleries or boreholes (from the galleries), depending on the disposal concept in question. As soon as one of these storage spaces is full, it will be backfilled to ensure the waste located behind the seal are isolated from the rest of the underground facility and, in particular, the people who work there. The containers will be placed in their final position before the space is backfilled. The spaces will be backfilled subject to the requirements of long-term safety, but in such a way that it will be possible to reopen them and retrieve the waste in accordance with an existing technological concept within an appropriate period of time, i.e. a period similar to that required for the emplacement of the waste in the first place. The design of the packages/containers will also have to ensure retrieval is possible. The disposal facility itself will remain in an operational state during this stage. It will be possible for emplacement to be suspended at any time and continued at a later date or even finally abandoned. It would also be possible to initially emplace some of the waste in a kind of pilot facility and backfill one gallery, then wait a certain

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[806] On this issue, see section B 5.5.3.

[807] Cf. the detailed account of this stage given in section B 6.

[808] Cf. the detailed account of this stage given in section B 6.3.2.

period, e.g. 20 years, to see how the host rock/waste container configuration develops in order to decide on the further action to be taken, which would be informed by the results of this study. Packages that have already been emplaced could remain in place or be retrieved in line with the conclusions that are arrived at. It will be possible to completely discontinue the procedure and switch to other pathways because the underground facility will remain functional. The waste that had still not been emplaced would then remain in interim storage facilities, subject to appropriate requirements concerning the measures taken to guarantee their safety. The end of the emplacement stage will be reached when the last loaded disposal package is transferred into the disposal facility. The disposal packages will be placed in various chambers or galleries, which will be backfilled so that exposure to radiation in the underground facility is minimised.[809]

Stage 4 Observation prior to the sealing of the geological disposal facility: During this stage, the underground facility will continue to be fully functional and accessible once emplacement has been concluded. The observation of its further development (for instance, temperature conditions, the stability of the geological formation and gas generation) will be ensured by monitoring.[810] The aims for the monitoring will have to be specified as early as possible. The emplaced packages will remain in the underground facility, but it will still be possible for them to be retrieved if this is required. It will also still be possible to discontinue the procedure at this stage and switch to other pathways. In this case, the emplaced waste would have to be retrieved and transferred to a safe location on the surface. The sealing of the geological disposal facility will mark the conclusion of this stage, while the amount of time the facility remains open after the emplacement of the waste has been completed will depend on the decisions taken by future generations. It will be possible for the sealing procedure to be halted, and the options that remain will be the same as during the phase after the conclusion of emplacement. The amount of effort involved in changing course will probably continue to increase; however, changes of course will remain technically possible.[811]

Stage 5: Sealed geological disposal facility: Once the geological disposal facility is sealed and has reached its final state, the aim of the safe, zero-maintenance isolation of radioactive waste in the disposal facility will have been achieved. It will continue to be possible for the sealed disposal facility to be observed externally. The extent to which processes within the disposal facility can continue to be observed will depend on the monitoring measures provided for in the course of emplacement or during the phase prior to sealing.[812] Where necessary, it will be possible for the packages to be recovered by drawing on available documentation to excavate a new underground access gallery. Recovery will be possible as long as the site of the disposal facility is known, the documentation can be found and is legible, the disposal packages (containers) are themselves in a recoverable state,[813] and the technical and societal preconditions for recovery (i.e. the excavation of a parallel underground access gallery) are in place. This approach will allow the aim of safe, zero-maintenance final disposal to be combined with the desired

[809] Cf. the detailed account of this stage given in section B 6.3.3.
[810] Cf., on this issue, section B 6.2.
[811] Cf. the detailed account of this stage given in section 6.3.4.
[812] Cf. also section B 6.2.
[813] Cf., on this issue, the requirements set out in section 6.8.

reversibility of decisions, retrievability of waste, measures that permit errors to be corrected and opportunities for learning during the process.

5.5.4 Provision of evidence about the safe isolation of the radioactive waste

The long-term safety of any disposal facility will be founded on the safe isolation of the radioactive waste being permanently guaranteed and any impermissible release of radionuclides into the biosphere prevented within the reference period of one million years. The whole disposal system is always to be analysed with this aim in mind. For disposal in deep geological formations, the disposalsystem will consist of:

- the (conditioned) waste (e.g. the glass matrix of reprocessed waste, fuel elements),
- the emplaced waste containers (technical barrier),
- the geological disposal facility that will surround the containers with its geotechnical barriers (backfilling, gallery seals, shaft seals),
- the isolating rock zone that will surround the disposal facility, contributing to the isolation of the radionuclides, and
- the geological strata that will in turn surround this containment zone or overlie it up to the surface of the Earth, provided they are significant for the site's safety and therefore to be taken into account in the safety case.

A disposal concept will describe how the aim of the long-term isolation of the radioactive waste by the suitable interaction of geological and technical barriers is to be achieved. The following approaches to disposal in deep geological formations are fundamentally possible as ways of providing evidence of safe long-term isolation:

a) The crucial isolation function is assigned to a geological barrier (the 'isolating rock zone').

b) The crucial isolation function is assigned to a technical barrier (based on containers that will be stable over long periods of time and their cladding).

c) The isolating effect of the whole system is achieved by the combination of a sequence of host rock characteristics and technical barriers.

On the basis of these approaches, a disposal concept and an evidence concept are to be developed for each type of host rock and site. It will be possible to use these concepts to demonstrate the system's long-term safety over the reference period. The reference period is set at one million years in the Site Selection Act.[814]

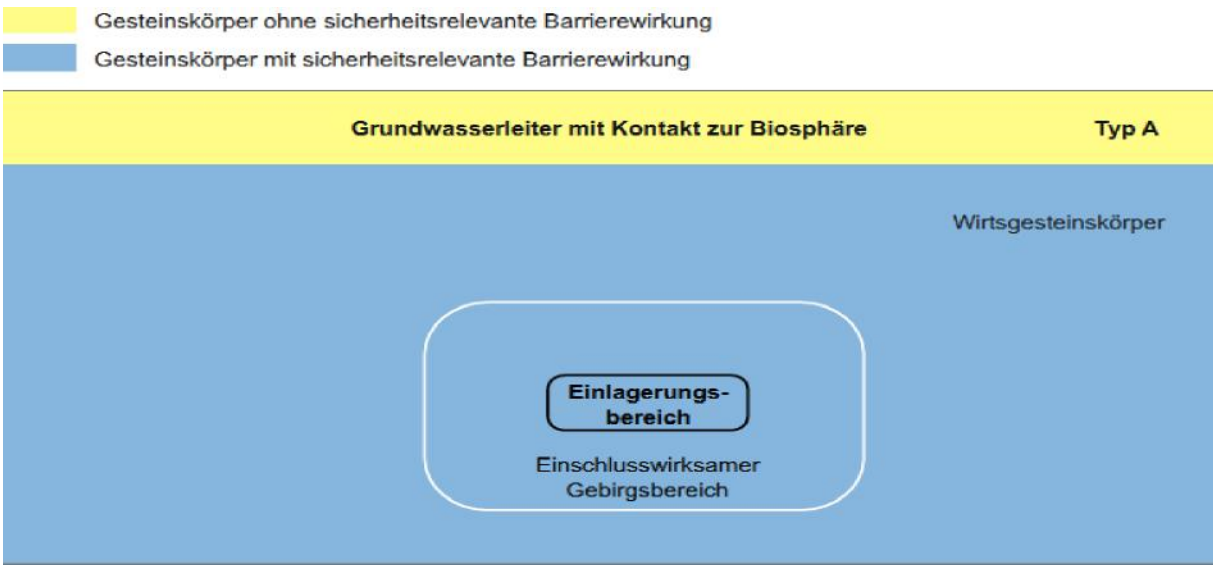
5.5.4.1 Provision of evidence via an isolating rock zone

The 'Safety Requirements' issued by the Federal Environment Ministry in 2010 are founded on the concept of the isolating rock zone. To demonstrate that a geological barrier is able to guarantee the safe long-term isolation of radioactive waste, an isolating rock zone is designated within the host rock around the location where the radioactive waste will be emplaced and/or between the waste and the biosphere. The isolating rock zone concept was developed in Germany by the Committee on a Site Selection Procedure for Repository Sites. In its definition, the

[814] Cf. the Site Selection Act of 23 July 2013, Federal Gazette I, p. 2553, Section 1(1).

Committee on a Site Selection Procedure for Repository Sites described the rock configurations depicted in the graphics below as being compatible with the concept of an isolating rock zone:

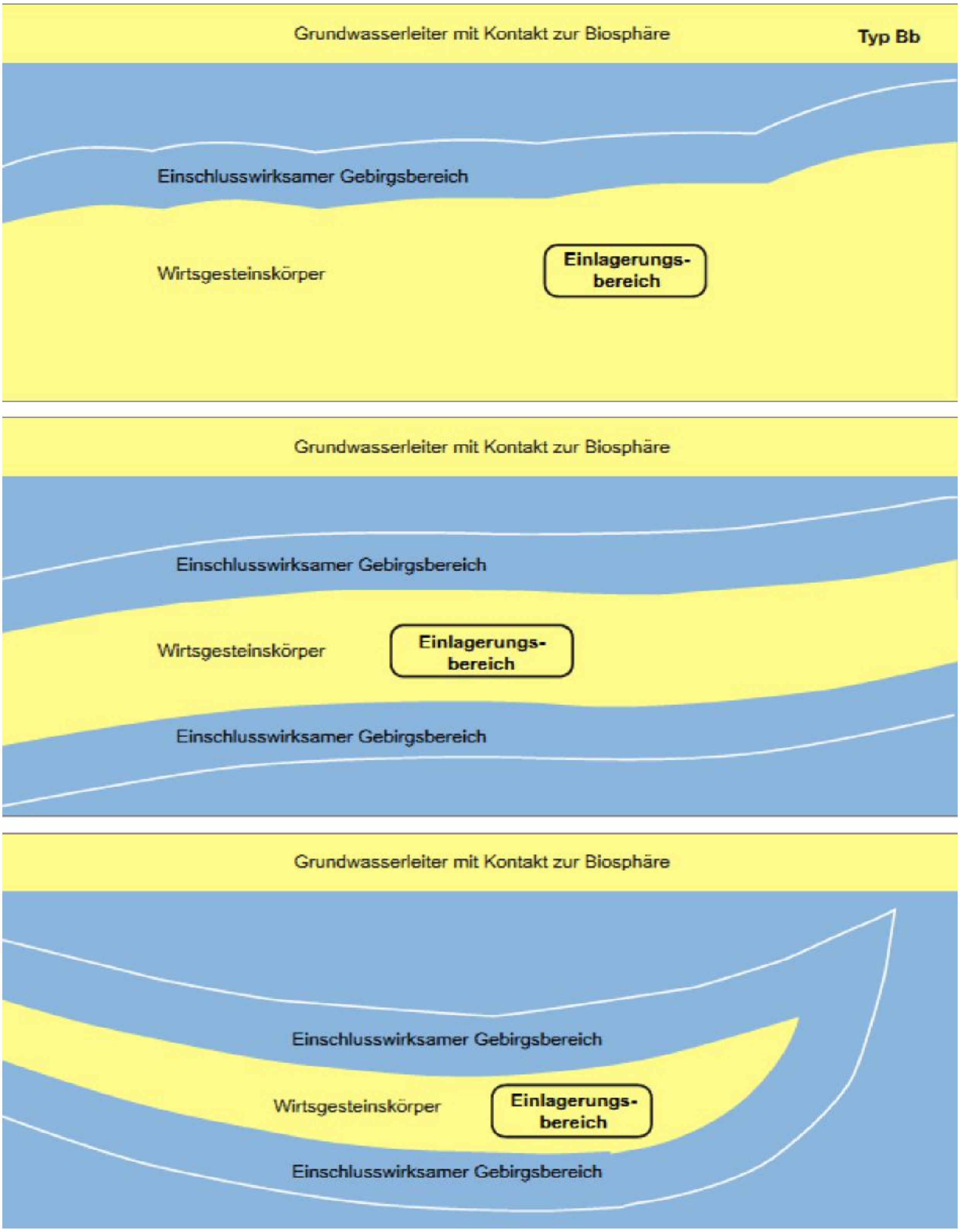
Graphic 12: Configurations between the host rock and the isolating rock zone Types A and Ba



Gesteinskörper ohne sicherheitsrelevante Barrierewirkung = Rock body without safety-relevant barrier effect
Gesteinskörper mit sicherheitsrelevante Barrierewirkung = Rock body with safety-relevant barrier effect
Grundwasserleiter mit Kontakt zur Biosphäre = Groundwater aquifer with contact to biosphere
Typ A = Type A
Wirtsgesteinskörper = Host rock body
Einlagerungsbereich = Emplacement zone
Einschlusswirksamer Bereich = Isolating rock zone
Typ Ba = Type Ba

In Type A, the isolating rock zone is part of a host rock body with a safety-relevant barrier effect and completely encloses the emplacement zone. In Type Ba, the host rock body that surrounds the emplacement zone does not have a safety-relevant barrier effect and forms different configurations with the isolating rock zone. The host rock body is completely enclosed by the isolating rock zone.

Graphic 13: Configurations between the host rock and the isolating rock zone: Type Bb



Gesteinskörper ohne sicherheitsrelevante Barrierewirkung = Rock body without safety-relevant barrier effect

Gesteinskörper mit sicherheitsrelevante Barrierewirkung = Rock body with safety-relevant barrier effect
Grundwasserleiter mit Kontakt zur Biosphäre = Groundwater aquifer with contact to biosphere
Typ Bb = Type Bb
Einschlusswirksamer Gebirgsbereich = Isolating rock zone
Wirtsgesteinskörper = Host rock body
Einlagerungsbereich = Emplacement zone

In Type Bb, the host rock body that surrounds the emplacement zone has no safety-relevant barrier effect and forms various configurations with the isolating rock zone. The host rock body is not completely enclosed by the isolating rock zone. Examples of Type Bb are depicted in Graphic 13 above.
The isolating rock zone is the part of the disposal system that interacts with the geotechnical seals to ensure the isolation of the waste (e.g. shaft seals, gallery seals, backfilling material). In this case, the isolating rock zone represents the main barrier (= geological barrier). Provision is made for geotechnical barriers (shaft and gallery seals, backfilling material) to 'heal' the technical interventions required in the isolating rock zone. Under the isolating rock zone concept, the container has a function as a technical barrier for a limited period of time, but the long-term safety case is not dependent on it.
As far as the different host rock types are concerned, an isolating rock zone concept is, in principle, applicable for suitable rock salt and claystone formations, as well as crystalline formations with low rock permeability. Depending on the local situation, disposal concepts are also conceivable in which not one, but several containment zones would be designated at a site. These isolating rock zones would be spatially separated from one another, and each could be used to finally dispose of a proportion of the radioactive waste safely over the long term. It would also be possible to imagine configurations in which it was not the host rock but the overlying strata that guaranteed safe isolation.[815]
During the proposed disposal site selection procedure, in line with the decision-making criteria described in section B 6.5, it will in the opinion of the Commission be possible to designate an isolating rock zone in such a way that its integrity can be demonstrated over one million years. If the host rock is of sufficiently low permeability, the evidence of the waste's isolation can be provided directly by the complete integrity of the isolating rock zone, including its backfilling and sealing structures. In this case, no radionuclides will be able to leave the isolating rock zone during the reference period ('complete isolation'). Alternatively, it will be possible to show in the course of the evidence procedure that the isolating rock zone will retain radionuclides during the reference period at least to such an extent that only minor releases into the biosphere are to be anticipated that could not result in the limits on effective doses specified in the Federal Environment Ministry's 'Safety Requirements' being exceeded ('safe isolation').
Under the isolating rock zone concept, the containers will, in particular, have the function of guaranteeing the retention of radionuclides when the disposal facility is in operation, as a rule for several decades; furthermore, the waste containers

[815] E.g., see 'Geologische Potentiale zur Einlagerung von radioaktiven Abfallstoffen unterhalb von stratiformen Salzformationen', K-MAT 42.

will have to permit safe handling under radiation protection conditions, potentially in combination with transfer containers. The same safety functions will be demanded of the containers for retrieval measures (that may be necessary) during the operational phase.[816] Once the disposal facility has been sealed, the waste will have to remain recoverable for up to 500 years, which gives rise to requirements concerning the mechanical stability and adequate corrosion resistance of the container. As of the point in time after which recoverability is no longer a requirement, the container will only have to perform a barrier function under the isolating rock zone concept (for several hundred or thousand years) until the long-term safety of the disposal system is demonstrated completely on the basis of the characteristics of the isolating rock zone, i.e. the geological barrier, and the gallery and shaft seals. After this, no credit will be taken any longer from the long-term characteristics of the containers in the safety and evidence concept for the reference period of one million years.

5.5.4.2 Provision of evidence via safe long-term technical barriers

Should the host rock or the surrounding rock not constitute a sufficient barrier, safe long-term isolation will then have to be demonstrated by the technical barriers, in particular, if a disposal facility is to be implemented at a site of this kind. This is conceivable for disposal systems in all the potential types of host rock, and it is mainly being pursued conceptually in countries whose disposal concepts are based on crystalline rock.

The primary technical barrier would be the waste container, which would have to be impermeable over the long term. In the disposal concepts of which the Commission is aware, the containers would additionally be protected against corrosion to ensure they were able to perform this function for the whole reference period of one million years as well. This would be done by covering them with a protective layer (known as a ‘buffer’), which would consist of a swelling bentonite cladding several dozen centimetres thick.

A long-term safety case essentially based on the characteristics of the container and the buffer would not be compatible with the Federal Environment Ministry’s current ‘Safety Requirements’[817] because they demand evidence concerning the isolating rock zone. The existing ‘Safety Requirements’ would therefore have to be amended to allow evidence to be provided in this form, as the Commission also suggests be examined in section B 6.5.1 of the present report.

When evidence of the system’s safety over the whole reference period was provided, the containers and buffer would have to perform the essential barrier function, while requirements concerning retrievability during operation and a subsequent phase of recoverability following the sealing of the disposal facility would also have to be taken into account as requirements concerning the container. Unlike when evidence is provided via an isolating rock zone, the container would therefore not only be safety-relevant for the disposal facility’s operational phase and a subsequent, relatively short amount of time, but for the whole reference period.

[816] See also section B 5.5.2.

[817] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2010): ‘Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste’.

Disposal concepts of this kind proposed at present in other countries (e.g. Sweden and Finland) provide for combinations of mechanically stable inner containers (e.g. made of ductile iron) and corrosion-resistant outer containers (e.g. made of thick-walled copper).[818] A mineral cladding that essentially consists of bentonite would be used as the 'buffer'. Bentonite is a highly swelling clay that swells if there is any ingress of moisture, as a result of which it would isolate the enclosed containers from water (and the ingress of salt solutions) in their immediate surroundings. This would depend on the bentonite product deployed as a buffer[819] being packed carefully with sufficient density about the waste containers, and no, or only negligible, erosion processes having to be anticipated immediately around the buffer area. The rock would have to be slightly damp in order to trigger the necessary swelling process in the bentonite and allow it to run its full course. The requirements placed on the combination of the containers, the buffer and the surrounding host rock would be intended to ensure that any container failure involving a release from the container would only be possible on such a small scale that it would not result in impermissibly high releases of radioactive substances into the biosphere.

If evidence was provided essentially on the basis of technical barriers, the surrounding host rock would have the function of ensuring the mechanical stability of the emplacement cavities. In addition to this, the choice of the host rock and the buffer would have to ensure that the fundamental requirements concerning the permeability of the host rock were also complied with over the long term and there was a stable, non-corrosive geochemical environment on the surface of the container. The depth of the geological disposal facility would primarily ensure the emplaced waste was protected from exogenous influences (ice ages, erosion). The host rock would not perform, or would not be crucial to, the function of preventing contact with water or radionuclide discharges during the reference period.

5.5.4.3 Provision of evidence via a combination of host rock characteristics and technical barriers

Combined concepts could also be developed that, while exploiting both the characteristics of the host rock and technical barriers, brought together existing, but maybe not completely isolating, characteristics of the host rock with the isolating characteristics of technical barriers, the combination of which would open up a further option for the demonstration of safe, long-term isolation. This is true for host rock formations that have a relatively high capacity to isolate waste from influences in the biosphere. In this respect, it would be characteristic that the geological and technical barrier(s) would have to be arranged in succession to prevent and/or limit possible releases, which means they would only have staged effects. The barrier characteristics of the host rock would be backed up by the barrier characteristics of the containers and buffers so that, in combination with one another, they could be used to demonstrate long-term safety over the required period of one million years. The evidence of safe isolation would then be based on an integrated analysis of the interplay of the technical and geotechnical barriers, and the characteristics of the host rock. It would be accepted there was no way of

[818] See sections B 4.2.3, B 4.2.4 and B 6.8.
[819] Internationally, various mixtures and product types have been developed.

ruling out the possibility that a certain percentage of containers would fail during the reference period. It would have to be set out conceptually how weaknesses in the geological barriers could be compensated for over the reference period by means of technical and geotechnical precautions and/or weaknesses in the technical barrier compensated for by the requirements placed on the geological characteristics of the host rock so that, at most, any release of radionuclides into the biosphere was below the relevant limits. The current Federal Environment Ministry ‘Safety Requirements’ would also have to be amended to permit the demonstration of safety in this way.

5.5.4.4 Status of evidence strategies in the disposal site selection procedure

In the opinion of the Commission, the isolating rock zone concept has the advantage that, as far as the long-term safety to be demonstrated is concerned, it is based on the geological characteristics of the disposal system, which may be viewed as comparatively reliably predictable at suitable sites. Although technical barriers will increase the robustness of the disposal system under this concept, the long-term safety to be demonstrated in the evidence procedure is not dependent on them. By contrast, apart from contributing to robustness, geotechnical barriers also have to make a relevant contribution to the system’s long-term safety – depending on the safety concept.
By contrast to this, under an evidence concept that was essentially founded on technical barriers (containers/buffers), predictions would have to be based on the long-term characteristics of these technical barriers.
The Commission does not rule out alternative methods of providing evidence with a stronger emphasis on technical barriers in principle. Under the geological parameters to be anticipated in Germany, they would be resorted to if disposal and evidence concepts were developed for sites where it could not be demonstrated the isolating rock zone had sufficient integrity. If this approach was taken, it would have to be shown that a long-term safety case based on container technology, a buffer and geotechnical barriers, potentially in conjunction with favourable host rock characteristics, would allow statements about the system’s safety to be made that were equivalent to and equally robust as a long-term safety case based on an evidence concept for an isolating rock zone.

5.5.5 Grounds for prioritisation

The central arguments for further elaborating the option described above, a ‘geological disposal facility with reversibility’, and recommending it to the German Bundestag are summarised below:

- This solution will be feasible in Germany in the foreseeable future (unlike most of the options discussed in sections B 5.3 and B 5.4).
- Some of the technical preconditions (containers, excavation and operation of the geological disposal facility, emplacement and sealing) are already state-of-the-art technology today, while the satisfaction of other technical preconditions appears feasible.
- This option does not conflict with the provisions of international law (unlike some of the options discussed in section B 5.3).

- Unlike, e.g., the concept of indefinite near-surface storage discussed in section B 5.3.4, this option will free future generations from the burdens imposed by radioactive waste as of a particular point in time (which may be very far off).
- Unlike most of the options discussed in section B 5.3, this option will allow a high degree of flexibility for the utilisation of newly acquired bodies of knowledge. During this process, it will remain possible to switch to other disposal pathways for a long time, which would demand a reasonable amount of effort and not cause any safety problems.
- This option will also offer far-reaching opportunities to learn from previous process steps and the action taken to correct errors (e.g. monitoring measures).
- From a contemporary point of view, it therefore accords best with the requirements derived from ethical principles.[820]
- Extensive scientific information is available about the requisite geological preconditions (passive safety systems, barriers) that make the implementation of this option appear highly promising.

In the opinion of the Commission, this means the 'geological disposal facility with reversibility/retrievability/recoverability' option is the most promising way of dealing responsibly with high-level waste in Germany.

5.6 Time required to implement the recommended waste management pathway

Under the Site Selection Act, the selection procedure for possible disposal sites can start as soon as the Bundestag and Bundesrat have evaluated the Site Selection Act on the basis of the present report from the Commission on the Storage of High-Level Radioactive Waste, and the procedure has been established by legislation with its criteria and foundations for decision-making. It will be possible for this to happen in 2017 at the earliest. The requisite institutions will then have to be established at the outset.
The amounts of time it will take to implement the procedure until a site is specified, the emplacement of waste is commenced or the geological disposal facility is sealed can only be estimated with difficulty from a contemporary point of view. The timescales may extend far into the future on account of long processes, intended or unintended waiting periods, disputes before the courts, alterations to the course of the process, changes of plan and decisions to return to earlier stages.
It is therefore not worthwhile at present specifying a schedule that sets precise deadlines. For what is decisive today is to begin the selection of a disposal site with the best-possible scientific, societally legitimated, responsible set of selection criteria and procedural steps. The question of the amount of time that would be required is nevertheless of great significance in several respects:

- It will crucially influence the technical requirements for necessary interim storage, the configuration of licensing procedures and the measures taken to ensure the safety of the intermediate storage facility until the waste is emplaced in a disposal facility

[820] On this issue, see section B 3.5.

- The amount of time required will partly determine the scale of the burden imposed on future generations by the waste produced during the use of nuclear energy
- The longer the procedure goes on, the greater will become the risks of societal instability, a weakening of the requisite diligence, a loss of societal interest, and therefore the public and civil society ceasing to pay attention to the matter
- The longer the periods of time under discussion today last, the easier it will be for a mood to take hold that encourages the view that these long periods of time mean there is no need to deal with the topic with any sense of urgency – a self-fulfilling prophecy that would further increase the amount of time required.

One customary approach taken when dealing with uncertainties about the future is the development of scenarios. Two qualitative scenarios are briefly described below that derive from different principles and are therefore not comparable at the same level: (1) the Site Selection Act, with the timings it mentions, serves as a framework; (2) the time required for the different steps is estimated and totalled drawing on up-to-date, empirical figures sourced from similar projects.

(1) According to the Site Selection Act, a disposal site is to have been specified by 2031. Subsequently, the licensing procedure will be commenced with the aim of obtaining a construction and operating licence for the disposal facility. Once the licence has been granted, the geotechnical engineering of the site for the emplacement of high-level radioactive waste will take a number of further years. Under this scenario, the implementation of all the required geotechnical functions is to be concluded in approx. 2050, so that it will then be possible to begin the emplacement of the waste. From a contemporary point of view, the emplacement operations will last at least 20-30 years. Depending on the time spent on post-emplacement monitoring, decision-making and the implementation of the sealing works, if would still be conceivable for the disposal facility to be in its sealed state before the end of the present century. The sealed geological disposal facility could continue to be observed externally – and where necessary also internally with appropriate measuring technology. Scenario 1 does not allow for decisions to return to earlier stages or unforeseen events.

(2) Informed by what recent experience suggests would be plausible amounts of time for the licensing procedure, public participation, coordination and consideration processes, legal redress proceedings, the reanalysis of data and the exploration of different areas, markedly different timescales are arrived at speculatively.[821] In line with past experience, just Phase 1 of Stage 1 would take four to five years, and the whole of the first stage between 35 and 61 years. Commissioning (the beginning of the emplacement of waste) could not be anticipated until the next century, and sealing not until late in the next century.

The range of differences between the two scenarios in terms of the amount of time required until emplacement and/or sealing is evidently very great. A look at the phases of the disposal site selection procedure[822] will show that scenario 1 is ultimately unrealistic.[823] The approx. 13 years allowed from the beginning of the disposal site selection procedure to the target point of 2031 can be divided plausibly between the phases as follows:

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[821] Cf., on this issue, K-Drs./AG3-119.
[822] On this issue, see the detailed discussion in section B 6.3.
[823] Cf., on this issue, 'Entwurf des Berichtsteils zu Teil B – Kapitel 5.6 (Zeitbedarf zur Realisierung des empfohlenen Entsorgungspfades): Änderungsvorschläge von Herrn Prof. Dr. Thomauske zu K-Drs. 160 b', K-Drs. 160c.

- Phase 1 (specification of possible siting regions for surface exploration on the basis of available data), including all quality assurance and participation measures, would probably only last approx. three years.
- Phase 2 (surface exploration as a means of selecting sites for underground exploration), including all quality assurance and participation measures, should only require approx. four years.
- Phase 3 (underground exploration and comparative consideration), including all quality assurance and participation measures, should only last approx. six years until the Bundestag takes a decision about the site.

The experience of the time taken for major projects (e.g. the ongoing search for a disposal site in Switzerland) shows more than clearly that contemporary estimates suggest such a schedule will not be practicable. In particular, the amounts of time required by potential follow-up studies and court cases are not factored in.

However, the need for noticeably longer amounts of time would cause considerable problems. Such lengthy timescales would significantly burden following generations, conflict with ethical demands,[824] make extensive interim storage arrangements necessary (subject to appropriate safety requirements and licensing procedures), entail the danger of waning enthusiasm and fatigue, and increase the risk of the whole process not being concluded purposefully.

Measured against the ethical requirements to which the Commission has committed itself, it is necessary to work for the whole process to be implemented within a justifiable timeframe. A considerable dilemma evidently arises here that is ultimately rooted in unresolvable conflicts between different aims. The three central aims,

- the greatest-possible safety throughout the process and for the sealed disposal facility,
- the most extensive possible involvement of the public and the configuration of the whole process as a self-interrogating system, and
- the shortest-possible duration of the procedure

cannot be achieved simultaneously. Guaranteeing safety, careful consideration and extensive participation will require time and lengthen the procedure. The procedure will last for many, many years, and will run on well beyond 2031/2050. Options that would speed up the procedure at the expense of safety or participation have been rejected by the Commission. Building trust takes time and conflicts with approaches intended to speed up the procedure. By the same token, it may be possible to limit the extent to which the procedure runs on once a high degree of societal trust has been built up.

In view of the need to consider these issues, the Commission has adopted the following position:

- In terms of its weighting, the time required is of lower priority than the aims of safety and participation.
- The situation of the intermediate storage facilities is also to be taken into account when the issues are considered.
- The project delivery organisation is to develop a framework schedule with key deadlines and milestones at an early stage in the disposal site selection procedure.
- All the parties involved are called upon to optimise the disposal site selection procedure and the construction of the disposal facility so they are implemented as

[824] Cf., on this issue, section B 3.

expeditiously as possible, and the delivery of the project is managed as time-efficiently as possible.

- Procedural steps should be followed in parallel where this is possible.
- Research is to be funded in order to develop options that allow time-intensive processes, such as underground exploration, to be shortened.

It would now be possible to ask whether a solution for high-level radioactive waste could be put in place more rapidly with options other than a geological disposal facility with reversability/retrievability/recoverability.[825] However, this is not the case. For there are neither developed technologies nor sites for any of these options at present. In a best case scenario, the process would consequently take just as long until the first waste package had been disposed of under other options as it would under the approach described above; due to the difficulties involved in investigating sites and the time required to develop technologies, however, it is likely other options would tend to take markedly longer. Even once the technology of another option had been implemented and was functioning, several decades at least would be required to 'dispose of' the existing waste. All in all, it is to be concluded that, from the point of view of the amount of time required, none of the other options offer any advantages over the option of a geological disposal facility with reversability/retrievability/recoverability.

5.7 Necessary interim storage prior to final disposal

Until the waste is emplaced in the disposal facility, it is to be kept in interim storage. To distinguish it from 'long-term interim storage', the Commission refers to this form of interim storage[826] as 'necessary interim storage' because it is not regarded as a waste management option *per se* and is to be reduced to what is unavoidable until the waste is emplaced in the disposal facility. It was not the Commission's task to develop criteria for necessary interim storage as well. In view of the timetables that have been set out[827] and the connections that exist between final disposal and interim storage, however, necessary interim storage is a topic that cannot be ignored. Even under the optimistic timescale of the Site Selection Act, there will be a time gap between the expiry of the current licences for the interim storage facilities at the sites of nuclear plants and the emplacement of the first containers in the disposal facility, all the more so the complete emplacement of all containers. This gap may last for between five years and many decades – depending on whether there are delays, set backs or decisions to return to earlier stages of the procedure.

In principle, the interim storage facility licences can be extended, but this should not be done without reflection. The objective specified in the National Waste Management Programme of avoiding any additional transport of each Castor cask (to another interim storage facility site and/or from this site to the disposal facility), and therefore transporting the casks directly from the on-site and centralised interim storage facilities to the disposal site is undoubtedly commendable. The National Waste Management Programme and the objectives it specifies are subjected to regular reassessment every three years as part of a review process (Directive 2011/70, Article 14(1)). It is to be borne in mind in this

[825] Described in sections B 5.3 and B 5.4.
[826] See section B 5.4.1.
[827] On this issue, see in particular section B 5.6.

respect that, against the background discussed above, the interim storage of radioactive waste is of noticeably more tangible significance to the current generation than a disposal facility that will not go into operation for several decades. If the emplacement of the last packages during the period from 2070 to 2075 is regarded as optimistic today, then there is certainly a real prospect for the people in the municipalities with nuclear sites that high-level radioactive waste will be stored near their homes for most of their lives.

It is also to be borne in mind that the parameters for on-site interim storage will shift over the next few years. The nuclear power plants will be closed and dismantled, and the handling equipment there will cease to be usable early on in the dismantling process. This is why it will have to be examined during the licensing procedure for the extension of interim storage whether the installation of hot cells is required. The nuclear power plants' staffing levels will be lowered further and further, and the organisational links between the on-site interim storage facilities and the nuclear power plants will be severed (autarchy). Following the emplacement of the last containers from the nuclear power plants, roughly during the period from 2025 to 2027, it will only be a question of interim storage until they are transported to the site of the disposal facility for conditioning. Practical handling activities at the sites (loading and unloading procedures, the handling of fuel elements, container movements) will not be carried out during this period, which will last for decades under certain circumstances, so giving rise to challenges for the preservation of the necessary know-how. Levels of acceptance for the on-site interim storage facilities could fall if, as the last remnants of the use of nuclear energy, they hold up the complete release of the power plant sites from nuclear regulation and those sites' subsequent conventional use. It is possible the operators will also undergo drastic changes.

During the disposal process, these parameters could place increasing pressure on the project delivery organisation and the licensing authority to make the disposal facility available as soon as possible, all the more so if problems were identified when containers were checked or if repairs had to be carried out. However, the most expeditious possible search for a site and commissioning of the disposal facility must not result in the primacy of safety being neglected when it comes to the emplacement of radioactive waste, and necessary steps and potentially also decisions to return to earlier stages not being taken or not being taken with the thoroughness they deserve. At this point, the search for a disposal site and the interim storage concept are intertwined with one another. Apart from this, there are further points of contact: At the interim storage facilities, the container inventories will have to remain in a state that will still potentially allow them to be repackaged into the containers appropriate for the disposal concept in question, and they will have to remain transportable. The timing of their removal from the interim storage facilities will have to be coordinated with the conditioning at the disposal site required under the disposal concept. It is uncertain whether the receiving storage facility envisaged in the National Waste Management Plan will exist, and if so how large it will be. If this storage facility were to be constructed before the disposal facility had a valid licence, the impression would be created that a decision had already been taken in advance, which would prompt doubts about the legality of the procedure. Furthermore, if a large receiving storage facility were constructed, this could be perceived as a greater burden than a disposal facility in the discussion at the local level. Furthermore, a range of other developments are difficult to

predict, such as the evolution of the techniques used to protect against interference by third parties, which has become highly dynamic in recent years. All this militates in favour of not only scrutinising the final disposal of high-level radioactive waste, but also their necessary interim storage.
In view of the background that has been described and the practices that are commonly followed, regular reviews of the resilience of the current interim storage concept are therefore to be recommended. In particular, these reviews will have to cover the following aspects: necessary measures for the continuing safe interim storage of irradiated fuel elements and waste from reprocessing until the last container has been cleared, steps to guarantee the technical transportability of the interim storage containers as a precondition for the granting of a transport licence, should one be needed, professional ageing management, regular random checks on the status of the inventory, the possibility of repairs to containers and repackaging at central or decentralised facilities, the preservation of personnel's technical expertise, aspects of installation security, levels of acceptance for storage and the development of the nuclear power plant sites. Where relevant, statements should also be made about how long the current concept will still be viable for from these points of view. This also means examining the advantages and disadvantages of consolidated interim storage at several larger sites, and various variants of transfer to an intermediate storage facility at the disposal site (buffer store for parts of the total volume of waste, storage facility that has the capacity for all containers and allows parallel emplacement activities in different parts of the same disposal facility). The next time the National Waste Management Programme is updated, the German Federal Government should examine the interim storage concept, including the planned receiving storage facility, to ascertain what is necessary in order to optimise it and where modifications are needed.
In a discussion paper published in October 2015 (K-MAT 41), the Nuclear Waste Management Commission[828] followed up a detailed analysis by highlighting a series of aspects to be clarified with regard to interim storage and the subsequent waste management steps, including:

- The safety cases required for the containers and extended interim storage inventories will require sufficiently robust data and information gained by evaluating the experience of operations and additional programmes of investigations.
- Programmes of investigations to provide evidence about the long-term behaviour of container components (e.g. metal seals) and inventories (e.g. the integrity of fuel rods) for extended interim storage should be initiated at an early stage.
- The availability of all replaceable container components (e.g. tightness monitoring systems, metal seals, trunnions, screws) must be guaranteed for the whole period during which waste will be kept in the interim storage facility.
- The behaviour of fuel elements is of essential significance for the suitable conditioning concepts that will be required for subsequent final disposal. Restrictions on the options for the conditioning of the fuel elements will have repercussions for the disposal concepts that can be implemented and are therefore to be taken into account as early as possible when such concepts are developed.

[828] See http://www.entsorgungskommission.de.

• Both the construction of new intermediate storage facilities and the extension of the periods for which waste will be stored in the 16 municipalities where they are sited will require acceptance in the societal and political spheres.
If there is a significant extension of interim storage, the preservation of competences over very long periods of time will come to be of great significance. These questions are also important in the view of the Commission on the Storage of High-Level Radioactive Waste. The research and development work needed on the aspects mentioned above is to be examined on an ongoing basis, and relevant studies are to be initiated.

PROCESS PATHWAYS AND DECISION-MAKING CRITERIA

6.1 Aims and procedure

After having previously derived and justified its preference for the 'deep repository with reversibility/retrievability/recoverability' pathway group, the Commission will now proceed to describe in detail the process pathways and decision-making criteria offering the best-possible safety to be applied when searching for a disposal site.
To start with, section 6.2 will explain how to determine a site that offers the best-possible safety. Section 6.3 then provides a detailed overview that includes a precise description of the individual stages and phases of disposal along with the procedure and role of the individual parties involved. This section also includes a description of the process monitoring, which is a key aspect when it comes to questions about reversibility. It should be noted that the key question of public participation will be covered separately in section 7.

The Commission holds the view that the entire process must be set up as a self-interrogating system. This will be covered in more detail in section 6.4. Following that, section 6.5 provides a detailed description of the decision-making criteria for the selection procedure. Ethical considerations already covered in section 3.4 play a relevant part when it comes to decision-making criteria. Section 6.5 itself deals with existing rules such as safety requirements.[829] It also contains the method derived for the safety studies set forth in the Site Selection Act, as well as several criteria to be applied throughout the course of the procedure as a further development of the criteria proposed by the AkEnd.

As considerations are being made to also dispose of certain other radioactive waste along with high-level radioactive waste, section 6.6 analyses and derives the requirements governing emplacement of other radioactive waste. Detailed specifications are to be documented for the process as a whole[830] since such documents will need to be consulted at a later stage and thus play a vital part in this extremely prolonged process.

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[829] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2010), 'Sicherheitsanforderungen an die Endlagerung wärmeentwickelnder Abfälle' (translation: 'Safety Requirements Governing the Disposal of Heat-Generating Radioactive Waste').
[830] Cf. section B 6.7 of the present report.

Along with the geological situation, the containers are an essential aspect of ensuring safety throughout various phases of the process, which is why the Commission has specified container requirements in section 6.8. Section 6.9 considers another key aspect involving the research and technological development necessary for disposal.

6.2 How to determine a disposal site offering the best-possible safety

According to Section 1(1) of the Site Selection Act, it is the 'aim of the disposal site selection procedure to find the site for an installation for the disposal of domestically produced, in particular high-level radioactive waste that guarantees the best-possible safety for a period of one million years.[831] The achievement of this objective was the central challenge faced by the Commission.

The task of determining the disposal site with the best-possible safety must be resolved during the site selection procedure. This procedure, with its process steps, but above all with its decision-making criteria, must be organised in such a way that the disposal site with the best-possible safety is arrived at as the outcome in a transparent, readily understandable fashion. Taking into account the specifications set forth in the Site Selection Act and the safety requirements provided by the Federal Ministry for the Environment, the Commission defines the best-possible site as follows:

The site for a disposal facility that is being sought for, in particular, high-level radioactive waste will offer what is, in accordance with the current level of knowledge, the best-possible safety for the permanent protection of humans and the environment against ionising radiation and other harmful effects of such waste for a period of one million years. This disposal site is to be selected in accordance with appropriate requirements in a step-by-step procedure by comparing the sites deemed eligible and suitable during each phase. The burdens and obligations placed on future generations are to be kept as low as possible. Guided by the vision of sustainability, the disposal site with the best-possible safety in accordance with the latest advances in science and technology will be specified using the selection procedure described in the present report, as well as the applicable criteria and safety studies it discusses. It must be possible for errors to be corrected during the selection procedure and subsequently at the disposal site that is found.

This means short, medium and long-term safety will have priority over all other aspects of the matter. During the disposal site selection procedure, it will be necessary to determine the best-possible site from a safety perspective. This definition stipulates the best-possible disposal site rather than the best site from a safety perspective because there may be a number sites promising safe disposal, yet it is not possible to have absolute clarity in terms of all potential sites. The best-possible disposal site from a safety perspective is to be demonstrated from among the list of potential sites. This therefore requires criteria distinguishing between potential and unsuitable disposal sites (exclusion criteria and minimum

[831]Act to Find and Select a Site for the Disposal of Heat-Generating Radioactive Waste and to Amend Other Acts (Site Selection Act - StandAG) of 23 July 2013. Federal Gazette I, p. 2553.

requirements) as well as criteria permitting comparative safety studies and corresponding considerations between the potential sites with a view to determining the best site from a safety perspective (consideration criteria). This approach imposes the main burden on the selection procedure and criteria used during the procedure so that the results of the search are in line with expectations and able to withstand scrutiny. To this end, the Commission chiefly uses the long-term effect of geological barriers [832] aimed at keeping radioactive materials away from humans and the environment. If deemed necessary, the geological barriers may also be complemented by technical barriers. Geoscientific exclusion criteria, minimum requirements and consideration criteria thus form the core set of criteria.[833] Together with the safety studies, this set of criteria are of utmost importance in terms of gradually steering the selection procedure towards the disposal site offering the best-possible safety.

This set of criteria will be kept constant throughout the selection procedure in order to avoid any contortions. They will be applied multiple times during the phases of the selection procedure[834], with an ever-increasing level of detail and increasingly precise data added during each phase, starting with the data already available (Phase 1) and moving on to the additional data gleaned from surface exploration (Phase 2) and then complemented by the data resulting from underground exploration (Phase 3). In this fashion, the pathway will gradually be followed from the 'blank map' all the way through to the identification of the disposal site with the best-possible safety.

This procedure requires utmost transparency and quality assurance, which is why it will undergo scientific review and public discussion while also serving to provide the given participation opportunities. In order to ensure this, the procedure forms part of a 'self-interrogating system [835] accompanied by process monitoring.[836] Particular attention will be paid to early error detection and their remedy.

The set of criteria will therefore be used to steer the selection procedure towards the disposal site with the best-possible safety, while the adequate application of the criteria (consideration criteria in particular) will have to be scrutinised during the procedure itself. The Commission regards this unprecedented procedure as ambitious, yet feasible.

6.3 Overview of the recommended disposal pathway

The present process of ensuring safe disposal of radioactive
waste for one million years can be divided up into the following stages:

- Stage 1 – Disposal site selection procedure
- Stage 2 – Geotechnical engineering of the site
- Stage 3 - Emplacement of radioactive waste in the deep repository
- Stage 4 - Observation prior to the sealing of the deep repository
- Stage 5 - Sealed deep repository

[832] On this issue, see section B 5.5.
[833] On this issue, see section B 6.5.
[834] See section B 6.3.1.
[835] Described in section B 6.4.
[836] Cf. section B 6.3.6.

These stages, which were already outlined in this report [837], will be described here in more detail.
Before initiating the process, there will be a period of time between submission of the Commission's report on the Storage of High-Level Radioactive Materials to the German Bundestag and the Bundesrat on 30 June 2016 and initiation of the disposal site selection procedure. During this period of time, the German Bundestag and Bundesrat will discuss and adopt the Commission's report, and then use the Commission's recommendations as a basis for further development of the Site Selection Act. The disposal site selection procedure will commence once the statutory and organisational requirements have been met.

Until that time, the following organisational requirements must be met:

- The project delivery organisation needs to be prepared so that it can immediately assume its duties. In contrast to the Site Selection Act, the Commission suggests that the project delivery organisation be founded as a private entity that is nonetheless fully owned by the state,[838] this proposal is also mentioned elsewhere within the present report. It is likely that a legal basis will be created to accommodate this change.
- The Federal Office for the Regulation of Nuclear Waste Management (BfE) needs to be made fully functional for its role as the licencing and supervisory authority of the disposal site selection procedure and as the organisation that will deliver the public participation.[839]
- The Commission also considers it expedient to set up the National Societal Commission[840] during this period so that it can commence its work before the disposal site selection procedure starts.

In terms of the scientific data and information required for the disposal site selection procedure, the Commission also considers it imperative to start providing available geological data at an early stage.[841] This can also be before the disposal site selection procedure formally begins. In order to ensure participation, it would make sense to set up a collaboration between the Federal and Land authorities, and to pool corresponding information and data held by the Federal and Land authorities. The legal basis needed to be able to use third-party geological data during the disposal site selection procedure should also be put in place. All of this information must be supplied to the project delivery organisation in as usable a form as possible once the disposal site selection procedure gets underway.

6.3.1 Stage 1: Disposal site selection procedure

The procedure can start following the decision of the German Bundestag and Bundesrat. The actors, procedural steps and decision-making criteria that are to be provided for and updated in the Site Selection Act on the basis of the Commission's recommendations will form the core of the procedure.

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[837] Cf. section B 5.5.3 of the present report.
[838] See section B 8.2.
[839] See section B 7.3.3.1
[840] See section B 7.4.1.
[841] See section B 6.5.8.

As governed by the Site Selection Act, the selection procedure will be split up into the phases set out below. One criterion is that at the end of a phase, a report containing the results gleaned to date and the approaches used to arrive at said results is to be submitted and then discussed and examined by the 'review entities', i.e. the general public, scientific bodies, the Federal Office for the Regulation of Nuclear Waste Management (BfE), and the German Bundestag and Bundesrat. The latter will then make a final decision regarding each subsequent phase based on the results of this process.
Phase 1: Start with a 'blank map' of Germany. Exclusion of regions in line with the agreed exclusion criteria and minimum requirements. A comparative analysis will be performed on the basis of available data and in accordance with the specified consideration criteria and the representative preliminary safety studies; this will allow for the identification of a number of potential siting regions for surface exploration
Phase 2: Surface exploration of the potentially suitable disposal facility siting regions identified in Phase 1. A comparative analysis will be accompanied by considerations based on the agreed exclusion criteria, minimum requirements and consideration criteria, as well as further developed preliminary safety studies. This shall result in a list of sites to undergo underground exploration.
Phase 3: Underground exploration of the disposal sites selected as the outcome of Phase 2. An in-depth study will be performed into the requirements placed on safe disposal. Comprehensive preliminary safety studies. Comparative consideration of possible disposal sites with the aim of identifying the site with the best-possible safety. This phase is concluded upon specification of the disposal site by the German Bundestag and Bundesrat.
The exclusion criteria, minimum requirements and consideration criteria to be applied, and the requirements placed on safety studies will remain valid throughout all three phases. They will be applied in an increasingly detailed manner and with ever more precise data between Phase 1 and Phase 3.

6.3.1.1 Phase 1 of the disposal site selection procedure

6.3.1.1.1 Overview of Phase 1:

Phase 1 of the disposal site selection procedure involves execution of Section 13 of the Site Selection Act to 'Identify eligible siting regions and select those to undergo surface exploration', followed by execution of Section 14 of the Site Selection Act 'Decision on surface exploration'.

In terms of geological information, work performed during Phase 1 will be based on data available to the specialist geological authorities in Germany. This phase will not involve any technical exploration or collection of additional geological data. However, extensive review and interpretation of the available information is required at this stage. It may become necessary to reanalyse data if the immediately available level of knowledge is insufficient for an assessment, and an in-depth evaluation of the raw data that are available throws up additional findings.[842]

[842] See also section B 6.5.8.

The geological and theoretical planning assessment in Phase 1 must be performed in several steps. Logically, the sequence of steps is based on the principle of primacy of safety, which forms the basis of the entire search procedure. This step-by-step procedure also acts as a standard for the project delivery organisation when organising its work internally.

The first step is to create the geological exclusion criteria, followed by the minimum requirements (step 1). Geological consideration criteria are then applied to narrow down the selection even further (step 2). Step 3 involves in-depth consideration by reapplying the geological consideration criteria and evaluating the results of the representative preliminary safety studies. This is the only way to assess the safety of a site, and thus why theoretical planning consideration criteria (which do not provide any safety statements) are created afterwards in order to further narrow down the selection based on subareas identified as being suitable from a safety perspective.

The representative preliminary safety studies in this phase are still of a highly generic nature since there are no in-depth insights available as to the given disposal site's geology and associated uncertainties.

The project delivery organisation must forward the proposal concerning eligible subareas, the associated preliminary safety studies and the proposal for a selection of siting regions for surface exploration put forward on this basis to the Federal Office for the Regulation of Nuclear Waste Management.[843] This means that a report is to be submitted that contains both the proposal for eligible subareas and the selection of siting regions for surface exploration.[844]

After step 2, the project delivery organisation must submit an interim report on the identified subareas which the BfE can use as a basis for a 'Subareas Conference'.[845] Unless public participation gives rise to the need for modifications, this interim report will form part of the project delivery organisation's report.

The project delivery organisation's report is to set out exactly how the results have been arrived at by providing transparent documentation, and explaining the grounds for all the steps and decisions that have been taken. The report constitutes the proposal put forward by the project delivery organisation, not the result of Phase 1.

The Commission proposes that this report should also set out and justify the grounds for the project delivery organisation's suggestions for the site-specific exploration programmes for the statutory requirements and criteria to be applied in Phase 2.[846]

After the project delivery organisation submits its report to the BfE, the latter will begin its scientific review and public discussion along with the opinion-forming process. This will be followed by a decision taken by the German Bundestag and Bundesrat. The following specific processes are required.[847]

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[843] Cf. Section 13(3) of the Site Selection Act.
[844] Based on various estimates, 20 to 30 subareas may be identified, with six to eight siting regions to be chosen for surface exploration; actual numbers will of course be determined after the procedure itself has been conducted.
[845] See section B 7.4.2
[846] Cf. Section 15(1) of the Site Selection Act
[847] Cf. Section 14 of the Site Selection Act.

- Review of the report by the BfE
- Hearings in line with Section 14(3)
- Submission of the BfE's review report to the Federal Ministry for the Environment
- Specification of site-specific exploration programmes for Phase 2 by the BfE.[848]
- Regional and supraregional consultations on the report[849], the review report and the proposed exploration programme[850]
- Deliberations on the report by the National Societal Commission
- Revision of the report within the scope of any necessary re-examination
- The BfE gathers statements and holds hearings
- The Federal Government submits these results to the German Bundestag and Bundesrat
- Decision on siting regions to undergo surface exploration enshrined in federal legislation.This legislation formally concludes Phase 1.

Table 21: Characteristics of Phase 1 of the disposal site selection procedure

Characteristic	Approach
Step 1	
Initial situation:	Blank map of Germany
Database:	Data available at the Federal Institute for Geosciences and Natural Resources (BGR) and geological Land offices
Criteria:	Geoscientific exclusion criteria Geoscientific minimum requirements
Approach:	1. Project delivery organisation identifies exclusion areas 2. Project delivery organisation identifies geological areas to be searched that meet the minimum requirements
Objective:	Geological areas to be searched

848 Cf. Section 15(2) of the Site Selection Act.
849 Cf. Section 14(2) of the Site Selection Act.
850 Cf. Section 15(2) of the Site Selection Act.

Step 2	
Initial situation:	Geological areas to be searched
Database:	Data available at the Federal Institute for Geosciences and Natural Resources (BGR) and geological Land offices
Criteria:	Geoscientific consideration criteria
Approach:	Where possible, the project delivery organisation identifies subareas for the 3 host rocks that provide particularly favourable geological preconditions
Objective:	Subareas proven to be particularly favourable based on consideration
Step 3	
Initial situation:	Subareas with favourable geology
Database:	Data available at the Federal Institute for Geosciences and Natural Resources (BGR) and geological Land offices; Spatial data held by the Federal Government and Länder
Criteria:	Geoscientific consideration criteria Representative preliminary safety studies Theoretical planning consideration criteria
Approach:	The project delivery organisation identifies potential siting regions for surface exploration
Objective:	Siting regions for surface exploration

The project delivery organisation will then present a report documenting the application of the criteria set out in steps 1 to 3 along with a plausible and readily understandable decision based on deliberations regarding the selection of siting regions for surface exploration.

The report will also set out and justify the site-specific exploration programmes for Phase 2.

The BfE will evaluate the report, make any necessary changes to the project delivery organisation’s proposals, and then forward it to the Federal Government.

Federal legislation will then stipulate the siting regions to undergo surface exploration.

6.3.1.1.2 Project delivery organisation tasks during Phase 1

The project delivery organisation is initially required to act. It must conduct the investigations and prepare the report to be used as the main document and as a basis for deliberations during Phase 1 of the selection procedure. According to Section 13 of the Site Selection Act, the project delivery organisation is charged with the following tasks during the first search phase of the selection procedure:

- ‘Identify eligible subareas’ and exclude ‘unfavourable areas’ (Section 13(1)),

- Perform ‘representative preliminary safety studies for eligible subareas’ (Section 13(2)) and select siting regions for surface exploration (Section 13(3)).

The project delivery organisation will then submit the following to the BfE as the outcome of its work during the first phase:

1. The proposal for the selection of subareas eligible for surface exploration

2. representative preliminary safety studies for all of these subareas on the basis of available data

3. The proposal for selecting siting regions for surface exploration put forward on this basis and resulting from considerations and comparisons

4. Designation of regions for which the project delivery organisation does not have enough information available to classify a given region in terms of exploration, deferral or exclusion; this shall include a clear statement of any information deficits
5. The project delivery organisation’s suggestions for the site-specific exploration programmes for the statutory requirements and criteria to be applied.

Point 1 forms part of the interim report to be published.

The Commission suggests that the fifth point[851] also be included in the final report. There are several reasons for doing that:

- From a technical perspective, the exploration programme to be used is already clear at the time of preparing the proposal for selecting siting regions for surface exploration. These synergies should be used.
- Public discussion of the project delivery organisation’s report will in any case lead to questions about the exploration programme and its associated criteria.
- This proposal can be evaluated during the BfE’s review.[852] The BfE’s work would also lead to a synergy.
- This would provide general time savings without having any limitations on review and discussion opportunities.

The available studies and findings form the basis of the project delivery organisation’s report. No new technical explorations can be performed and no in-situ data can be gathered in order to prepare the report. If the data available are insufficient for evaluation and consideration during this phase, existing data gathered for other purposes may need to be drawn upon and submitted for secondary analysis.[853]

The project delivery organisation is responsible for preparing the report. It is also responsible for transparent application of the statutory decision-making criteria throughout each step of the first phase’s selection process, and, in particular, for documenting every evaluation and each individual step of the consideration process. The reasoned path, the data and information taken into account, the applied criteria and the consideration process steps also need to be documented in a transparent manner. Intensive continuous and ongoing scientific and organisational quality assurance measures[854] are required while preparing the report. An analysis should be performed to determine whether and to what extent the report needs to be modified based on the results of the Subareas Conference.

[851] Cf. Section 15(1) of the Site Selection Act
[852] Cf. Section 15(2) of the Site Selection Act.
[853] See section B 6.5.8.
[854] Cf. also section B 6.4 of the present report, ‘Process design as a self-interrogating system.

In terms of the subareas, the report needs to justify which ones, based on application of the criteria and after any subsequent collection of information,

- are definitely not eligible for further inclusion in the site selection procedure
- are in principle eligible for further inclusion in the site selection procedure
- cannot be assigned to one of the two categories above due to insufficient geological data.

Subareas that are clearly technically unsuitable will be excluded from the procedure. Subareas that are in principle eligible for further inclusion will be retained in the site selection procedure. The project delivery organisation will derive the siting regions proposed for the next steps of the selection procedure from among the subareas that are in principle eligible for further consideration. The other subareas that are eligible in principle will be temporarily deferred. The project delivery organisation will suggest how to proceed with subareas that cannot be assigned to one of the above two categories due to insufficient geological data.[855]

The project delivery organisation's report must be viewed within the overall context of Phase 1 and presented as an entire package. The National Societal Commission is entitled to view all of the project delivery organisation's files and documents at any time while the project delivery organisation is preparing (or after it has prepared) its report. This will help to ensure and verify that the project delivery organisation is complying with the prescribed rules, and, in particular, documenting each step of the process of deriving results, in full and in a transparent manner, so as to be ideally prepared for subsequent scientific review and public discussion.

6.3.1.1.3 Review of the project delivery organisation's proposal during Phase 1

Immediately after the project delivery organisation submits its report to the BfE, the report must also be published so that it is available to the general public and for scientific review.
On the one hand, the BfE will review the project delivery organisation's reasoning. On the other hand, the results and the manner by which they came about have to be discussed publicly; statements provided by the public and scientific reviews must be incorporated into the overall assessment.
When the BfE draws upon external scientific expertise to perform its review, the project delivery organisation may be faced with subsequent demands for additional documentation or sections of the report.

The reviews may lead to several outcomes:

- Critical review resulting in approval of the project delivery organisation's recommendations
- Critical review resulting in new findings on individual subareas and/or siting regions
- Recommendations to amend the list of eligible subareas

[855] See section B 6.5.8.

- Recommendations to amend the list of siting regions put forward for surface exploration
- Recommendations on how to deal with disposal sites for which there is insufficient geological data available.

The final decision for this is to be taken by the German Bundestag and Bundesrat who will base their verdict on deliberations involving the BfE and the Federal Government as well as on feedback provided by the general public. Only then has a clear decision been taken as to which siting regions are to undergo surface exploration. Public participation during Phase 1 is described in detail in section B 7.5.2.

6.3.1.2 Phase 2 of the disposal site selection procedure

6.3.1.2.1 Overview of Phase 2:

Phase 2 involves execution of Section 16 of the Site Selection Act, ‘surface exploration and proposal for underground exploration’, followed by execution of Section 17 of the Site Selection Act, ‘selection for underground exploration’.

Phase 2 starts with the project delivery organisation performing surface exploration work, followed by an analysis of the exploration results and preliminary safety studies based on those results. The exploratory work is performed in line with the site-specific exploration programmes and examination criteria stipulated by the BfE.[856]

At the same time, socioeconomic potential analyses will be performed in the siting regions.[857] Public participation shall involve regular inclusion of regional and supraregional elements along with additional measures designed to foster interaction with the public. Further details about this is provided in section B 7.5.

The information gained from exploration activities and further-developed preliminary safety studies will be assessed by the project delivery organisation with a view to deep repositories’ environmental compatibility and their other possible effects.

On this basis, the project delivery organisation will prepare a report in which it will propose an objectively justified selection of disposal sites to the BfE for the types of host rock that are to be covered by the further exploration activities. Accompanying exploration programmes for underground exploration are linked to this proposal.[858] The Commission holds the view that this report must also contain proposals for an in-depth geological exploration programme and site-specific examination criteria, as well as the documents required for the sites to be appraised from a spatial planning perspective.[859]

The project delivery organisation’s report is to set out exactly how the results have been arrived at by providing transparent documentation, and explaining the grounds for all the steps and decisions that have been taken. The report is the project delivery organisation’s proposal and does not constitute the result of Phase 2. After the project delivery organisation submits its report to the BfE, the

[856] Cf. section B 6.3.1.1.
[857] Cf. section B 6.5.10.
[858] Cf. Section 16(2) of the Site Selection Act.
[859] Cf. Section 18(1) of the Site Selection Act.

latter will begin its scientific review and public discussion along with the opinion-forming process. This will be followed by a decision taken by the German Bundestag and Bundesrat. The following specific processes are required:[860]

- Review of the report by the BfE
- Hearings
- Submission of the BfE's review report to the Federal Ministry for the Environment
- Regional and supraregional deliberations on the report
- Deliberations on the report by the National Societal Commission
- Revision of the report within the scope of any necessary re-examination
- The BfE gathers statements and holds hearings
- The Federal Government submits these results to the German Bundestag and Bundesrat
- Decision on siting regions to undergo underground exploration enshrined in federal legislation. This legislation formally concludes Phase 2.

Table 22: Characteristics of Phase 2 of the disposal site selection procedure

Characteristic	Approach
Initial situation:	Siting regions for surface exploration
Database:	Available geological information and results of surface exploration
Criteria:	Geoscientific exclusion criteria, minimum requirements and consideration criteria Further developed preliminary safety studies Socioeconomic potential analysis
Approach:	1. Project delivery organisation conducts further developed preliminary safety studies based on exploration results 2. Project delivery organisation performs socioeconomic potential analyses
Objective:	Sites for underground exploration

The project delivery organisation will present a report describing the exploration results, the further developed preliminary safety studies, the socioeconomic potential analyses and their results along with derived proposals for underground exploration sites as well as an exploration programme.

[860] Cf. Section 17 of the Site Selection Act.

The BfE will evaluate the report, make any necessary changes to the project delivery organisation's proposals, and then submit it to the Federal Government (BMUB).

The BfE will issue a decision based on Section 17(4) of the Site Selection Act.

The Council of the Regions Conference and regional conferences will support the process during Phase 2 and will have the same rights they held during Phase 1. The Bundestag and Bundesrat will then issue legislation stipulating the sites that will undergo underground exploration.

6.3.1.2.2 Project delivery organisation tasks during Phase 2

First of all, the project delivery organisation must conduct explorations at the siting regions to be explored from the surface by applying the exploration programme specified beforehand. It must then analyse the exploration results and prepare a report to be used as the main document and basis for deliberations during the second phase of the selection procedure.

The project delivery organisation's report will be based on findings about the siting regions that underwent surface exploration, and on the further developed preliminary safety studies. The project delivery organisation will be responsible for preparing the report. It is also responsible for transparent application of the statutory decision-making criteria throughout each step of the second phase's selection process, and, in particular, for documenting every evaluation and each individual step of the first and subsequent report. The reasoned path, the data and information taken into account, the assessed criteria and the consideration process steps also need to be documented in a transparent manner. While preparing this report, intensive continuous and ongoing scientific and organisational quality assurance measures[861] are also required during this phase. Transparency and accountability will be boosted thanks to the participation and involvement of BGE and BfE representatives at regional conference meetings.

The report will also include and document the results of the conducted socioeconomic potential analyses.[862]

The Commission suggests that this report include the preparation and description of proposals for an in-depth geological exploration programme and site-specific examination criteria for Phase 3[863]; it also suggests adding to this report the documents required for the sites to be appraised from a spatial planning perspective.[864] There are several reasons for doing that:

- From a technical perspective, the exploration programme to be used is already clear at the time of preparing the proposal for selecting disposal sites for underground exploration. These synergies should be used.
- Public discussion of the project delivery organisation's report will in any case lead to questions about the exploration programme and its associated criteria.

[861] See also section B 6.4 of the present report, 'Process design as a self-interrogating system.

[862] See section B 6.5.10.

[863] Cf. Section 18(1)(1) of the Site Selection Act.

[864] Cf. Section 18(1)(2) of the Site Selection Act.

• This proposal can be evaluated during the BfE's review.[865] The BfE's work would also lead to synergies.

• This would provide general time savings without having any limitations on review and discussion opportunities.

In terms of the siting regions explored from the surface, the report needs to justify which of those siting regions, based on application of the criteria,

• should no longer be considered as a disposal site, e.g. because exploration shows that they meet the exclusion criteria or fail to meet the minimum requirements, and are therefore to be excluded from further consideration,

• are highly promising and should be considered and put forward for underground exploration,

• are of secondary importance in terms of underground exploration because they appear to be less promising; such sites will be temporarily deferred, but remain within the procedure in case they are in fact required at a later time.

If many of the siting regions explored from the surface are assigned to the first category and therefore not suitable for further consideration, the project delivery organisation must also state why it thinks a step back should be taken to re-examine the siting regions[834] temporarily deferred in Phase 1.

• The National Societal Commission will play a central role in monitoring the project delivery organisation during this phase. The National Societal Commission is entitled to view all of the project delivery organisation's files and documents at any time while the project delivery organisation is performing (or after it has performed) exploration and while it is preparing (or after it has prepared) its report. This will help to ensure and verify that the project delivery organisation is complying with the prescribed rules, and, in particular, documenting each step of the process of deriving results in full and in a transparent manner.

6.3.1.2.3 Review of the project delivery organisation's proposal during Phase 2

Also during this phase, immediately after the project delivery organisation submits its report to the BfE, the report must also be published so that it is available to the general public and for scientific review.

On the one hand, the BfE will review the project delivery organisation's reasoning by drawing upon independent scientific expertise on a domestic and international level. On the other hand, the results and the manner by which they came about have to be discussed publicly; statements provided by the public and scientific reviews must be incorporated into the overall assessment.[866]

The BfE's review may lead to the project delivery organisation being faced with subsequent demands for additional documentation.
Should many of the siting regions explored from the surface definitely not suitable for further consideration, the BfE must determine whether the procedure

[865] Cf. Section 18(2) of the Site Selection Act.
[866] Cf. the definition of re-examination by the regional conferences in section B 7.4.3.5.

should take a step back to re-examine the siting regions[867] temporarily deferred during Phase 1.
The reviews may lead to several outcomes:

- Critical review resulting in approval of the project delivery organisation's recommendations in terms of sites to undergo underground exploration
- Recommendations to amend the list of disposal sites put forward for underground exploration
- Too many of the siting regions explored from the surface have subsequently proven to be unsuitable based on the exploration results. This then gives rise to the question of whether the procedure needs to take a step back. In this case, the subareas identified in Phase 1 that are, in principle, eligible for further consideration as a disposal site but have not been explored from the surface, and subareas that were temporarily deferred due to a lack of geological data, need to be examined to determine which of them should then be explored from the surface as a potential siting region.

The final decision on the outcome of this examination is to be taken by the German Bundestag and Bundesrat, who will base their verdict on the deliberations involving the BfE and the Federal Government as well as on feedback provided by the general public. Only then has a clear decision been taken as to which disposal sites are to undergo underground exploration.
Public participation during Phase 2 is described in detail in section B 7.5.3.

6.3.1.3 Phase 3 of the disposal site selection procedure

6.3.1.3.1 Overview of Phase 3

Phase 3 involves execution of Section 18 of the Site Selection Act, 'in-depth geological exploration', followed by execution of Section 19 of the Site Selection Act, 'final site comparison and proposal', and Section 20 of the Site Selection Act, 'decision on the site'.

The project delivery organisation conducts its exploratory work during Phase 3. It will then draw up a report for submission to the BfE on the results and conclusions of its exploration activities.[868] The report is to set out exactly how the results have been arrived at by providing transparent documentation, and explaining the grounds for all the steps taken and the evaluations that have been carried out.

It can be assumed that the BfE[869] will need several months to review this report, provide a definitive comparison of the disposal sites, and propose a site; public participation will take place at the same time by way of an environmental impact assessment.[870]

A key contrast to Phases 1 and 2 is that the project delivery organisation will not present a proposal for a disposal site at this point. Rather, this will be the BfE's task during Phase 3.

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[867] See section B 6.3.1.1.2.
[868] Cf. Section 18(4) of the Site Selection Act.
[869] Cf. Section 19 of the Site Selection Act.
[870] Cf. Section 18(4) of the Site Selection Act.

Phase 3 should see the conclusion of an agreement between the Federal Republic of Germany and the local authorities of the region which defines, among other things, the configurable key elements of the installations (such as transport links and emissions control), long-term obligations during the operational and post-operational phases, and compensation measures with intergenerational effects.[871] The last step of Phase 3 will be the decision on a disposal site enshrined in federal legislation.[872] Subsequently, stage 2 will begin the 'geotechnical engineering of the disposal site', which will commence as the first sub-step of the licencing procedure under Section 9b of the Atomic Energy Act.

Table 23: Characteristics of Phase 3 of the disposal site selection procedure

Characteristic	Approach
Initial situation:	Disposal sites for underground exploration
Database:	Available geological information and results of underground exploration
Criteria:	Geoscientific exclusion criteria, minimum requirements and consideration criteria
	site-specific examination criteria and exploration programmes, comprehensive preliminary safety studies for operational and post-operational phases, comparative safety studies
Approach:	1. The project delivery organisation proposes site-specific examination criteria and exploration programmes at the start of Phase 2 2. The BfE specifies site-specific examination criteria and exploration programmes at the start of Phase 2 3. The project delivery organisation carries out underground exploration 4. The project delivery organisation carries out comprehensive preliminary safety studies for disposal sites that underwent underground exploration 5. Comparative safety studies for the disposal site comparison 6. The BfE conducts an environmental impact assessment
Objective:	Stipulate the disposal site

The project delivery organisation will present a report describing the comprehensive preliminary safety studies and their results along with the disposal sites that are to undergo underground exploration.

871 See section B 7.2.2.
872 Cf. Section 20 of the Site Selection Act.

The BfE will assess the explored sites and conduct a site comparison based on comprehensive preliminary safety studies. The BfE will then propose a site and issue a decision as to whether the disposal site selection procedure carried out until that point in time is in line with the requirements and criteria of the Site Selection Act, and whether the disposal site proposal meets its own requirements and criteria.[873]

The Council of the Regions Conference and regional conferences will support the process during Phase 3 and will have the same rights as they had during Phase 2.

Acceptance of the decision on a disposal site will be enshrined in federal legislation.

6.3.1.3.2 Project delivery organisation tasks during Phase 3

First of all, the project delivery organisation must conduct explorations at the siting regions to be explored underground.

It must then analyse the exploration results and prepare a report to be used as the main document and as a basis for deliberations during the third phase of the selection procedure.

The project delivery organisation's report will be based on findings about the disposal sites that underwent underground exploration. Here, the project delivery organisation is also responsible for transparent application of the statutory decision-making criteria throughout each step of the third phase, and, in particular, for documenting all evaluations and each individual step in its subsequent report. The reasoned path, the data and information taken into account, the assessed criteria and the consideration process steps also need to be documented in a transparent manner. For the entire period spent preparing this report, intensive continuous and ongoing scientific and organisational quality assurance measures[874] are also required during this phase. Exchanges with the regional bodies shall again play a major role here, as is the case during Phase 2.

In terms of the siting regions that underwent underground exploration, the report needs to justify which of those sites, based on application of the criteria,

- should no longer be considered as a disposal site, e.g. because exploration shows that they meet the exclusion criteria or fail to meet the minimum requirements,
- are suitable as a disposal site; the project delivery organisation is not responsible for ranking the sites in order of eligibility.

The National Societal Commission is entitled to view all of the project delivery organisation's files and documents at any time while the project delivery organisation is performing (or after it has performed) exploration and while it is preparing (or after it has prepared) its report. This will help to ensure and verify that the project delivery organisation is complying with the prescribed rules.

[873] Cf. section B 8.3 of the present report.
[874] See also section B 6.4 of the present report, 'Process design as a self-interrogating system'.

6.3.1.3.3 Handling the project delivery organisation's report during Phase 3

Also during this phase, immediately after the project delivery organisation submits its report to the BfE, the report must be published so that it is available to the general public and for scientific review.

On the one hand, the BfE will review the project delivery organisation's reasoning by drawing upon independent scientific reviews. On the other hand, the results and the manner by which they came about have to be discussed publicly; statements provided by the public must be incorporated into the overall assessment.[875]

The BfE's review or feedback from the general public may lead to the project delivery organisation being faced with subsequent demands for additional documentation.

The reviews may lead to several outcomes:

- should no longer be considered as a disposal site, (e.g. because exploration shows that they meet the exclusion criteria or fail to meet the minimum requirements);
- are suitable as a disposal site; the project delivery organisation is not responsible for ranking the sites in order of eligibility.

Following its review of the project delivery organisation's report, the BfE will then prepare a proposal for a disposal site (provided there are no grounds for taking a step back as described above).

The final decision on the disposal site is to be taken by the German Bundestag and Bundesrat, who will base their verdict on the deliberations involving the BfE and the Federal Government as well as on feedback provided by the general public. Only then has a clear decision been taken as to which disposal site is to be used.

Public participation during Phase 3 is described in detail in section B 7.5.4.

6.3.2 Stage 2: Geotechnical development of the site

Stage 2 begins using the disposal site decision as a basis. First of all, the licencing procedure is carried out step by step, with the typical roles distributed between the applicant BGE (the 'project delivery organisation' up until this point) and the licencing authority (BfE). To this end, the applicant must first of all supplement the exploration process to the extent required to provide evidence within the scope of the licencing procedure; it must also conduct disposal facility planning, furnish evidence of compliance with the licencing requirements and prepare the licencing documentation required to build the disposal facility. It goes hand in hand with the review performed by the licencing authority to ensure compliance with the licencing requirements, which may lead to subsequent demands being submitted to the applicant.

The public participation procedure stipulated in the licencing procedure also has to be carried out. If the licencing requirements are met, this procedure will end in the granting of a construction licence, which may also contain advance partial construction licences, e.g. for the receiving storage facility. Where appropriate,

[875] Cf. the definition of re-examination by the regional conferences in section B 7.4.3.

this will be accompanied by separate licencing procedures for additional surface plants at the deep disposal site if they are considered to be separate plants from a licencing perspective (this may be the case, for example, with a conditioning plant for waste packages).

The disposal facility will then be built along with any accompanying surface plants. Following construction and individual system testing, integral 'cold' commissioning tests, i.e. without any radioactive material, will be performed in order to demonstrate that the disposal system is free of structural and functional defects, and that all technical and organisational aspects have been covered and complied with. On the basis of this testing, the applicant will be granted an operating licence subject to the corresponding preliminary licencing procedure. This represents the end of Stage 2.

The applicant also needs to submit the necessary plant management documentation along with evidence of being fit to run the disposal facility in a safe manner. The licencing authority will then review the submitted documentation.

The following items also need to be submitted for the licencing procedure:

- Monitoring documents divided up into monitoring activities that can be started immediately and monitoring activities to be performed during subsequent stages. The former must be described in detail, while the latter can be submitted as a concept. However, this concept should also indicate any negative effects, e.g. construction work, that authorities designated for subsequent monitoring may incur and which will need to be avoided.
- A concept for sealing the deep repository. This is necessary because proof of being able to seal the disposal facility is a licencing prerequisite. Zones required to ensure functionality of key parts of the sealing system, e.g. dam structures, also have to be covered sufficiently during the construction phase and subsequent operation – this would not be possible if such zones and their precise location were not known at all due to the lack of a sealing concept.

The technical processes to be carried out prior to emplacement must be known and available in detail, at the latest upon submission of a licence application. This is because the conceived concept may entail a number of different surface plants on the subsequent deep repository premises. The licence application must therefore provide answers to the following questions:

- Will buffer/interim storage and conditioning of radioactive waste take place at the disposal site or some other site?
- How and where will inspection of waste containers take place in terms of the disposal facility's acceptance requirements?
- Is buffer storage available for conditioned waste packages? If so, what capacity is available?
- Is buffer storage available for unconditioned waste packages? If so, what capacity is available?
- Is interim storage beyond that of buffer storage available at the site or not?

Following receipt of the respective licence, construction work on the disposal facility and any other surface plants can begin. This includes building galleries/ramps or shafts in order to develop the disposal facility. The terms of the licence must be complied with during construction work. Mistakes that could impede subsequent proper operation or which may pose a threat to the disposal facility's long-term safety must not be allowed to occur during this phase. This stage therefore requires a competent, active applicant appointed as operator that is capable of taking action alongside an expert, active licencing and supervisory authority also capable of taking action. The requirements profile of an applicant changes significantly after it has been granted a licence to operate and thus becomes an operator. The operator must have the competences required by Section 7(2) of the Atomic Energy Act (AtG). This is an integral part of the licencing requirements and must be demonstrated during an ongoing licencing procedure.

As an applicant, duties included the performance of analyses and preparation of licencing documents, while as an operator duties also include safety and quality aspects pertaining to construction and subsequent operation.

In terms of public participation, methods should be developed in good time for this stage in order to permanently guarantee transparent information for anyone and to ensure viable participation opportunities for interested members of the public. This applies to the public at national and regional level, and, in particular, to locally and regionally elected institutions. These options should be carried out in extension of the public participation measures in Stage 1 (disposal site selection procedure). This particularly refers to the public participation measures carried out during Phase 3 of the disposal site selection procedure.

6.3.3 Stage 3: Emplacement of radioactive waste in the deep repository

Stage 3 begins once construction of the disposal facility has been completed, cold commissioning has taken place, and the nuclear supervisory authorities have approved the disposal facility for emplacement. Prerequisites for approving the disposal facility for emplacement are the granting of an operating licence and the presence of waste packages for emplacement. Emplacement of the first waste package shall be carried out during a 'hot trial'. If this is successful and permission for permanent emplacement is granted, further waste packages will then be emplaced. This stage will end with emplacement of the final package and sealing of the final emplacement chamber. After that, Stage 3 is complete and Stage 4 will commence.

The core technical procedure during this stage is to emplace waste packages, i.e. the disposal containers filled with waste, in various chambers, galleries or boreholes. The cavity between the waste containers and host rock will be filled with backfill material in order to ensure safe long-term sealing and to allow heat to be transferred to the rock. Places of emplacement are spaces where waste packages are to be permanently stored. Once one of these storage spaces is full, it will then be sealed to ensure that the packages are protected, e.g. in the event of water ingress. Sealing should be carried out such that the positioning of the containers and their surrounding materials is final, while also ensuring that the storage space can be re-opened to facilitate retrieval. To achieve this, the container and backfilling technology as well as the storage spaces must be designed such that retrieval is possible within an appropriate period of time. In the event of retrieval, it must be possible to determine and take advantage of the emplacement technology present at the emplacement site.

Prior to emplacement, the waste packages must first be approved at the surface disposal site. Depending on the given concept, the packages may have to be conditioned for disposal before being delivered to the deep repository.

Then, upon arrival at the disposal site itself, the packages are inspected before emplacement. If conditioning is to take place at the disposal site, the necessary conditioning facilities must be available. Both of these concepts are feasible, and the Commission has no preference or recommendation in favour of either concept. Once each waste package has met the acceptance requirements and passed inspection, they can then be transported from the surface storage facility to their underground disposal facility for disposal.

The extent and capacity of pre-emplacement facilities to be built and operated at the surface storage site will not be covered here.[876] In any case, conditioning and disposal must be kept separate from one another by creating on-site buffer storage with a capacity for several to many months of emplacement so as to avoid any emplacement disruptions due to problems incurred while delivering transport containers or processed waste packages.

During this phase, the deep repository and its surface facilities must be in a proper operational state at all times. As was the case during Stage 2, Stage 3 therefore also requires an active licencing and supervisory authority capable of taking action alongside an active operator that is also capable of taking action.

The necessary interim storage[877] at other sites during this stage will give rise to the following: The waste will be gradually transported from existing interim storage facilities to the disposal site. This in turn means that each interim storage facility must continue to be operated until all of the waste stored there has been transported to the disposal site. If necessary, the capacity of all or individual interim storage facilities may be reduced in line with the rate at which the waste is transported to the disposal facility.

Reversibility and the option to correct errors give rise to the following situation: As the deep repository must remain functional at all times, emplacement may be interrupted at any moment and subsequently continued, or it may be discontinued permanently. The disposal facility can also be partially filled, e.g. starting with a single gallery, and then sealed before waiting to see what happens to the combination of host rock, backfill material and disposal containers. Then, depending on the results of this observation, a decision can be taken on how to proceed. Depending on the result, packages that have already been emplaced can either remain where they are or they can be retrieved. Emplacement can be discontinued and switched over to other pathways as the deep repository must remain functional. The waste that had not yet been emplaced would then remain in interim storage facilities subject to appropriate requirements that guaranteed their safety.

The following reviews must be performed during this stage:

- If necessary, safety-related aspects of surface and underground operations must be repeatedly updated to reflect the latest advances in science and technology
- The sealing concept to be initially submitted during the previous stage must be updated on a regular basis (e.g. every ten years)

[876] On this issue, see section B 5.7.
[877] See also section B 5.7.

- The long-term safety analysis must be updated on a regular basis (e.g. every ten years)
- The monitoring concept must be updated on a regular basis (e.g. every ten years), both in terms of ongoing monitoring measures and with regard to additional future monitoring measures and the latest advances in science and technology.

In terms of public participation, methods should be developed in good time for this stage in order to permanently ensure that information is readily available to everyone, and to provide viable participation opportunities for interested members of the public. This applies to the public at national and regional level, and, in particular, to locally and regionally elected institutions. It is safe to assume that societal requirements, informational needs, and technology will change over time, which is why no exact requirements can be put forward at this time.

6.3.4 Stage 4: Observation prior to the sealing of the deep repository

As things stand today, final backfilling of the deep repository cannot be expected to start immediately after emplacement of the designated radioactive waste; instead emplacement will be followed by a stage involving deliberations on how to proceed. During this stage, the generation active at that time will make a decision on how to proceed based on knowledge and assessments available at that point in time.

Once emplacement has been completed, several options are available:

- Make an immediate decision regarding final sealing,
- Wait and keep the disposal facility open until a decision regarding final sealing at a later date has been taken,
- Observe the filled and still accessible disposal facility for a period of time yet to be defined and then analyse the observations,
- Retrieve the emplaced packages.

The waste packages must be emplaced in the disposal facility in such a way that they can remain in the deep repository, yet also be retrieved if necessary. In terms of reversibility, it will still be possible for the procedure to be discontinued at this stage too, and it will be possible to switch to other pathways. In this case, the emplaced waste would have to be retrieved and transferred to a safe storage facility.

The technical status of the deep repository was covered in the previous stage of emplacement, and is laid out as follows for this stage:

- The waste packages are emplaced in various chambers, galleries or bore holes. The remaining cavities will then be filled with suitable backfill material.
- Each of these storage spaces is then sealed to protect the packages in case of any incidents such as water ingress. Sealing is to be performed such that the deep repository can in theory be reopened and the packages retrieved.
- The deep repository itself is to remain functional and unfilled outside of the storage spaces, i.e. there are accessible galleries, shafts and, if necessary, access ramps and the disposal facility’s surface facilities.
- During this phase, safe operation and observation of the as-yet unsealed disposal facility are required along with maintenance and upkeep in order to avoid any impact on the effective containment zone together with the risk of radioactive material release.

Overall, this status requires active operation to keep the deep repository open which only differs from that of the previous stage in that emplacement and preparation of waste packages for emplacement no longer occur. As was the case during Stage 3, Stage 4 therefore also continues to require an active licencing and supervisory authority capable of taking action alongside an active operator that is also capable of taking action.

During this stage, organisational and legal prerequisites must be created and put in place to ensure that a decision can be taken regarding the options described above. From a contemporary perspective, this could hardly be left up to interaction between the operator and licencing authority; instead it should be based on a decision-making procedure involving a large spectrum of society. As things currently stand, in a manner similar to the stage involving the site selection procedure, the final decision-maker should be parliament and not an authority. However, today it is neither possible to say how future generations will design the procedure, nor to dictate how they should go about doing that.

From a technical perspective, this stage gives rise to the question of whether the monitoring programmes specified in the previous stages should be accompanied by monitoring of other situations and whether more modern methods should be used to achieve that. Amendments to monitoring goals could be considered based on the findings and issues available at that time. It is not until this stage that the remaining interim storage facilities will become superfluous as all of the material stored there will have been transferred to the disposal facility by the end of the preceding stage. This in turn means that operations at all of the interim storage facilities can be discontinued. However, if the decision to retrieve material is taken during this stage, interim storage facilities with sufficient capacity will again be required and must be set up.

This stage gives rise to two topics surrounding public participation:

- Transparency and information about the state of the deep repository; this is linked to the procedure already implemented during the previous stage
- Interaction related to the decision-making procedure and taking a decision on the next steps.

Basically, emplacement of waste and sealing of the mine building are linked to the decision to fully prepare the effective containment zone.

6.3.5 Stage 5: Sealed deep repository

The aim of the stages described above is to arrive at a sealed disposal facility. Once the sealing work has been completed, the radioactive waste has been safely contained in the deep repository without the need for any maintenance.

The technical work required to prepare for a sealed deep repository mainly involves

- backfilling the remaining galleries in the deep repository and sealing the shafts and access ramps,
- installing all of the technical facilities required to monitor the disposal facility,
- assuring the quality of all of the technical work and structures
- removing the deep repository’s surface facilities.

The seal must lead to the deep repository being sealed with such quality that the effective containment zone is guaranteed to retain radionuclides for a period of one million years. The sealing concept is already available from previous stages,

during which time it will be repeatedly updated. However, the licencing process for the seal will require the sealing concept to be completed in enough detail so as to meet the licencing requirements and reflect advances in science and technology at that time. The same applies to the monitoring concept for the sealed deep repository.
Once sealing is completed, this will lead to a fundamental shift in terms of the requirements on how to ensure safety. To date, safety has been ensured by a mixture of active and passive facilities and systems, and by way of geology; however, looking ahead, safety must also be ensured in an entirely passive manner without any need for maintenance.
Active safety components that were required because the deep repository had been open until that time will be discontinued. One such example involves measures for the unsealed deep repository to ensure that flooding does not occur, i.e. that there is no excessive water ingress in the open cavities. Once the deep repository and its cavities have been sealed, such measures are no longer required as the cavities no longer exist.
After sealing, all that is required is to ensure the long-term safety of geological conditions and the (geo)technical systems, e.g.sealing structures, containers, backfill, and to make sure they do not require any maintenance. The host rock and overall technical concept will define how to go about this.

Organisational changes are to be expected during this stage. An operator and supervisory authority will be required until sealing work has been completed, after which time the majority of their duties are no longer required and limited to the following:

- Monitoring the sealed deep repository and analysing monitoring results[878]
- Updating documentation and passing it on to future generations[879]

Right now it is futile to think about how things should be organised at that time. All we can do now is convey to future generations that from a contemporary perspective, there needs to be an organisation for further monitoring and (possibly an additional organisation) for updating documentation and passing it on to future generations.

As the seal has led to safe, maintenance-free containment of the radioactive waste in the deep repository, the aim of monitoring is, in particular, to ensure that no unanticipated developments can call this into question. In general, no action should ever be required after sealing has taken place.

Should subsequent generations see things differently (for whatever reason), recoverability should still be a feasible option. Recovery will be possible as long as the site of the deep repository is known, the documentation can be found and is legible, the waste packages (containers) are themselves in a recoverable state, and the technical and societal preconditions for recovery, i.e. the excavation of parallel underground access ways, are in place.

This also includes a technical recovery concept that must be in place when the disposal facility is built.

It is also important to have a suitable site available for the construction of an access gallery so that subsequent generations are also able to perform recovery if

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[878] See section B 6.3.6.2.
[879] See section B 6.7.

they decide in favour of that option. Provision of a site for potential construction of an access gallery disposal facility must be taken into consideration during the site selection procedure stage as it has an impact on the minimum size the potential site needs to have.

Updating and passing on documentation to the respective subsequent generation remains a key aspect of ensuring that recovery remains an option.

During the stage involving the sealed deep repository, public participation is bound to align with social needs present at that time which cannot be predicted at present. The operator, supervisory authority and general public may exchange information and opinions during the seal licencing and construction periods. After sealing has taken place, the question of retention and passing on knowledge may arise among the general public.

6.3.6 Process and disposal facility monitoring

The term 'monitoring' involves ongoing observation or regularly occurring observations based on parameters specified in advance. The results of such observations are then analysed in keeping with applicable requirements or shifting general requirements and estimates. Ancillary monitoring allows for constant transparency in terms of the current state of the individual stages of the disposal procedure as well as the geological status at the subsequent site. This transparency allows for early detection of unanticipated developments as well as any potential errors, i.e. the opportunity to learn as a result of rectifying mistakes. It also helps to foster trust in the procedure and involved parties, both throughout society as a whole and, in particular, among people in the affected region.

Disposal therefore gives rise to two different kinds of monitoring:

a) Process monitoring, evaluation and optimisation:[880] This involves ancillary monitoring of the entire process pathway resulting in a disposal facility, all of the decision-making processes during that time, relevant changes to surroundings (political changes, shifts in values, new scientific findings, etc.) and evaluation of the results in order to determine subsequent steps. The Commission also takes this to mean process support that is both independent of and in addition to the main parties (waste producers, regulatory authority, operator), while also contrasting the process design as a self-interrogating system to be demanded by the parties themselves.[881]

b) Disposal facility monitoring:[882] This entails ancillary observation of a potential or real disposal site in terms of the prevailing geological and hydrogeological situation and its changes as well as the state of the emplaced waste. Disposal site monitoring is largely performed by the operator and regulatory authority, i.e. the main parties involved in disposal, who in turn are directly obliged to critically monitor their activities as part of a self-interrogating system.[883]

[880] See section B 6.3.6.1
[881] See section B 6.4.
[882] See section B 6.3.6.2.
[883] See section B 6.4.

Both kinds of monitoring form key aspects of disposal as a learning process. They forge links to the participation process, the structure of the authorities and the commitment to a self-interrogating system[884], while linking up with the need for and alignment with future research and technology development.[885]

6.3.6.1 Process monitoring, evaluation and optimisation

Based on current understanding, the German Bundestag is set to initiate the procedure in search of a site offering the best-possible level of safety in 2017. Several decades will pass until emplacement starts, and it may take more than a century before sealing occurs. As a result of the extremely long period of time this entire process involves, it must undergo ancillary monitoring and periodic critical evaluation right from the very beginning in order to optimise the quality, content and timeframe of the procedure. Process monitoring, i.e. ancillary observation and reflection of the entire process pathway, must also start at the same time as the selection procedure as this will set the course for decades to come. As a result, the structures required to achieve this also need to be put in place at an equally early stage.

Process monitoring should comprise the following aspects at the very least:

- Regular reflection and evaluations of the process status, measured against self-defined parameters; the parameters themselves or their intended timeframes may need to be modified
- Regular evaluation of the institutional situation: operator, structure of the authorities, supervisory authority, transparency, etc.
- Involvement of the steps involved in the participation procedure[886] and provisions to detect problems of trust and weak points in terms of participation as early as possible
- When looking for a disposal site, raise the question of which parameters can or should be observed for monitoring at each potential site
- Regular review to determine whether the exploration process and designated technology reflect the latest national and international advances in science and technology
- Determine the state of knowledge of monitoring on a regular basis (e.g. new monitoring technologies).

Effective process monitoring requires access to relevant data from within the documentation process.[887]

The Commission holds the view that the National Societal Commission’s tasks should involve demanding methodically adequate and transparent process monitoring, supporting the process of selecting methods, monitoring

[884] See section B 6.4.
[885] See section B 6.9.
[886] See section B 7.
[887] See section B 6.7.

implementation of the methods and the analysis of the results. Given the fact that the disposal site selection procedure will take many years to complete, process monitoring is imperative to ensure that the procedure is carried out in an ideal way.

Experience from previous decades has shown that technical mining and mineral deposit exploration processes, in particular those of the oil and gas industry, are in a state of constant development. Even now, seismic exploration (3D seismic imaging) and drilling (horizontal extended-reach drilling) methods are available that provide high-quality data without any major negative impact on the host rock's barrier functionality within a potential effective containment zone. The optimisation potential derived from anticipated technical advancement may lead to temporal optimisation of the site selection procedure. For this reason, the project delivery organisation must draw upon the latest advances in science and technology when specifying the exploration programmes for Phases 2 and 3[888] in order to carry out the exploration work without unnecessarily impeding the host rock's barrier functionality, without taking up any unnecessary space, or without having any negative impact on the environment.

As the exploration and observation methods to be used in the future cannot be defined at this time, process monitoring must ensure that the latest international advancements in science and technology are applied during disposal site exploration so that the data gleaned from each site included in the process can be subsequently assessed and used as a basis for making a decision. The geological and technical data to be collected during each phase shall be based, among other things, on the underlying disposal concept.

6.3.6.2 Disposal facility monitoring

Disposal facility monitoring serves the purpose of systematically observing the state of the geological formation, the hydrogeological conditions, and the waste along with the effects the disposal facility has on its surroundings during the various stages of disposal. To this end, a number of methods will be applied at different times throughout the various stages of disposal.

Throughout the entire process implemented to discover potential erroneous developments or unforeseen occurrences at an early stage, constant monitoring of the disposal system, its components and its surroundings is to be performed in order to draw conclusions and rectify any errors (and, at worst, to retrieve or recover radioactive waste). It also serves to optimise the impending geotechnical steps, e.g. when designing the various sealing structures, and to facilitate a regular review of the assumptions and information used as a basis for safety cases related to construction, operation and the post-operation phase of the disposal facility.

Monitoring requires specification of the parameters to be used at each site as this will have an effect in terms of the monitoring techniques to be used (sensors and equipment used to transmit data to the surface). At the very least, these should be the parameters relevant to safety considerations, e.g. in relation to the effectiveness of geological and technical barriers. The monitoring parameters can

[888] Cf. section B 6.3.1.

only be specified if potential disposal sites are selected in conjunction with the respective disposal concepts (Phase 3). Nevertheless, monitoring parameters can only be specified in detail once a final decision regarding the disposal site has been taken.

When it comes to monitoring, there needs to be a compromise between the desire to monitor safety-related parameters for a disposal facility to the greatest possible extent and the fact that sensors, measuring equipment and cables installed to convey information from within a sealed gallery may allow the ingress of water. This conflict will be exacerbated if monitoring is to continue after the entire deep repository has been sealed. This therefore gives rise to a conflict of interests: On the one hand, a disposal site that is not fully sealed may represent a safety risk. On the other hand, monitoring may help to improve safety in the event of unanticipated developments. This conflict of interests is likely to be solved or at least alleviated if advancements in wireless data transfer, which are currently still at a research and development stage, give rise to new monitoring options.

In order to be able to interpret observations across as broad a timespan as possible, geological formation monitoring needs to start at the same time as sites are chosen for underground exploration. This will provide information about the system's initial state which can then be compared with data collected as the disposal system continues to develop. To be able to determine subsequent uplift or subsidence, the early set-up of permanent fixed geodetical points to measure the site surface is one of the first disposal facility monitoring measures required after selecting a site for underground exploration.

When setting up underground facilities (initially for exploration purposes once a decision has been taken to use a site as a disposal facility), additional monitoring facilities will be installed and operated to monitor, for instance, states of stress and their associated development along with the formation of potential water pathways. Emplacement of waste will also entail other additional monitoring activities in relation to waste packages and their emplacement surroundings. By sealing emplacement zones and, at a later stage, the disposal facility itself, decisions will need to be made regarding the installation of measuring equipment to capture specific data (e.g. about temperature development, water ingress, gas formation or radionuclide release in the vicinity) and as to how data is to be conveyed to the surface. The time limit for monitoring sealed zones depends upon the lifespan of the equipment used. For this reason, indirect observation, e.g. site surface, groundwater in the overburden or the planned outer zone of the effective containment zone, will become increasingly important when it comes to monitoring the disposal site in the long term.

This in turn means that throughout the entire process, disposal facility monitoring will also develop in line with the progress made during the disposal stages. Here, various items of information will be collected at different points in time which then need to be analysed and interpreted in terms of their relevance to safety at the disposal facility. Monitoring information can demonstrate the ongoing functionality of a disposal system throughout the various stages of its creation and existence, thus boosting the level of trust in the correctness of the decisions taken. Disposal facility monitoring is therefore also a technical/scientific basis for making decisions related to error detection. In light of this, standards need to be developed in order to determine when deviations from the anticipated value are to be considered errors that require correction. Here, active disposal facility monitoring is needed at least until a container recovery concept has been finalised. It is not possible to provide methods for this long-term monitoring, but it is possible to stipulate the need for disposal facility monitoring to be based on the latest advancements in science and technology throughout every stage, and for further specific development of methods to monitor the safety of the disposal facility.[889] As there cannot be any specific end to monitoring the disposal facility, it is to be expected that a society informed of the presence of the disposal facility will want to monitor the disposal site and environmental assets (e.g. surface, groundwater) in the long term. The methods to be used for this remain open-ended and are to be decided in the future. Precautionary documentation[890] can be passed on to future generations in order to provide them with a basis for making decisions.

6.4. Process design as a self-interrogating system

6.4.1 Introduction

The Commission holds the view that every person and institution involved in the site selection procedure must repeatedly question themselves and others, and must perform structured self-critical analysis of the attained status time and again throughout the entire disposal[891] process pathway as the Commission considers this a fundamental aspect of a process that continues to successfully learn with the aim of creating a disposal facility with the best-possible safety. The challenge that comes in the form of disposal of high-level radioactive waste is an extremely enduring task of utmost relevance when it comes to safety, yet there are not all that many experts available from the pertinent sciences. For this reason, it is not only sensible but in fact imperative to accord high priority to self-critical structures that remain diligent over time. Such a structure has the following objectives:

- Prevent undesirable developments
- Identify unexpected developments as soon as possible
- Initiate open communication of any undesirable and/or unexpected developments, and trigger processes to deal with them
- Detect and eradicate signs of institutional or personal ‘blindness’ at an early stage

This challenge can only be mastered by putting in place measures and safeguards at various levels which facilitate mutual scrutiny and criticism. In fact, the entire process needs to be set up as a self-interrogating system.

As is the case with process monitoring, the disposal facility procedure designed in the form of a self-interrogating system should pursue the aim of enabling a long-term, safety-related task to be performed continually at the highest level of safety in order to avoid undesired developments or making mistakes. Compared

[889] See section B 6.9.
[890] See also section B 6.7.
[891] See section B 6.3.

to process monitoring and expressed in simple terms, the self-interrogating system actually puts in place the prerequisites for including and adopting the findings and insights generated by the actors involved in the ancillary monitoring, reflection and evaluation process. In addition, self-interrogating systems are characterised by ongoing self-reflection.

From a psychological perspective, there are a number of different factors that can impede a self-interrogating mindset, such as blocking out information that does not fit in, or denigrating information that negates one's own concept. As a result of this, the implementation and upkeep of a self-interrogating system is not something that simply runs on its own; instead it requires constant attention and must be anchored in organisational processes. To this end, three levels should be involved: (1) individual, (2) institution (internal) and (3) intraorganisational relations (system). These three levels are inseparable from one another, but should nevertheless be considered and developed on the basis of their respective form and effectiveness. The following statements apply, in particular, to both the institution(s) of the operator and regulator, who are the drivers and main actors of the site selection process. However, all of the other institutions involved, such as those performing research, scientific and societal duties, should also be included and follow this system.

Implementation of a self-interrogating system requires consideration at several levels: an individual level as covered in section B 6.4.2, an institutional level as covered in section B 6.4.3, and an intraorganisational relations as covered here in section B 6.4.4. Irrespective of the level, care should be taken to ensure that each part of the system does not become self-referential, i.e. that the parts become externally inaccessible. Such a development would pave the way for 'blindness' and intransparency. A self-interrogating system should therefore always undergo critical monitoring by external actors. In line with this, the design of a self-interrogating system related to the disposal of high-level radioactive waste should ensure that it is not possible to create a closed circle; instead it should involve an intelligently balanced model based on mutual observation at various levels. Based on democratic principles, the top level should be the general public.

6.4.2 Individual level

On an individual level, individual cognitive aspects often determine perception of information and how that information is processed. Established methods (such as workload management) can be used to train cognitive information processing skills and self-interrogation skills. However, such coaching will still reach its limits if employees are partially or completely unwilling (or unable) to adopt a reflecting behaviour and open approach to other opinions. When selecting management figures in particular, the candidates' corresponding personal skills should be taken into account as a hiring requirement and as an aim for further personal development.

6.4.3 Institutional level

Individual behaviour in terms of willingness to reflect and perform self-critical analysis is defined by the cultural and organisational parameters of the respective institution, which are reflected both in the organisational structures and in the culture of the organisation.

Over the last two decades, safety-related technological approaches for a reflecting culture have been drafted in line with a ‘safety culture’. These approaches have since been implemented and developed further by institutions, and shall also be adopted by the disposal facility institutions and then adapted to meet their needs.[892] A culture cannot be prescribed per se, meaning that an institution’s commitment to adopting such a culture is of key importance in this regard. Suitable external verification mechanisms, such as reviews, are also required to provide outside parties and the general public with evidence that involved institutions do in fact have a culture of safety or self-reflection in place. These review processes cannot just be limited to a typical ‘supervisory authority - operator’ interaction. A culture of safety or self-reflection also needs to be established within the authority or authorities responsible for regulatory and supervisory tasks, and this culture must also be open to review processes. The statements below on intraorganisational organisation cover the question of review processes.

A self-interrogating system also requires involved institutions to develop and foster a culture that is not defined by the aim of imposing a closed unit and, at worst, hiding behind its own findings, opinions and views by adopting a ‘siege mentality’. This applies both to individual organisational units within an institution, and also primarily to the institution as a whole. To this end, BGE and BfE should select a type of organisation that sufficiently reflects the requirements resulting from a hierarchical management structure (‘uniform opinion of an authority’, top-down mentality, necessity of decisions) as well as requirements emerging from a self-interrogating system (‘plethora of opinions, open discussions’). Institutions should in fact provide incentives within their own ranks to open themselves up to the outside world, to listen to and reflect upon other opinions, and to play an active and open part in (scientific) discussions at various levels with the aim of being able to continually reflect upon their own positions and develop them further. Institutions can support such an approach by promoting employee dialogue skills, making such training a fixed component of personal development plans, and corresponding reflection upon employee performance during review sessions. When doing so, care should be taken to convey the notion that fair communication and factual discussions should always take precedence over assertion of one’s own position.

Work should not have to be performed under constant time pressure so as to that employees or organisational units are given enough time and are therefore willing to exchange their opinions and look at societal needs. Such conditions can be put in place by managers and superiors by ensuring a sufficient number of employees who are adequately trained to do the work. They can also be anchored in

[892] For implementation of the safety culture by the regulatory and supervisory authorities, see also: Nuclear Energy Agency (OECED/NEA): The Safety Culture of an Effective Nuclear Regulatory Body, NEA No. 7247.

procedural rules that stipulate, for example, the length of time required for each step of a process.

The organisational structure of an institution has a major influence on the attainment of material objectives as well as the development of the intended cultural values. Organisation theory has a broad portfolio of methods that can be used to investigate processes within organisations and highlight any areas where improvements can be made. Such investigations should be performed with the right level of care so as to minimise the risk of disconcerting employees throughout and as a result of implementing organisational changes.

6.4.4 Intraorganisational system and relations

The site selection procedure also incorporates the interests and aims of the various parties involved. This situation should also be taken positively within the scope of a self-interrogating system as, above all, a range of different opinions and objectives help to ensure that positions, plans and structures are called into question and adjusted as and when necessary.

Disposal in deep geological formations is a highly specialised field, which is why it is handled by a relatively small number of experts along with people affected by or interested in the process. Given the importance of a self-interrogating, learning system, opportunities for discussion should be provided and used to allow the groups involved to interact with one another. Here, particular attention should be paid to retaining the multitude of viewpoints, i.e. allowing critical viewpoints to be aired and taken into consideration without bias during subsequent steps of the process.

When designing the institutional / organisational system as a whole, care should be taken to ensure that an individual institution's expertise or decision-making powers are not bundled in such a way that they prevent the decisions taken from being reviewed and, where necessary, corrected. For this reason, antagonisms are to be established within the system as a whole, such as distribution of decision-making powers or targeted formation and retention of expertise, with the aim of ensuring that institutions act on an equal footing.

An organisational system that meets the stated requirements will change over time and develop in line with needs at the given time. In order to initiate the site selection procedure, the following measures need to be observed and/or established:

In terms of the number, responsibilities and interactions of the institutions involved, the system as a whole must be designed in such a way that it is clear to anyone involved as well as external parties, and that it does not end up blocking itself due to unclear or contradictory competencies. Clear structures and responsibilities also enable experts and other interested parties not directly involved in the process to address their issues and feedback to the appropriate people and bodies. This overall system should also account for the general public as an actor with various participation options and rights throughout the various phases of the selection procedure. This must be clear and transparent so as not to impede or prevent the general public from being involved due to unclear conditions. Otherwise the general public will hardly be able to ascertain current developments within the disposal site selection procedure whenever it likes, nor will it be able to learn about the challenges, potentially unanticipated developments and progress made at any given stage of the procedure. However, these options for the general public represent a core aspect of a self-interrogating supervisory structure. This is because transparency and the right to view all relevant documentation will lead to a constant awareness within scientific and institutional circles that they are, at least in theory, always under scrutiny from the outside world.

An authority not directly involved as an actor in the selection procedure is crucial to a self-interrogating system. This function should be assumed by the National Societal Commission[893], which can also request corresponding scientific support if necessary. The National Societal Commission will ensure that the above requirements to ensure and account for differing opinions are met, and, if necessary, will demand corresponding measures.

In the interests of promoting scientific diversity, care must be taken to ensure that research funding is provided to a range of different research organisations rather than just a few select institutions. The National Societal Commission can also play a part in this process.

The National Societal Commission should also ensure that suitable organisational conditions are put in place. On the one hand, this affects the above review processes for ensuring that a culture of safety and self-reflection is present at the institutions involved. On the other hand, this should lead to regular questioning as to whether the institutional system meets the given needs.

A scientific community is required for the findings gleaned within the context of site selection so as to ensure the intrascientific process of mutual scrutiny and, as a result, the self-correction of prematurely drawn conclusions. An annual colloquium series is to be established for expert discussions, and these conferences should aim to map out the range of different opinions and promote discussions on an expert level. Annual documentation of the conferences should enable information to be collected which can be used for critical reflection. Alongside the stated conference transcripts and documentation, a series of publications including periodical specialist reports will help to retain and transfer knowledge.

It is essential to ensure that the German expert community involved in the disposal facility situation does not remain among itself but instead makes its progress and conclusions available for international debate and scrutiny. This external perspective should also be fostered by tasking specific external scientists with preparing statements on certain issues and with performing peer reviews.

6.4.5 Conclusion

The Commission holds the opinion that the overall process, designed as a self-interrogating system, represents a key process quality requirement to be consciously implemented right from the beginning, particularly during the site selection procedure, and subsequently monitored at all times. The overall process

[893] See section B 7.4.1.

must be implemented on two levels: firstly, by shaping institutions by imposing rules pertaining to duties as well as the duties themselves; secondly by organising external monitoring and ensuring the transparency required to achieve that. The following points, which are by no means exhaustive due to the learning aspect of the system, are of major importance in achieving this:

- Basic commitment to and ongoing attention to be paid to process design as a self-interrogating system
- Anchoring in the organisation structure of the institutions involved, e.g. by applying methods with which processes within organisations can be reviewed to identify any potential for improvement
- Development and fostering of an open culture that is not defined by the aim of imposing a closed unit and prevents institutions from adopting a 'siege mentality'
- Promotion of individual skills and a willingness to adopt a reflecting mindset and an open approach to different opinions voiced by other persons involved in the process
- Fostering of dialogue skills among employees so as to promote active and open participation in scientific discussions
- Due consideration of the manpower and time required to deal with the range of opinions that arise, particular opposing viewpoints
- Uphold the range of opinions and, particularly when it comes to research funding, consciously establish antagonisms within the overall system, and foster the build-up of expertise in order to ensure an equal footing
- Clear structures and responsibilities that also enable interested parties not directly involved in the process to address their issues and feedback to the appropriate people and bodies
- Establish the function of an actor not directly involved in the selection procedure so as to ensure compliance of the self-interrogating system within the National Societal Commission
- Regular verification mechanisms or reviews that provide outside parties and the general public with evidence that involved institutions do in fact have a culture of safety or self-reflection in place. International expertise is to be involved in this aspect
- Initiation of a scientific community and promotion of expert discussions by establishing an annual colloquium series aimed at mapping out the range of different opinions and promoting discussions on an expert level.

6.5 Decision-making criteria for the selection procedure

6.5.1 'Safety Requirements'

Following previous deliberation by the Nuclear Waste Management Commission and the General Committee of the Länder Committee for Nuclear Energy (LAA), the 'Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste'[894] were approved with a majority by the LAA on 30 October 2010 and subsequently published by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) on the Internet. They were not published in the *Bundesanzeiger (Federal Gazette)*.

In particular, the 'Safety Requirements' include specifications on the following points:

- the protection targets pursued with the disposal of radioactive waste,
- the safety principles to be observed,
- a stepwise approach and the optimisation of radiation protection, operational safety and the reliability of the safe, long-term isolation of waste, with due regard for feasibility,
- protection from damage caused by ionising radiation,
- requirements concerning safety analyses, and their evaluation for operations and long-term safety,
- requirements intended to make retrieval or recovery possible,
- design requirements concerning the safety concept for the disposal facility during the operating and post-closure phases,
- safety management for the construction and operation of the disposal facility,
- the documentation of the disposal facility.

To date, the Nuclear Waste Management Commission (ESK) has adopted three guidelines on 'human intrusion into a repository for radioactive waste', 'the classification of evolutions according to probability categories' and 'the safe operation of a disposal facility for in particular heat-generating radioactive waste,[895] which provide technical interpretations of the 'Safety Requirements'.

Pursuant to point 2 of Section 4 (2) of the Site Selection Act, the Commission on Storage of High-Level Radioactive Waste is, among other things, to elaborate proposals for general safety requirements concerning the storage of, in particular, high-level radioactive waste. The Commission therefore decided to initially hold a hearing to ascertain whether the 'Safety Requirements' still accorded with the latest advances in science and technology. The deputy director-general responsible for these issues within the Federal Environment Ministry and five further experts were sent 15 questions and were asked for written statements on this issue. At the meeting on 19 November 2015, the experts were heard on the basis of their responses and additional follow-up questions discussed.

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[894] Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (2010), 'Sicherheitsanforderungen an die Endlagerung wärmeentwickelnder radioaktiver Abfälle'; translation: 'Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste'.

[895] These guidelines were published on 26 April 2012, 13 November 2013 and 10 December 2015 at http://www.entsorgungskommission.de.

The hearing reached the following conclusions:

- The ‘Safety Requirements’ do not include any requirements concerning a site selection procedure for a disposal facility, and have so far only pertained to the site that will eventually be selected. Nonetheless, they will not be irrelevant for the selection procedure because the Site Selection Act prescribes preliminary safety analyses during various phases, which are to be conducted, among other things, in accordance with the ‘Safety Requirements’.
- Overall, with respect to all the requirements, including those concerning radiation protection, in the opinion of the overwhelming majority of the individuals heard, the ‘Safety Requirements’ accord in principle with the latest advances in science and technology, and are consistent with the international discussion as it currently stands. Despite this, various proposals were made at the hearing for the further development of the ‘Safety Requirements’.[896]
- The reference period of one million years that is to be taken as a basis under the ‘Safety Requirements’ is to be viewed as long when compared internationally. The Commission is of the opinion that this reference period is appropriate to the significance of the problem of the final disposal of radioactive waste.
- The values specified in the ‘Safety Requirements’ for the long-term appraisal of radiation protection are generally high, i.e. stringent, when compared internationally.
- Significantly lower, i.e. more stringent, indicator values are taken as the basis for the analysis of the post-operational phase in the Safety Requirements[897] than the limits that apply for the operation of nuclear installations under the Radiation Protection Ordinance.

The Commission sets out its proposals concerning the approach to be taken to the updating of the Safety Requirements at length in section B 8.7.7.

The hearing and the discussion in the Commission raised a series of points that should be addressed in any revision of the Safety Requirements:

- Deletion without replacement of the option of the ‘simplified long-term radiological statement’.[898]
- Safety management[899] should not only be a matter for the applicant, operator or project delivery organisation, but also for all participating authorities and other organisations.
- The question of the preservation of competence and knowledge should be dealt with in greater detail.
- Establishment of decision-making points during the process and descriptions of what is to happen, and what action is to be taken, at these points.
- Since the ‘Safety Requirements’ are formulated considering the host rocks claystone and salt, it is to be reviewed whether a repository in crystalline host rock would be covered completely by their specifications.

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[896] Cf. ‘Anhörung der Kommission vom 19. November 2015 „Sicherheitsanforderungen des BMU 2010“: Zusammenfassung der mündlichen Anhörung’, Commission Printed Paper K-Drs. 146.

[897] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2010): ‘Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste’, section 6.

[898] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2010): ‘Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste’, section 7.2.2.

[899] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2010): ‘Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste’, section 9.

- Examination of whether the period of 500 years specified for the requirement of recoverability in the 'Safety Requirements' is sufficient and examination of further preconditions for retrievability or recoverability.
- Review of the classification of developments into the three probability categories, 'probable developments', 'less probable developments' and 'improbable developments', in particular whether the distinction between 'probable developments' and 'less probable developments' is justified.
- Review of whether different dose levels should be used as indicators for the two probability categories 'probable developments' and 'less probable developments' (as provided for in the current version, which dates from 2010) or whether the same dose level is to be set.
- With regard to the examination process, account is to be taken of the arguments for a deterministic approach.
- Provisions on compliance with permissible temperatures.

Apart from this, work is to be commenced promptly on guidelines on the following topics that will underpin the 'Safety Requirements':

- safety management,
- Release modelling, dynamic processes and dispersion modelling, biosphere modelling,
- the approach to optimisation and options for the correction of errors,
- the approach to specify the isolating rock zone and necessary barriers.

6.5.2 Methodology for preliminary safety analyses

6.5.2.1 Content and context of safety analyses

As far as the foundations for decision-making for the selection of the disposal site are concerned, the Commission has the task of drawing up proposals for the 'methodology for the preliminary safety analyses that are to be conducted.'

The Site Selection Act views the methodology for the preliminary safety analyses that are to be conducted as an essential basis for decision-making when the areas to be searched are narrowed down and the disposal site is selected.

According to the explanatory memorandum to the Act, the behaviour of the disposal system when subjected to stresses of all kinds will be analysed in a safety analysis that takes account of data uncertainties, malfunctions and possible future developments in the performance of safety functions. Furthermore, it will include an appraisal of the reliability with which the safety functions will be performed and so the robustness of this system as well.

The preliminary safety analyses must include assessments of which geological properties of the siting regions and/or the site could have particularly positive or negative impacts on the disposal system.

Various overall geological situations can have very different advantages and disadvantages, in particular for long-term safety. In so far as this is the case, when siting regions with potentially different geological situations are compared, it must be determined what properties have particular significance for long-term safety and what sets of instruments will be used to assess their safety significance in the comparison process. These may be different for the various steps of the site selection procedure.

To ensure credibility of the results of the preliminary safety analyses and the comparisons of different sites and host rock formations, it will be necessary for the methodology of the safety analyses that are to be conducted, and the data and information required for these studies to be determined prior to the commencement of the comparative study.

A preliminary safety analysis differs from a long-term safety case in a licensing procedure because comprehensive data and information about the disposal system, the isolating rock zone, geological barriers and the geological environment are required for such a safety case. However, by their nature, these data and information cannot be available at the beginning of the selection process and/or during the phase in question.

The conclusive safety case for the site that is ultimately selected will build on a comprehensive safety analysis, which will require comprehensive data and information about the disposal system, the isolating rock zone and the geological environment.

The level of detail included in the preliminary safety analyses and the evidential value of their results will increase from phase to phase of the selection procedure as more information is obtained from the exploration of the siting regions/sites. Accordingly, the safety concept and the disposal concept are to be reviewed and further developed as the level of knowledge available develops further. During the final phase of the selection procedure, the project delivery organisation will have to compare the remaining sites on the basis of the examination criteria intended for the appraisal of the results from the underground exploration, as well as the comprehensive preliminary safety analyses for the operational and post-sealing phases, then present a proposal for a site.

All the (preliminary) safety analyses will be conducted in accordance with the latest advances in science and technology. This will also apply for the disposal concept – including sealing and backfilling measures –, which will make it possible for the best-possible precautionary action against damage to be taken in accordance with the latest advances in science and technology. As a matter of course, new developments in science and technology will have to be taken into account in subsequent safety analyses. This may result in (preliminary) safety analyses that were conducted years before having to be reassessed.

6.5.2.2 Methodological approach for preliminary safety analyses

6.5.2.2.1 Safety analyses as an instrument in the selection process

Under the site selection procedure, the areas to be searched for a disposal site are to be narrowed down during the phases of the comparative procedure, starting from the whole territory of the Federal Republic of Germany. During each phase, the primary selection criterion is to be compliance with the exclusion criteria and minimum requirements, the host rock-specific exclusion and selection criteria, and the non-host rock-dependent consideration criteria. It must be possible for compliance with the ‘Safety Requirements’ to be anticipated. The criteria for the possible correction of errors must be fulfilled.

The proposal for eligible subareas will therefore be drawn up during the comparative exclusion and consideration procedure.

The project delivery organisation will have to draw up preliminary safety analyses for each of the remaining, and therefore eligible, subareas in accordance with the methodology specified previously by federal legislation and the criteria for the preliminary safety analyses.

The new Agency for the Disposal of Nuclear Waste (Bundes-Gesellschaft für kerntechnische Entsorgung, BGE) will have to draw up a proposal for eligible subareas and, furthermore, on the basis of the preliminary safety analyses, a proposal for a selection of siting regions for surface exploration, then communicate these proposals to the Federal Office for the Regulation of Nuclear Waste Management (BfE). When it does this, BGE will select siting regions that are to undergo surface exploration, in particular with a view to the aim of the best-possible safety.

6.5.2.2.2 Safety analyses during the various phases of the site selection procedure

The (preliminary) safety analyses are already regulated practically in the Site Selection Act. Provision is made for them to be conducted as the selection of potentially suitable siting regions and sites is narrowed down during the various phases of the site selection procedure.[900] The project delivery organisation will be responsible for the conduct of the preliminary safety analyses.[901] The project delivery organisation will have to explore the sites specified during the site selection procedure from the surface and underground. When doing so, it will have to report regularly to the BfE, set out the results of the exploration work, summarise the results of the preliminary safety analyses and assess those results.[902]

The level of detail included in the preliminary safety analyses and the evidential value of their results will rise from phase to phase of the selection procedure as more information is obtained from the exploration of the siting regions or sites and the further developing safety and disposal concept – or concepts, where several are pursued simultaneously.

The adjectives chosen to qualify the safety analyses conducted during the various phases of the selection process under the Site Selection Act already anticipate this progress in the information available. E.g.:

- Section 13 (2): representative preliminary safety analyses,
- Section 16 (2): further developed preliminary safety analyses,
- Section 18 (3): comprehensive preliminary safety analyses.

[900] See Section 13(2), Section 16(2) and Section 18(3) of the Site Selection Act.
[901] See Section 6(4) of the Site Selection Act.
[902] See Section 12(1) of the Site Selection Act.

Thus, during Phase 1 of the site selection procedure, the project delivery organisation will have to draw up *representative* preliminary safety analyses to determine eligible subareas and select siting regions for surface exploration.[903]

During Phase 2, further developed preliminary safety analyses will be conducted by the project delivery organisation for the siting regions explored from the surface (Section 16 (2)). On the basis of these *further developed* preliminary safety analyses and further data, the project delivery organisation will elaborate a proposal on which siting regions and/or sites are to be explored underground. To supplement this, it will propose examination criteria for the appraisal of the results of the exploration activities. After these proposals have been examined by the BfE, the proposed sites will be explored underground.

During Phase 3, comprehensive preliminary safety analyses for the operational and post-operational phases will be conducted on the sites that are explored underground by the project delivery organisation.[904] On the basis of the comprehensive preliminary safety analyses and further data,[905] the BfE will propose a disposal site for, in particular, heat-generating waste.

The safety of the disposal facility will be the supreme priority during all phases.

As the selection process advances, the types of safety analysis demanded will have to become more detailed. This also makes it clear that a site selection procedure cannot be reduced solely to a comparison of the geological characteristics of various potential regions and sites, but will always have to be seen in context with the appropriate disposal system.

6.5.2.2.3 Foundations for safety analyses during the site selection procedure

Before the safety analyses are begun, the following specifications should be adopted:

- Superordinate safety aims for the disposal of, in particular, high-level radioactive waste materials in deep geological formations, depending on the characteristic safety-relevant properties of the types of host rock that come into question under the Site Selection Act (salt, clay and crystalline rock): complete and/or safe isolation with, at most, negligible releases within the reference period of one million years.
- Generic safety concepts for disposal systems and/or disposal system types in characteristic forms in which the host rock types occur.
- Technical dispoasl concepts tailored to the disposal system types that are to be analysed and the associated safety concepts with adapted technical and geotechnical barriers that are to be further developed site-specifically in the course of the selection procedure on the basis of the increasing levels of information and knowledge that are acquired.

The following foundations are required for the safety analyses:

- A) Precise and early information about the volume, type and properties of the radioactive waste materials

903 See Section 13(2) of the Site Selection Act.
904 See section 18(3) of the Site Selection Act.
905 See section 19(1) of the Site Selection Act.

- B) Information about geological conditions in the potential siting regions and/or at the sites

Appropriate information must be available during the individual phases in the depth required in each case or is to be compiled before decisions can be taken in the course of the selection procedure, e.g. decisions on the exclusion or deferral of potential siting regions or sites. It will not be permissible for regions or sites to be excluded on account of a lack of data and information.

Re A):

Information is available about the type and volume of heat-generating radioactive waste materials and spent fuel elements in Germany, e.g. in the National Programme for the Safe and Responsible Management of Spent Fuel and Radioactive Waste (2015). Where the project delivery organisation envisages the emplacement of further waste materials that generate negligible amounts of heat at the site that is analysed, the type and volume of these waste materials must be specified. Their emplacement is to be taken into account in the disposal concept.

Re B):

Information and knowledge about the geological conditions in a region or at a site can initially be obtained from data that are available (borehole sections, geophysical explorations, etc.), and cartographic material that are held by the Land geological offices and federal authorities. In particular, the information obtained from seismic studies and exploratory boreholes by the petroleum and natural gas industries is helpful in this respect, provided it is, or can be made, publicly accessible. The geological conditions are to be explored in a targeted fashion as the potential siting regions and sites are narrowed down further.

6.5.2.2.4 Approach to safety analyses – proposed methodology

The aim of disposal is to use the suitable interaction of geological, geotechnical and technical barriers to guarantee the complete isolation of radioactive waste and so prevent releases into the biosphere and/or limit such releases to the lowest, most negligible possible level below specified limits. In this connection, the object of the (preliminary, provisionally further developed and comprehensive) safety analyses is, as a matter of principle, to review the extent to which this aim, i.e. the complete or safe long-term isolation of radioactive waste materials, can be guaranteed by exploiting the geological conditions at the site.

When it comes to the selection of sites, the eligible siting regions/sites and/or disposal systems will have to be compared with the help of preliminary safety analyses. In doing this, the entirety of the disposal system will be analysed with all its safety-relevant components and its safety directly assessed. Furthermore, provided this is actually possible/expedient on the basis of the phase-dependent information that is available, the prospects of compliance with the protection targets and the further safety requirements will be assessed pursuant to the ‘Safety Requirements’. Compliance is to be confirmed in a stepwise fashion during the further course of the procedure and conclusively demonstrated in the licensing procedure.

For a robust comparison of disposal systems by means of site-specific safety analyses in accordance with the latest advances in science and technology, criteria are primarily to be used that are based on safety indicators. During Phases 2 and 3 (not during Phase 1), these will also include criteria for the appraisal of possible releases from the disposal facility in terms of their volume, their type and the radiological consequences they will entail. Furthermore, uncertainties that exist at the time of the comparison will also have to be factored into the consideration process, as will the robustness of the safety case and the safety of the disposal system, i.e. extant safety reserves. In this respect, conservative assumptions will have to be declared wherever they occur.

While there is a great deal of certainty about the waste data because nuclear energy will have been used for a limited period in Germany, the type and scale of the information and knowledge that will be available about the specific geological conditions during the various phases of the site selection process and for the corresponding safety analyses will vary considerably.

As a matter of principle, it is assumed the (preliminary) safety analyses will be conducted using the same process as the later safety analyses, which is set out below. In consequence, it should also be assumed, as a matter of principle, that the same approach will be taken as is sketched out and explained below. Even though there is no uniform standard for the conduct of safety analyses and/or safety analyses of the long-term safety of a disposal facility for radioactive waste materials in deep geological formations, the studies will essentially involve the following steps (building on the foundations discussed in section 6.5.2.2.3). In particular, Steps 1 and 2 will not be undertaken in strict chronological order:

- 1.) Phase-appropriate drafting of a safety concept and evidence concept for the specific geological situation, depending on the host rock.
- 2.) Elaboration of a (preliminary) disposal concept for the implementation of the safety concept.
- 3.) Long-term geoscientific and climatic forecast: identification and assessment of influences on the integrity of the isolating geological, geotechnical and technical barriers, as well as processes that may lead to releases and/or the retention of radionuclides.
- 4.) Assessment of possible releases to ascertain the probability[906] of their occurrence and their scale. Assessment of the radiological consequences of possible releases (only during Phases 2 and 3, not during Phase 1).
- 5.) Assessment of uncertainties and safety reserves, as well as the robustness of the disposal system and its safety.
- 6.) Derivation of the exploration and R&D work needed, and opportunities for the optimisation of the disposal concept.

In this respect, ‘assessment’ is understood as the presentation of reasoned, qualitative and, in some cases, also quantitative arguments that deal with all relevant points of view (e.g. with regard to possible release pathways through technical or geotechnical and geological barriers) and, in particular, address the long period of safe isolation that is necessary. If various siting regions with both

[906] It is to be borne in mind here that, in practice, ‘probabilities’ will be determined on the basis of a specialist expert assessment, while it will not be possible to determine such probabilities numerically on account of the lack of a statistically sound empirical basis.

the same and different host rocks are compared to one another, they will be assessed qualitatively in the course of the safety analyses.

Drafting of a safety concept for the specific geological situation: According to the Federal Environment Ministry's 'Safety Requirements', 'isolation' and 'integrity' (meaning the retention of isolation-relevant properties) can be derived as superordinate safety functions. These will then have to be further specified in accordance with the geological situation. In addition to this, there are functions and requirements focussed on 'integrity', i.e. the retention of these isolating properties.

The safety concept will give a reasoned account of how the natural conditions (the host rock), processes (e.g. the compaction of the salt backfilling under creeping salt rock) and technical measures (e.g. the containers) as a whole are to ensure that the long-term safe isolation of the waste disposed of at the analysed site and/or in the siting region is guaranteed.

As far as the design of the safety concept is concerned (in particular during Phase 1), recourse may initially be had to concepts that are already available – some of them developed abroad – for repositories for, in particular, high-level radioactive waste materials in various host rock formations that are approximately comparable with the host rock types that are considered in Germany, provided they represent the latest international developments in science and technology.[907]

During the subsequent phases of the site selection process, it will be possible for the safety concept to be further developed on the basis of the geological data that are then available, with account being taken of the information gained from previous – preliminary – safety analyses. The core of the safety concept will be the assignment of safety functions[908] to the components of the system.

Elaboration of a (preliminary) disposal **concept for the implementation of the safety concept:** Apart from requirements focussed directly on safety, requirements concerning the feasibility of a disposal facility must also be derived. These may, e.g., relate to the extent and depth of the host rock or the geomechanical conditions.

The next step is to draw up a (conceptual) plan for the facility. This will include concepts for

- the containers (type, size, technical barriers),
- the type of emplacement,
- separation distances to the adjoining rock,
- shaft seals and gallery seals (geotechnical barriers),

[907] These include the disposal projects conducted in claystone in Switzerland and France (e.g. the studies carried out by the French National Radioactive Waste Agency (ANDRA) ('Dossier Argile' (2005 and 2013)), the licence applications for repositories for spent fuel elements in crystalline rock in Sweden (studies conducted by Swedish Nuclear Fuel and Waste Management Company (SKB) at the Forsmark site (2011)) and Finland (studies conducted by Posiva Oy at the Olkiluoto site (2012)), and concepts for rock salt discussed in Germany. In addition to this, the R&D studies commissioned by the German Federal Ministry of Economic Affairs and Energy are to be highlighted with a view to the heat-generating radioactive waste materials to be disposed of in Germany and the prevailing geological conditions.

[908] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2010), 'Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste', Commission Material K-MAT 10.

- the backfilling concept,
- the dimensions for the isolating rock zone that is subsequently to be designated,
- ideas about the low-impact excavation of the emplacement galleries,
- where low and intermediate-level waste materials are also to be emplaced: a conceptual plan for a second emplacement zone,
- The schedule for the emplacement work,
- A concept for retrieval and/or recovery.

The above list is intended as an example and is not exhaustive. However, it contains the main points.

During the following phases of the site selection process, the disposal concept is to be further developed on the basis of the geological data that are then available, with account being taken of the information gained from previous safety analyses.

When this is done, a disposal concept will have to be drafted for each host rock type and/or the extant generic disposal concepts modified to take account of the conditions at the sites. If possible, several disposal concepts should also be drafted for a subarea and/or siting region and these concepts compared with one another (comparison of variants and optimisation).

Long-term geoscientific and climatic forecast: Identification and assessment of influences on the integrity of the isolating geological, geotechnical and technical barriers, as well as the processes that may lead to releases and/or the retention of radionuclides.

One essential precondition for this will be the long-term site and/or region-specific geoscientific and climatic forecast. It will describe the main geological and climatic changes to be taken into account during the reference period of one million years, with an emphasis on possible impairments to the isolating barriers. Initially, prior to the beginning of the site exploration activities, the long-term geoscientific forecast will essentially build on what is known about the region's geological development and suitable analogical analyses; during the following phases of the selection procedure, it is to be updated using exploration data that have been gathered in a targeted fashion.

The long-term geoscientific forecast will be incorporated directly into the scenario analysis, which will describe and analyse possible developments in the disposal system during the reference period with an emphasis on possible influences on the integrity of the isolating barrier and processes that may lead to releases and/or the retention of radionuclides.

The long-term geoscientific forecast will make it possible to infer what processes (e.g. erosion, subrosion) could threaten the integrity of the isolating rock zone. This may give rise to requirements concerning, e.g., separation distances, the overburden and protective or sacrificial layers.

These parts of the (preliminary) safety analyses and/or analyses will look directly at the extent to which the aim of final disposal, the safe long-term isolation of waste materials, can be guaranteed. To this end, the effectiveness of the isolating geological, geotechnical and technical barriers, possible impairments to them, and processes that could lead to the mobilisation and retention of radionuclides and other pollutants are to be analysed.

Initially, the influences that may impair the integrity, and therefore the effectiveness, of the isolating geological, geotechnical and technical barriers, and processes that may lead to releases and/or the retention of radionuclides are to be identified. To do this, a scenario analysis is to be drawn up that is based on a large number of assumed FEPs (features, events, processes). Appropriate collections of FEPs for all eligible host rocks can be found in national and international studies. A comprehensive list of FEPs is administered by the OECD/NEA and is being further developed into a database with German participation.

However, it does not appear appropriate to conduct independent scenario analyses as part of (preliminary) safety analyses prior to the beginning of the site exploration activities, but to have recourse to comparable safety analyses that are already available for repositories in comparable host rock formations, and review the extent to which the relevant influences and processes can be transferred to other situations, taking account of the specific site conditions and the preliminary long-term geoscientific forecast.

For this purpose, a set of relevant influences and processes is to be derived for each host rock type, which will mean identifying individual site-specific differences. As a matter of principle, it is advisable to draw up a prototype safety analysis for each host rock type, and to conduct differential analyses on this basis for each site and/or area that is analysed. Subsequently, the differences with regard to the safety aspects to be investigated are to be clarified with the help of the concrete site and/or area-specific characteristics.

The influences on the isolating barriers and release-relevant processes (FEPs) that are identified are to be assessed with a view to the extent to which they may lead to releases into the biosphere. While numerical integrity analyses of the isolating barriers (e.g. reviewing the dilatancy criterion or the fluid pressure criterion), and mobilisation and transportation calculations will be indispensable for this purpose in the subsequent safety analyses, the use of indicative estimates and analogical analyses informed by the national and international studies of already available safety analyses discussed in footnote 907 is regarded as appropriate for safety analyses during the first phase of the site selection procedure (prior to the beginning of site exploration activities).

During Phase 1, the preliminary safety analyses will involve, e.g.:

1. Assessment of the isolating rock zone, and therefore the area in which the fluid pressure criterion and the dilatancy criterion must be complied with
2. Studies of the heat input into the host rock attributable to the emplaced waste materials over time
3. Reflections on, and studies of, the robustness of the components deployed

Robustness is defined as the reliability and quality of the safety functions of the disposal system and its barriers, and therefore their insensitivity to internal and external influences and disturbances, as well as the insensitivity of the results of the safety analyses to deviations from the underlying assumptions.

In addition to the safety analyses during Phase 1 that have been discussed, the following studies are integral to Phases 2 and 3 (although some may also be expedient during Phase 1, depending on the level of knowledge available):

- Demonstration of the integrity of the isolating rock zone; evaluation of the fluid pressure criterion and the dilatancy criterion
- Identification of areas in which the fluid pressure criterion is violated outside the isolating rock zone, and identification of all sources of pore water, crystallisation water, solution pockets, fractures and other possible sources for the inflow of fluids,
- Studies of the compaction of the backfilling material over time
- Thermomechanical design calculations for the underground structure of the facility (and therefore the uplift in the surface of the site as well)
- Design of the shaft seal and determination of groundwater ingress rates over time, depending on the structure of the seal and the surrounding loosening zone
- Evidence of the load-bearing capacity of, and restriction of fissures by, the shaft seals
- Studies of the influences of earthquakes on the underground structure of the disposal facility, specifically the shaft seals
- Development of concepts for the retrieval, recovery or location of containers
- Studies of the generation of gas over time on account of the residual moisture in the containers, backfill moisture (additionally, for claystone and crystalline rock: with account being taken of inherent moisture and ingressing waters)
- Studies of the corrosion of the containers
- Radiological release calculations (the results are only safety indicators!)
- Studies of the mobilisation of radioactive substances, or other groundwater or soil-relevant substances that occur naturally in the disposal system
- Investigation of radiolytic processes
- Studies of dynamic processes and the self-organisation of processes,
- Studies of changes in geochemical and catalytic conditions due to the increase in temperature in the emplacement zone
- Studies of the increase in temperature and, building on them, changes in the geochemical conditions in the groundwater aquifer of the overburden
- Studies of criticality and demonstration that criticality is ruled out
- Ideas for the prevention of human intrusion following closure
- Studies of the technical design and optimisation of the emplacement machinery
- Studies of ventilation systems favourable from the perspectives of operational safety and radiation protection
- Ideas for a monitoring concept
- Ideas for the optimisation of all components of the disposal facility

- Studies of the overburden, including its protective function for the isolating rock zone and its retention capacity.

- Studies of compliance with the temperature limits set out in section B 6.5.6.3.2

The above-mentioned safety analyses are only listed as examples and are by no means exhaustive. The project delivery organisation will have to conduct all the safety analyses itself in order to take account of all design cases identified as relevant and fulfil all the safety requirements discussed in the 'Safety Requirements' issued by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, adapted in each case to the current phase of the site selection procedure.

Studies of the suitability of sites for surface installations and operational safety will also be conducted as elements of the safety analyses. The review of the suitability of the site for the surface installations will include, e.g., the examination of flood protection at the site and its exposure to rising sea levels, major accidents at neighbouring industrial installations, aircraft crashes, etc. The safety analyses on the issues that have been mentioned will therefore also have an influence on the selection of the site for the surface installations.

Assessment of the probability and scale of possible releases; assessment of the radiological consequences of possible releases: With regard to cases identified in the preceding step in which the possible development of the disposal system could cause releases into the biosphere, the scale of such releases and the probability of their occurrence are to be determined.

As a rule, the quantification of such probabilities encounters significant problems. For this reason, by analogy to the 'Safety Requirements' issued by the Federal Environment Ministry in 2010, releases into the biosphere have been categorised in practice to date as

- probable developments,
- less probable developments,
- improbable developments.

The categorisations are derived from the probability of the occurrence of relevant developments and processes, and/or the probability of their combination. They are based not on quantitative calculations, but on categorisations informed by expert estimates. With regard to the need seen by the Commission for the amendment of the Safety Requirements, reference is made to section B 6.5.1, '"Safety Requirements"'.

As a rule, numerical transportation and dispersion calculations are required to assess the scale of releases into the biosphere. In the (preliminary) safety analyses conducted during the first phase of the site selection procedure prior to the beginning of targeted exploration measures, however, it must be assumed that no suitable data basis is yet available for a quantitative assessment. It is therefore preferable for qualitative categorisations of the scale of the releases anticipated in the analysed cases to be undertaken with the help of indicative estimates and analogical analyses. For this purpose, it may be helpful to analyse the proportion of the radionuclide inventory affected, the possible timing of releases, and the amount of time it may take for the radionuclides to be transported and reach the biosphere, together with the progressive decay of the radionuclides.

As a rule, the radiological consequences that would ensue from possible releases will be assessed by comparing the calculated dose rates with relevant regulatory limits. The hypothetical exposure of an assumed critical group with particular living and consumption habits will usually be taken as the basis for this assessment. Irrespective of the fact that the dose levels determined in this way represent an important safety indicator, they are affected by significant forecasting uncertainties because neither people's living and consumption habits nor the dispersion pathways in the upper part of the geosphere, which are subject to significant fluctuations, can be predicted in a suitable fashion over such a long reference period.

It is to be clarified what information is actually available for the comparison process during each specific phase. Only this information is to be used; it is to be clarified what scope for interpretation is allowed by the information and what sensitivity this information shows with regard to the safety functions. According to the OECD/NEA (2015),[909] 'Uncertainties need to be acknowledged and appropriately accounted for when making comparisons. In a generic state, prior to site characterisation it is difficult to use safety assessment results for discrimination between sites, because it is likely to be just discrimination between assumptions.'[910]

It is apparent from this that, depending on the phase of the site selection procedure, it is still not possible for the preliminary safety analyses to have the character of fully fledged safety analyses. Model calculations can certainly play a role (e.g. diffusion calculations to assess the isolation potential of claystone formations or thermomechanical model calculations to assess the integrity of a rock salt formation). Such model calculations supply what are known as indicators (e.g. the 'status of barriers related indicators' discussed in OECD/NEA (2012)), which can be used in the formulation of criteria.

Assessment of uncertainties and safety reserves, and the robustness of the disposal system and its safety: As discussed above, the assessment of the safety of a disposal system and, in particular, its comparison with other systems cannot exclusively be carried out by looking at possible releases into the biosphere and the radiological consequences that would result from them. Uncertainties will inevitably have to be accepted in the (preliminary) safety analyses and can be reduced with targeted exploration programmes, but not completely eliminated. These uncertainties are therefore explicitly to be identified, and factored into the assessment and comparison processes.

The (preliminary) safety analyses will offer a general understanding of the safety-oriented interaction of the various components of the disposal system, as well as the impacts these or other geological characteristics of a site and/or region and their manifestations have on its safety. Without them, the reliable weighting of consideration criteria that relate to geological characteristics, the suitable quantitative categorisation of such characteristics and, in particular, the well founded consideration of their relative merits are not to be regarded as expedient.

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[909] Cf. http://www.oecd-nea.org, last accessed 27 June 2016.
[910] Cf. http://www.oecd-nea.org, last accessed 27 June 2016.

Derivation of the exploration, research and development activities required, and options for the optimisation of the disposal concept: Internationally, when disposal programmes have been implemented in accordance with corresponding recommendations,[911] preliminary safety analyses and/or analyses that are gradually further developed as the disposal site selection procedure or implementation of the disposal facility progresses have proved their worth as suitable tools for

- targeted site exploration,
- the management of research and development programmes,
- the optimisation of disposal concepts.

When preliminary safety analyses are conducted, the crucial deficiencies in knowledge about the geology of the analysed sites, open questions that are to be studied in more extensive R&D studies and the options for the optimisation of the disposal concepts that have been decided on will become evident. The control function this gives the (preliminary) safety analyses will therefore more or less inevitably have to be exploited in a targeted fashion during all the phases of the site selection procedure.

6.5.2.2.5 Assessment of safety analyses

Given their status as benchmarks for the assessment of safety, the safety requirements specified by the Federal Environment Ministry will be taken as the basis for the following discussion.[912]

During Phase 1, the results of the preliminary safety analyses are only to be understood as guideline figures that, due to the paucity of knowledge about the site-specific geological conditions, will still be full of uncertainties and therefore will not permit a sufficiently robust safety case to be made (to a large extent, these will merely be generic studies).

The results of the (provisionally further developed or comprehensive) safety analyses conducted during Phases 2 and 3 (including dose calculations) will be set out together with the assessment of the consideration criteria relating to safety and technical feasibility. In this way, an overall safety assessment of the siting regions and/or sites will be conducted, with account being taken of their specific advantages and disadvantages. It will be possible for this to be used to compare siting regions and/or sites. When the assessment is carried out, account will be taken of the anticipated development of the overall system (near field and far field, geosphere) and its robustness. The variability and uncertainty of the input data will also have to be allowed for at the same time. Furthermore, uncertainties in the models are to be discussed, and it is to be indicated how account is to be taken of them.

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[911] Cf., for instance, ‘The Nature and Purpose of the Post-closure Safety Cases for Geological Repositories’, NEA/RWM/R(2013)1, p 15. Or: ‘IAEA Safety Standards for protecting people and the environment: The Safety Case and Safety Assessment for the Disposal of Radioactive Waste’, Specific Safety Guide No. SSG-23, p. 19.

[912] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety: (2010) ‘Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste’.

When sites are compared, no site may be excluded on account of differences in dose that are only attributable to uncertainties in the data taken as the basis for the comparison.

Release and dose calculations of the kinds undertaken in preliminary safety analyses will be required during Phases 2 and 3 of the selection procedure when sites are compared. These release and dose calculations will merely be used to assess whether, as a matter of principle, there is the potential for safety requirements to be fulfilled at a site.

6.5.3 Different criteria and their functions in the selection procedure

The procedure for the selection of an ‘facility for the final disposal of, in particular, high-level radioactive waste with the best possible safety’ will be conducted in stages and criteria-led. The Commission proposes the use of the following types of criteria:

- Geoscientific exclusion criteria
- Geoscientific minimum requirements
- Geoscientific consideration criteria
- Examination criteria
- Spatial planning criteria
- Socio-economic potential analysis

Definitions:

To ensure a systematic approach to the development of the criteria, the Commission has developed a consistent understanding of the categories ‘exclusion criterion’, ‘minimum requirement’ and ‘consideration criterion’ that has led it to the following definitions:

Exclusion criterion: An exclusion criterion is a criterion whose fulfilment indicates a siting region or site is unsuitable for disposal and will therefore be excluded from the further procedure. The exclusion criteria will remain valid throughout the selection procedure.

Minimum requirement: A minimum requirement for the selection of a region and/or site of a disposal facility is a requirement that has to be complied with in any event. Should it not be complied with, the site is unsuitable and will therefore be excluded from the further procedure. The minimum requirements will remain valid throughout the selection procedure.

Consideration criterion: Siting regions and/or sites that have remained in the procedure following the application of the exclusion criteria and minimum requirements are to be compared with one another using consideration criteria (together with the results from safety analyses).

The exclusion criteria, minimum requirements and consideration criteria to be applied, and then also the requirements concerning the safety analyses, will remain valid throughout all three phases of the selection process for all three host rocks. They will be applied in an ever more detailed fashion and with ever more precise data from Phase 1 to Phase 3 of the site selection procedure.

Geoscientific exclusion criteria and minimum geoscientific requirements: These two types of criteria will be applied first during the process – in Step 1 of Phase 1. The geoscientific exclusion criteria will be used to permanently exclude all areas from the further procedure that are unsuitable as a disposal site from the outset on account of circumstances of the kinds defined by the criteria. Analogously, the application of the minimum geoscientific requirements will mean any areas that do not fulfil these minimum requirements will be permanently excluded from the procedure.

In addition to this, data will be obtained on the sites studied in greater detail during the further phases of the selection procedure: by means of surface exploration during Phase 2 and by means of underground exploration during Phase 3. If these additional data show that a disposal site included in the procedure up until this stage either not fulfils a geoscientific exclusion criterion or fails to comply with a geoscientific minimum requirement, the site in question will have to be finally excluded from the procedure at this point in time.

The geoscientific exclusion criteria and minimum geoscientific requirements do not exclude any of the possible host rocks prescribed in the Site Selection Act (salt, clay and crystalline rock) from the outset.

The geoscientific exclusion criteria and minimum requirements are elaborated in sections B 6.5.4 and B 6.5.5, and are to be stipulated by legislation pursuant to the Site Selection Act prior to the start of the selection process. This is required because, for reasons relating to the transparency of the procedure, and following the principle of procedural clarity, these criteria will have to be defined before they are applied.

Geoscientific consideration criteria: The geoscientific consideration criteria will be used to appraise geological circumstances to ascertain their greater or lesser suitability for a disposal site. The application of these criteria will consequently not lead to areas being excluded, but to their being ranked in comparison to other areas. They are to be used to appraise whether a favourable overall geological situation is found in a subarea or siting region. In this respect, as a matter of principle one individual consideration criterion is not enough to provide evidence of, or rule out, a favourable overall geological situation. Such a favourable overall geological situation will not therefore depend on the particularly good fulfilment of a single criterion, but on the sum of the requirements fulfilled or the extent to which all the requirements and the associated consideration criteria are fulfilled.

The geoscientific consideration criteria will be applied for the first time in Step 2 of Phase 1 of the site selection procedure and will be valid from that point on for the entire further consideration process.

In Step 2 of Phase 1, they will initially be used to designate subareas with favourable geological preconditions. In Step 3 of Phase 1, they are to be used as part of the in-depth consideration of the subareas, together with the representative preliminary safety analyses and the application of spatial planning criteria, to designate siting regions for surface exploration.

They will also be applied during Phase 2 and Phase 3, together with the results from the relevant safety analyses, in order to elaborate the safety aspects of, and set out the grounds for, the proposal concerning the sites to be explored underground and/or the site proposal.

A reasoned consideration process will be required whenever the siting regions or sites to be analysed are assessed and compared. Formal aggregation rules, in particular rules for the compensatory aggregation of the individual results from the application of the criteria, are not regarded as expedient by the Commission.

The geoscientific consideration criteria are elaborated in section B 6.5.6 and, pursuant to the Site Selection Act, are to be specified by legislation prior to the start of the selection process. This is required because, for reasons connected with the transparency of the procedure, and following the principle of procedural clarity, these criteria must be specified before they are applied.

Examination criteria: Examination criteria have the function of laying down requirements concerning the results of the underground exploration of a site that, as a minimum, the concrete site has to fulfil for safety reasons. They are therefore used to appraise geological circumstances whose particular significance has been deduced from the results of preliminary safety analyses on the basis of the results of the preceding surface exploration activities. The examination criteria will therefore have to be developed specifically for each site.

Should the results of the underground exploration show that one of the site-specific examination criteria is not fulfilled, this will lead to the exclusion of the site or the corresponding part of the site. Functionally, these are therefore site-specific exclusion criteria.

It will only be possible to specify examination criteria in the course of the procedure, for the results of preceding studies and the exploration programme must be available before such criteria can be defined. To satisfy the requirements of the transparency of the procedure and the principle of procedural clarity before their application, examination criteria will have to be specified in good time prior to the conduct of the in-depth underground exploration.

The Commission has therefore not itself proposed examination criteria in section B 6.5.7, but the procedure by which, and the point in time when, these examination criteria are to be specified.

Spatial planning criteria: The Commission is of the opinion that spatial planning criteria are always to be consideration criteria. This is the implication of the primacy of safety. Pursuant to Section 1(1) of the Site Selection Act, a ‘site for a facility for the final disposal of […] radioactive waste [is to be found] that guarantees the best possible safety for a period of one million years.’ The Commission has confirmed this objective and specified that long-term safety will have priority over other considerations that might also be factored in when the sites are being narrowed down. Long-term safety will be appraised by means of an overview of the application of the geological criteria and the results of the preliminary safety analyses.

This means the spatial planning consideration criteria will only ever be applied during the process if the safety assessment of the areas to be analysed has been completed. They will come to be applied for the first time in Step 3 of Phase 1 in order to further narrow down the selection of subareas that are suitable from safety points of view. Analogous action will also have to be taken during Phase 2 and Phase 3 of the selection process.

A reasoned consideration process will be required whenever the siting regions or sites to be analysed are assessed and compared. Formal aggregation rules, in particular rules for the compensatory aggregation of the individual results from the application of the criteria, are not regarded as expedient by the Commission.

The theoretical planning consideration criteria are elaborated in section B 6.5.9 and, pursuant to the Site Selection Act, are to be stipulated by legislation prior to the start of the selection process. This is required because, for reasons relating to the transparency of the procedure, and following the principle of procedural clarity, they will have to be defined before they are applied.

Socio-economic potential analyses: The socio-economic potential analysis was developed by the Committee on a Site Selection Procedure for Repository Sites (AkEnd) to survey and appraise the effects of influential socio-economic factors in the siting region, and therefore fundamentally has the same character as the appraisal criteria. With regard to the analysis of the socio-economic potential for development that is required and the indicators to be examined for this purpose, the Commission has adopted the principle of the methodology previously proposed by the AkEnd. Here too, the primacy of safety has validity; this means long-term safety enjoys priority over considerations that may be brought into play by socio-economic potential analyses.

The socio-economic potential analysis is described in greater detail in section B 6.5.10. The socio-economic criteria to be taken into account during this analysis are based on the idea that the long-term development of a siting region is not to be harmed by the construction of a disposal facility.

From a procedural point of view, socio-economic potential analyses will be conducted for the first time during Phase 2 of the selection procedure for the siting regions that are to be explored from the surface during this phase. They will then be conducted in greater depth and/or updated during Phase 3 for the regions of the sites that are to be explored underground.

6.5.4 Geoscientific exclusion criteria

6.5.4.1 Large-scale vertical movements

A siting region with anticipated mean large-scale geogenic uplift of more than one millimetre a year during the reference period (~one million years) will be excluded. The siting region is to display the lowest possible levels of tectonically induced large-scale uplift.

Explanation: Large-scale uplift of the area of rock in which a repository is embedded could lead to greater erosion occurring at the surface of the site, which may impair the necessary protective effect of the rocks that overlie the repository.[913]

[913] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, p. 81.

6.5.4.2 Active fault zones

In the isolating rock zone, including a safety distance, no geologically active fault zones may be present that could impair the disposal system and, in particular, the isolating rock zone, and the technical and geotechnical barriers. 'Active fault zones' are defined as both faults with clear rock displacement and shatter zones with tectonic origins. Faults along which it is demonstrable or highly probable movements have taken place during the period from the Rupelian (a geological age that began approximately 34 million years ago) to the present day are regarded as 'active disturbances' with safety relevance for a disposal facility. Atectonic and/or aseismic events (i.e. events not explicable by the laws of tectonics or not attributable to seismic activity) that may cause safety consequences similar to those of tectonic faults are to be treated as tectonic faults.[914]

Explanation: The probable widths of fault zones are to be assessed individually. Since the exact width of a fault zone usually cannot be determined, a 'safety margin' of several kilometres should be specified on both sides of any identified zone for the designation of areas with particularly unfavourable conditions.[915]

6.5.4.3 Influences of current or previous mining activities

The rock in the siting region may not be damaged to such an extent by current or previous mining activities that negative influences on the state of stress and permeability of the rock in the area of the repository and, in particular, the isolating rock zone are to be feared as a result. Exploratory measures undertaken in the course of the site selection procedure are to be planned and carried out in such a way that the isolating rock zone is only interfered with on a scale unavoidable to obtain the information required, and its integrity is not threatened.

The repository will have to be constructed in a newly excavated underground facility. Old boreholes that are present must demonstrably not impair the isolation function of the surrounding isolating rock zone.

This will not affect the excavation of potential disposal sites, their operation and their stand-by operation for the purposes of exploration.

Explanation: To begin with, since no rock-mechanical stability calculations are yet undertaken in the first step of the site selection procedure, the influences of current and previous mining activities will have to be assessed qualitatively.

6.5.4.4 Seismic activity

The seismic activity levels to be anticipated in the siting region must not be higher than in Earthquake Zone 1[916] according to DIN EN 1998-1/NA 2011-01.

[914] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, pp. 82-83.
[915] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, p. 83.
[916] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, pp. 83-85.

6.5.4.5 Volcanic activity

No quaternary volcanism must be found, or anticipated, in future in the siting region.

Explanation: An inflow of magma into the repository is to be avoided because temperature stresses, volcanic tremors and induced movements in disturbed areas would impair the integrity of the repository, and could reduce the barrier effect as a result of the ingress of groundwater. In addition to this, a safety zone of ten kilometres around potentially threatened areas is to be taken into consideration when it comes to the exclusion of regions with volcanic activity.[917]

The AkEnd assessed the volcanic threat in Germany on the basis of a survey of experts,[918] arriving at the conclusion that, apart from the Eifel and Vogtland/Eger Rift areas, no further areas with volcanic threats have to be discussed in Germany. It is to be assumed there will definitely be a resurgence of volcanism in the Eifel during a forecasting period of one million years. Signs of an imminent eruption should make themselves felt approx. one to two years in advance. In the Vogtland area and the adjoining region of north western Bohemia, the level of information available suggests there is a probability of approximately 50 per cent of the resurgence of volcanism in the western part of the Eger Rift.

6.5.4.6 Age of groundwater

No young groundwater may be present in the isolating rock zone and/or emplacement zone. Tritium and carbon-14 must therefore not be detectable in concentrations above the natural background level in this groundwater.

Explanation: Young groundwater is indicative of the groundwater's participation in the hydrological cycle. The age of the groundwater calculated on the basis of tritium/carbon-14 concentrations must be validated and, where necessary, reviewed drawing on further geochemical and isotope-hydrogeological evidence.[919]

6.5.5 Minimum geoscientific requirements

6.5.5.1 Rock permeability

The rock permeability k_f must be less than 10^{-10} m/s in the isolating rock zone. Where direct evidence still cannot be provided during the first and second phases of the search for a disposal site, it must be demonstrated that the isolating rock zone consists of rock types to which a rock permeability lower than 10^{-10} m/s can be assigned.

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917 Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, pp. 85-87.

918 Cf. Jentzsch, G. (2001): 'Vulkanische Gefährdung in Deutschland: Entwicklung eines Kriteriums zum Ausschluss von Gebieten für die weitere Untersuchung hinsichtlich der Eignung als Standort eines Endlagers für radioaktive Abfälle', K-MAT 12-14.

919 Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, pp. 88-89.

The fulfilment of this criterion may also be demonstrated by overlying strata. This means the isolating rock zone will be located outside the host rock (Type 'Bb'[920]).

Explanation: As a matter of principle, it is accepted that the rock permeability is to be as low as possible so that advective fluid transportation is avoided and, at most, substances are transported by diffusion.[921]

Although crystalline rocks may possess homogeneous areas with very low levels of rock permeability ($k_f < 10^{-10}$ m/s), the rock permeability attributable to joint surfaces (fractures, faults) may be markedly elevated. Accordingly, homogeneous areas are to be identified during the exploration work in which thick, hydraulically active fault zones are not present. As homogeneous as possible and minimally deformed blocks of rock of low permeability must be identified between any hydrogeologically relevant fault zones that may be present, with due attention being paid to separation distances. This is why a detailed survey and hydrogeological assessment of the structural inventory are required to provide evidence of a site's suitability.[922] The presence of altered rock varieties with good sorption characteristics in these areas is favourable for radionuclide retention. In line with this, the rocks in the near and far fields of the repository should have well developed isolation and/or radionuclide fixation characteristics.

However, the level of knowledge at the beginning of the selection procedure will still not be completely sufficient for the exact delimitation of these areas. If geological information (e.g. a correspondingly high degree of separation, hydrogeologically relevant or hydraulically active fault zones) is available for crystalline rock formations that suggests their rock permeability is greater than 10^{-10} m/s, these crystalline rock formations will be excluded.

Evidence of isolation may also be provided by impermeable overlying rocks (clay/salt).[923] In this case, the isolating rock zone will be located outside the host rock (Type 'Bb'[924]).

6.5.5.2 Thickness of the isolating rock zone

The isolating rock zone must be at least 100 metres thick.[925] In the case of rock bodies of crystalline host rock that are not as thick as this where the field permeability is low, the evidence of long-term isolation for the containment zone in question may also be provided by the concurrent safety performance of the

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[920] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, pp. 123-127.

[921] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, pp. 88-89 and pp. 106-121.

[922] Cf. Ziegenhagen, J., Hammer, J., Fahrenholz, C. et al. (2005): 'Anforderungen an die Standorterkundung für HAW-Endlager in Hartgesteinen (ASTER) – Abschlussbericht', Federal Ministry of Economic Affairs and Labour (BMWA), FKZ 02E9612 and 02E9622.

[923] Cf. Schreiber, U., Ewert, T., Jentzsch, G. (2015): 'Geologische Potenziale zur Einlagerung von radioaktiven Abfallstoffen unterhalb von stratiformen Salzformationen', University of Duisburg-Essen, K-MAT 42.

[924] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, pp. 123-127.

[925] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, p. 90.

host rock, and the geotechnical and technical barriers. The subdivision of a disposal system into several such containment zones will be permissible.

Explanation: Since the isolating rock zone is to have a thickness of at least 100 metres, in the course of the site selection procedure areas of host rock with a barrier function are to be designated that are sufficiently thick in order to accommodate the isolating rock zone.

The derivation of the minimum thickness by the AkEnd was originally based on ideas about 'rock types with very low field permeabilities'[926] in which the concept of the isolating rock zone would be valid unrestrictedly across the whole volume of the disposal facility.

As far as potential sites with crystalline rock are concerned, on the one hand, this implies an aspiration to designate accordingly large areas of homogeneous crystalline rock;[927] on the other hand, areas of crystalline rock are also imaginable that will be dealt with in accordance with the other safety concepts set out in section 5.5.4. In these cases, however, the barrier concept for crystalline rock will also be different with its emphasis on long-term safety being ensured by the combined effect of the container and the geotechnical barriers.[928]

6.5.5.3 Minimum depth of the isolating rock zone

The top of the isolating rock zone must lie at least 300 metres below the surface of the site. In areas where exogenous processes are to be expected during the reference period, the direct or indirect impacts of which could lead to the integrity of the isolating rock zone being impaired, the top of the isolating rock zone must lie deeper than the greatest anticipated depth of such impacts.

For the 'rock salt in steep stratification (salt dome)' disposal system type, the salt overburden above the isolating rock zone must be at least 300 metres thick to take account of possible future subrosion.

For the 'claystone' disposal system type, the thickness of the overburden remaining after the occurrence of the exogenous processes that are to be anticipated must be sufficient in order for it to be possible for any impairment of the integrity of the isolating rock zone by decompaction to be ruled out.

Explanation: The specification of the minimum depth for the isolating rock zone, with account being taken of exogenous processes that may occur regionally (in particular, intensive erosion), is intended to prevent the integrity of the isolating rock zone from being impaired by their direct and indirect consequences (e.g. exposure and/or decompaction of the isolating rock zone and/or host rock, increased subrosion). In the north German lowlands, e.g., the creation of deep subglacial channels must be assumed during future ice ages. The top of the isolating rock zone must be a sufficient distance from the deepest anticipated

[926] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, p. 89.
[927] See also section B 6.5.4.1.
[928] See also section B 6.8.

base level of these channels, to be derived from the greatest known depth of such channels plus a safety margin that takes account of forecasting uncertainties.[929]

6.5.5.4 Maximum depth of the emplacement zone

From the Commission's point of view, this requirement proposed by the AkEnd is to be discarded.

Grounds: The depth of a deep repository is determined by the local geological situation, the emplacement concept, what is geotechnically feasible and, where relevant, additional requirements concerning occupational health and safety underground (e.g. ambient air temperature). A disposal site should be sought for the emplacement of waste materials at a depth of between 500 metres and 1,000 metres. Depending on the emplacement concept (e.g. vertical borehole disposal), greater depths may also be reached or necessary. The emplacement depths required at particular sites may therefore vary very widely from site to site. Under these parameters, in contrast to the proposal made by the AkEnd, the Commission is of the opinion that it is not expedient to define a minimum requirement concerning the maximum depth of the emplacement zone.

6.5.5.5 Area of the disposal facility

The isolating rock zone must have an areal extent sufficient to permit the construction of the disposal facility. The area required for the facility will include areas that are required for the implementation of measures to retrieve waste containers, and space must be kept available for the later excavation of an access gallery for the recovery of waste containers.

Explanation: The isolating rock zone of a disposal facility is still not known when the siting regions are being selected (Step 1 of the selection procedure). It was assumed in the AkEnd report that the size of the isolating rock zone, including the entire deep repository, would be three square kilometres in salt and ten square kilometres in claystone.[930] The Commission has had these figures for the minimum required area reviewed in an expert opinion.[931] The expert opinion calculated the following minimum required areas for the scenarios it examined:

[929] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, p. 90.
[930] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, pp. 90-91.
[931] Cf. DBE Technology GmbH (2016): 'Gutachten Flächenbedarf für ein Endlager für wärmeentwickelnde, hoch radioaktive Abfälle', K-MAT 58.

Table 24: Total repository area required according to DBE Technology GmbH (2016)

Disposal facility variant Area calculated	Salt 200ºC	Salt 100ºC	Claystone 100ºC	Granite 100ºC
Required width of pillars between emplacement galleries	2 x width of gallery	2 x width of gallery	5 x width of gallery	2.5 x height of gallery
Area required for packages (m^2)	800,800	1,632,600	4,871,000	2,212,700
Separation distance required (m)	50	50	40	100
Area required by separation distance (m^2)	228,000	401,200	1,082,000	1,026,000
Area required for infrastructure zone (m^2)	250,000	250,000	630,000	320,000
Total area of facility (m^2)	**1,278,800**	**2,283,800**	**6,583,000**	**3,558,700**

The Commission has taken note of the expert opinion as guidance, but also believes that the actual area needed in the course of the site selection procedure may easily be markedly larger, e.g. as a result of additional pillars or to make the geometry of the disposal facility more flexible.

Furthermore, according to the report on the National Waste Management Programme, further volumes of waste from uranium enrichment and the Asse mine are to be accommodated at the disposal facility for high-level radioactive waste materials – provided a suitable site for a combined disposal facility can be found. The storage concept, including access galleries, underground laboratories, sealing structures, etc. also has to be borne in mind when calculating the areal extent of a facility.

In comparison to the minimum required areas calculated in the expert opinion, the figures estimated by the AkEnd may be regarded as conservative. In consequence, they are still suitable as minimum requirements for the site selection process and may therefore be retained.

6.5.5.6 Information concerning the isolating rock zone over the reference period

There must be no information or data available that give rise to doubts as to whether the minimum geoscientific requirements concerning the rock permeability, thickness and extent of the isolating rock zone, and therefore its integrity can be complied with over a period of one million years.[932]

6.5.6 Geoscientific consideration criteria

The aim of the site selection procedure is to find a site that guarantees the best-possible safety for the isolation of waste materials from environmental assets for a period of one million years. Once the geological areas to be searched have been identified, with the geoscientific exclusion criteria and minimum requirements being applied, it is to be appraised with the help of the consideration criteria discussed below whether a generally favourable overall geological situation is found in a subarea and/or siting region. In this respect, it is accepted as a matter of principle that one individual consideration criterion is not enough to provide evidence of, or rule out, a favourable overall geological situation. Such a favourable overall geological situation will not therefore depend on the particularly good fulfilment of a single criterion, but on the sum of the requirements and associated consideration criteria fulfilled or the extent to which all the requirements and associated consideration criteria are fulfilled. In this respect, it is not only the indicators quantified below that will have to be looked at in the examination process, but the complete description of the requirement with which they are associated.

A favourable overall geological situation is a sub-aim. It is subordinate to the overall aim of arriving at a favourable overall situation with regard to the safety of the disposal facility. The safety of the disposal facility will be appraised in the course of the safety analyses.

The geoscientific consideration criteria are divided below into eleven requirements and three criteria groups:

Criteria group 1: Quality of isolation capacity and reliability of evidence

- Requirement 1: No or slow transportation through groundwater at the repository level
- Requirement 2: Favourable configuration of rock bodies, in particular host rock and isolating rock zone
- Requirement 3: Ease of spatial characterisation
- Requirement 4: Good predictability of the long-term stability of favourable conditions

Criteria group 2: Protection of isolation capacity

[932] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): ‘Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites’, K-MAT 1, p. 90.

- Requirement 5: Favourable rock-mechanical preconditions
- Requirement 6: Low tendency to the formation of water flowpaths in the host rock body/isolating rock zone

Criteria group 3: Further safety-relevant properties

- Requirement 7:Good conditions for the prevention and/or minimisation of gas generation
- Requirement 8: Good temperature resistance
- Requirement 9: High radionuclide retention capacity of the isolating rock zone
- Requirement 10: Favourable hydrochemical conditions
- Requirement 11: Protection of the isolating rock zone by the favourable structure of the overburden

The geoscientific consideration criteria will first come to be applied in Step 2 of Phase 1 of the site selection procedure and will then be valid for the entire further consideration process until the conclusion of Phase 3 with the selection of the disposal site.

In Step 2 of Phase 1, they will be used initially to designate subareas with favourable geological preconditions. In Step 3 of Phase 1, they are to be used as elements of the in-depth consideration, together with the representative preliminary safety analyses and the application of spatial planning criteria, to designate siting regions for surface exploration (conclusion of Phase 1).

During Phase 2 and Phase 3, safety analyses[933] founded on what will still be generic disposal concepts will gradually be incorporated into the procedure on the basis of the increasing levels of site-specific information from the surface and underground exploration activities. These generic concepts will be iteratively refined and adapted to the site conditions. The comparison of the siting regions and/or sites analysed in each case will inform the proposals for the underground exploration work at the conclusion of Phase 2 and, ultimately, the proposal for the site with the best-possible safety (conclusion of Phase 3).

In this process, differences in the suitability of the sites will be brought out with the help of the geoscientific consideration criteria.

Criteria group 1, ‘quality of isolation capacity and reliability of evidence’, consists of the consideration criteria that will be used during the comparison of siting regions or sites to assess the quality of the isolation of the radioactive materials at the location for their final disposal, as well as the reliability of the evidence provided for the long-term safety case. With regard to the final disposal of radioactive waste, both will be central aspects and indicate that

- the safe, long-term isolation of radioactive materials is possible at the potential location of emplacement;
- this can also be demonstrated with sufficient certainty in an evidence procedure and forecast for the reference period.

Whether it is ensured by the designation of, and provision of evidence about, one (or, in certain circumstances, several) isolating rock zones, or whether it is

[933] See also section B 6.5.2.

ensured by the interaction of technical, geotechnical and geological barriers in a long-term stable environment, the isolation capacity at the location of the repository will be the central geological property of the whole disposal system and, in so far as this is the case, the primary characteristic of the site that will be sought during the selection procedure. When siting regions and sites are considered, it will be a matter of comparing and ranking siting regions or sites where the capacity to isolate radioactive waste materials can be anticipated as a matter of principle. The lack of isolation capacity at a potential repository location would lead to its exclusion from the procedure, which is why sites of this kind would no longer be dealt with by the geoscientific consideration process.

<u>Criteria group 2</u>, 'protection of isolation capacity', includes consideration criteria that can be used to assess how well the rock will maintain its isolation capacity when subject to the stresses that will be generated during the construction and operation of the disposal facility's underground cavities. Rock with a high load-bearing capacity (i.e. in which the cavities to be excavated will be highly stable), as low as possible a tendency to rock loosening, as low as possible a tendency to the formation of new water flow paths or reactivation of fossil water flowpaths in the isolating rock zone and the capacity to respond to fissure formation with self-healing processes are favourable properties.

<u>Criteria group 3</u>, 'further safety-relevant properties', includes consideration criteria that will be used to assess the robustness of the disposal system. They reflect the fact that the function of the disposal system will not end with the reference period but, as far as it is humanly possible to tell, the waste is to remain isolated for an infinite period, and properties that will support this are to be rated positively when otherwise equivalent sites are being considered. Favourable properties in this criteria group will strengthen and enhance the safety of the overall system further to the isolation capacity assessed in criteria groups 1 and 2, e.g. because a favourable environment for the minimisation of corrosion and gas generation prevails in the near field of the waste materials, or the heat from the waste materials is dissipated into the rock rapidly and without mineral metamorphosis, countering any build-up of critical gas pressure levels. The capacity to retain radionuclides in the rock of the isolating rock zone will limit or hinder the transportation of radionuclides into the biosphere if there is a release from the waste materials. An overburden that additionally protects the isolating rock zone against unfavourable influences (e.g. erosion, subrosion or glacial channels) and/or is able to retain radionuclides will increase the robustness of the disposal system as well.

With regard to the safety of the site to be selected, the consideration criteria are assigned different degrees of significance, which may also vary sometimes depending on the specific concept and host rock. Account is to be taken of these differences during the consideration of siting regions or sites. The effects of their combination may also be relevant to the consideration process. For this reason, <u>all</u> requirements with their associated consideration criteria are to be analysed and checked in line with the level of information available at the time for the siting regions or sites analysed at each process step. As a matter of principle, it is not possible for any of the requirements to be discarded during the analysis on account of other requirements either.

A reasoned consideration process will be required for the assessment and comparison of the siting regions and/or sites to be analysed in each case. Formal aggregation rules, in particular rules for the compensatory aggregation of the individual results from the application of the criteria, are not regarded as expedient by the Commission. The comparative overall analysis of all requirements will be undertaken with the aim of designating siting regions and/or sites with the most favourable possible overall manifestation of their safety-related geological characteristics, make the differences between them transparent with the help of the safety-related advantages and disadvantages of the siting regions and/or sites, and use this to derive a selection of regions or sites for the following process step. At each step, the sites' advantages and disadvantages, and what they reveal about the safety of those sites may be reviewed and assessed iteratively on the basis of the information that is available and the knowledge that has been gained. In the course of this process, the results of the safety analyses will gain in significance compared to the consideration criteria as they become more detailed. Sensitivity analyses will make it possible to distinguish more robust combinations of characteristics from less robust combinations. In this respect, changes in the initial ranking and opportunities to return to initially deferred sites are also to be kept in mind.

6.5.6.1 Criteria group 1: Quality of isolation capacity and reliability of evidence

6.5.6.1.1 Requirement 1: No or slow transportation through groundwater in the isolating rock zone

The requirement 'no or slow transportation through groundwater at the repository level' characterises favourable hydrogeological conditions for the safe final disposal of radioactive waste materials. Conditions are termed favourable if both the groundwater supply to the waste materials and the levels of groundwater movement in the isolating rock zone are low: Among other things, a low groundwater supply will limit the corrosion suffered by the waste containers and therefore the release of radionuclides from the waste materials. Low levels of groundwater movement are the condition for slow advective transportation of pollutants from the isolating rock zone. The displacement velocity of the groundwater will be used as the assessment variable for this. It is calculated from the distance the groundwater covers during a unit of time. In conditions where the groundwater is stagnant, diffusion will be the only transportation mechanism that comes into question.

Associated criteria: The groundwater flow in the isolating rock zone, measured as its displacement velocity, should be as low as possible, i.e. markedly less than one millimetre a year.

The **groundwater supply** in the isolating rock zone should be as low as possible. The isolating rock zone should therefore consist of rock types that, experience suggests, display low levels of rock permeability.

The **diffusion velocity** in the isolating rock zone, measured by the effective diffusion coefficient, should be as low as possible (less than 10^{-11} m^2/s).

Presumably, insufficient information about the assessment benchmarks for these criteria will be available during the first phase of the selection procedure. As long as this situation continues, the following indicators will be applied in their place:

The characteristic rock permeability of the three types of host rock (rock salt, claystone and crystalline rock) will be taken as an indicator for the appraisal of groundwater flow and groundwater supply.[934] Since no information will initially be available on this topic either, the rock type itself will be deployed as an indicator for rock permeability:[935]

Indicator: 'Rock type' for rock permeability, displacement velocity and groundwater supply.

Associated criterion: The isolating rock zone should consist of rock types that, experience suggests, display low rock permeability (the values for this given in Table 25 below for the assessment benchmark 'groundwater supply' are also valid for the assessment benchmark 'displacement velocity').

Of the potential types of host rock, the presence of rock salt and claystone may be regarded as indicators of low rock permeability because the probability that rock bodies of these types display the desired low field permeability is relatively high. However, it is to be shown in the course of the further selection procedure that, as a matter of principle, properties that increase permeability and cannot be ruled out, such as inhomogeneities or permeable chasms, are not pronounced in an analysed rock body or are not of such significance that they would threaten the isolation capacity of the isolating rock zone.

The presence of crystalline rock is only suitable to a limited degree as an indicator of low rock permeability because rock bodies of this rock type typically display chasms or fractures that increase permeability. This makes the existence of rock bodies with low rock permeability less probable (but, as examples show, does not rule it out) and leads, where relevant, to a different safety concept.

Further possible indicators for a lack of, and/or merely low levels of, groundwater movement in the isolating rock zone for which the AkEnd did not derive any criteria are:

- Permanently 'dry' rock[936]
- The temperature distribution in the deep underground environment[937]
- The depth-dependent increase in groundwater density[938]
- The 'actual' age of the groundwater in the isolating rock zone

[934] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, pp. 107ff.

[935] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, p. 113.

[936] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, p. 106.

[937] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, pp. 114ff.

[938] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, p. 118.

During Phase 1 of the selection procedure, the circumstances connected with these indicators are to be analysed in the course of the in-depth consideration process, provided appropriate information is available.

Diffusion is restricted in water-saturated rocks compared to free water. Apart from limited pore volume, the limited accessibility of pores with small pore openings (constrictivity) and, in particular, the convoluted shape of the pores (tortuosity), something that lengthens migration paths, are factored additionally into the diffusion coefficient that characterises the effective diffusion velocity.

With regard to the diffusive transportation of substances through the isolating rock zone, it is to be ensured that radionuclides' migration times correspond as much as possible to the desired isolation period.[939] In consequence, the extent of the isolating rock zone must be matched to the diffusion speed of the radionuclides: For this purpose, a 50-metre-thick barrier is assumed as a model, to one side of which an elevated initial concentration of an ideal tracer is applied. The desired low diffusion speed means that the concentration of the tracer once it has passed through the isolating rock zone will remain less than one per cent of the initial concentration over a period of one million years. This is the case with an effective diffusion coefficient $< 10^{-11}$ m^2/s (the relevant values are assigned to the assessment groups in Table 25 below).[940]

Table 25: Transportation through groundwater: properties of, assessment benchmarks and/or indicators and fulfilment functions for the criteria

Assessment-relevant property of the criterion	Assessment variable and/or indicator for the criterion (dimension)	Assessment group		
		Favourable	Relatively favourable	Less favourable
Groundwater flow	Displacement velocity of the groundwater (mm/a)	< 0.1	0.1-1	> 1
Groundwater supply	Characteristic rock permeability of the rock type (m/s)	$< 10^{-12}$	10^{-12}-10^{-10}	
Diffusion velocity	Characteristic effective diffusion	$< 10^{-11}$	10^{-11}-10^{-10}	$> 10^{-10}$

[939] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, pp. 119ff.

[940] Important aspects of the safety appraisal of diffusion that are to be dealt with in the course of safety studies (among other things, the dependence of the diffusion coefficient on the diffusing ion, the temperature and the rock fabric, and their interaction with sorption), are not taken into account here.

	coefficient of the rock type for tritiated water (HTO) at 25 °C (m^2/s)			

Sufficient information will not be available about the effective diffusion coefficient as a measure for the diffusion velocity in concrete rock deposits at the beginning of the site selection procedure. Since the diffusion coefficient (like the rock permeability) is generally dependent on the pore volume of the rock, absolute porosity may come into question as a helpful indicator for diffusion velocity.

This is true when it comes to claystone.[941] Here, like porosity, the diffusion velocity and effective diffusion coefficient generally decline with an increasing degree of compaction and/or consolidation of the rock, so that both properties come into question as indicators:

Indicators: ‘Absolute porosity’ and ‘degree of consolidation’ for diffusion velocity and/or effective diffusion coefficient in claystone.

Associated criterion: the isolating rock zone should consist of rock(s) with low absolute porosity and a high degree of diagenetic consolidation.[942]

Table 26: Transportation through groundwater: assessment variables for diffusion velocity in the ‘claystone’ host rock type

Assessment-relevant property of the criterion	Assessment variable and/or indicator for the criterion (dimension)	Assessment group[943]		
		Favourable	Relatively favourable	Less favourable
Diffusion velocity	Absolute porosity	< 20%	20%-40%	> 40%
	Degree of consolidation	Claystone	Stiff clay	Semi-stiff clay

As a matter of principle, the dependence of the diffusion velocity and/or effective diffusion coefficient (as well as permeability) on porosity is also recognisable in crystalline rocks. However, quantitative connections between the parameters are not always clear, even if a correlation is found between the effective diffusion coefficient and permeability.[944] Reliable statements concerning the distinction and delimitation of more or less favourable rock bodies in terms of their diffusion

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[941] A comprehensive account of the derivation and application of indicators is found in: Mazurek, M., Gautschi, A., Marschall, P., Vigneron, G., Lebon, P., Delay, J. (2008): ‘Transferability of geoscientific information from various sources (study sites, underground rock laboratories, natural analogues) to support safety cases for radioactive waste repositories in argillaceous formations’, *Physics and Chemistry of the Earth* 33 (2008), pp. 95-105.

[942] See Table 26.

[943] The boundaries between the assessment groups specified for absolute porosity are to be understood as approximate figures, but are not accurate for all claystone formations in strict quantitative terms.

[944] Kuva, J., Voutilainen, M., Kekäläinen, P., Siitari-Kauppi, M., Timonen, J., Koskinen, L. (2014): ‘Gas Phase Measurements of Porosity, Diffusion Coefficient, and Permeability in Rock Samples from Olkiluoto Bedrock, Finland’, *Transp Porous Med*, DOI 10.1007/s11242-014-0432-2, Springer Science+Business Media.

speed are therefore not possible solely on the basis of indicators, i.e. without targeted measurement of the effective diffusion coefficients.

The diffusion speed of dissolved (and gaseous) substances is very slow in intact rock salt due to its very low porosity. This means favourable preconditions are found for the selection of such a site in this case.

6.5.6.1.2 Requirement 2: Favourable configuration of rock bodies, in particular of host rock and isolating rock zone

The term 'configuration' is defined primarily as the extent and function of the rock body that determines a favourable overall geological situation or – where there are several rock bodies – the geometrical arrangement of the rock bodies involved as characterised by their extent and function. In addition to this, there is the depth of the isolating rock zone within the geosphere and the possible impairment of its barrier effect as a result of its proximity to rock bodies with an elevated hydraulic potential.

As a rule, the extent, arrangement and depth of rock bodies are easier to survey than particular rock properties or the hydraulic and hydrochemical conditions at a site. In consequence, the configuration of safety-relevant rock bodies in the geological barrier is accorded particular significance as a characteristic of a 'favourable overall geological situation' that can be detected early on in the selection procedure.

Associated criteria: The barrier-effective rocks of the isolating rock zone must be of a thickness that ensures the isolation of the radionuclides over a period of one million years. This is to be deduced mathematically subject to the precondition of an ideal barrier effect.

Disposal zone configuration type 'A'[945] and/or host rock body configuration type 'Ba'[946] should be enclosed by the barrier-effective rocks of the isolating rock zone.

If the host rock and the isolating rock zone are different rock bodies, and if the host rock body is not completely enclosed by the isolating rock zone, as in configuration type 'Bb',[947] it is not possible for the arrangement of both units alone to make a sufficient contribution to a 'favourable overall geological situation', even if they display the desired rock properties.

At the least, the quality of the barrier-effective function of the isolating rock zone cannot be derived easily from the arrangement and extent of the rock bodies involved. In a first approximation, the isolating effect of such a configuration is likely to be dependent on how extensively the host rock is enclosed by the isolating rock zone and in what hydraulic position (one or several) gaps in the isolating rock zone consequent upon its configuration are located, through which

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[945] See also Graphic 14. Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, pp. 122ff.

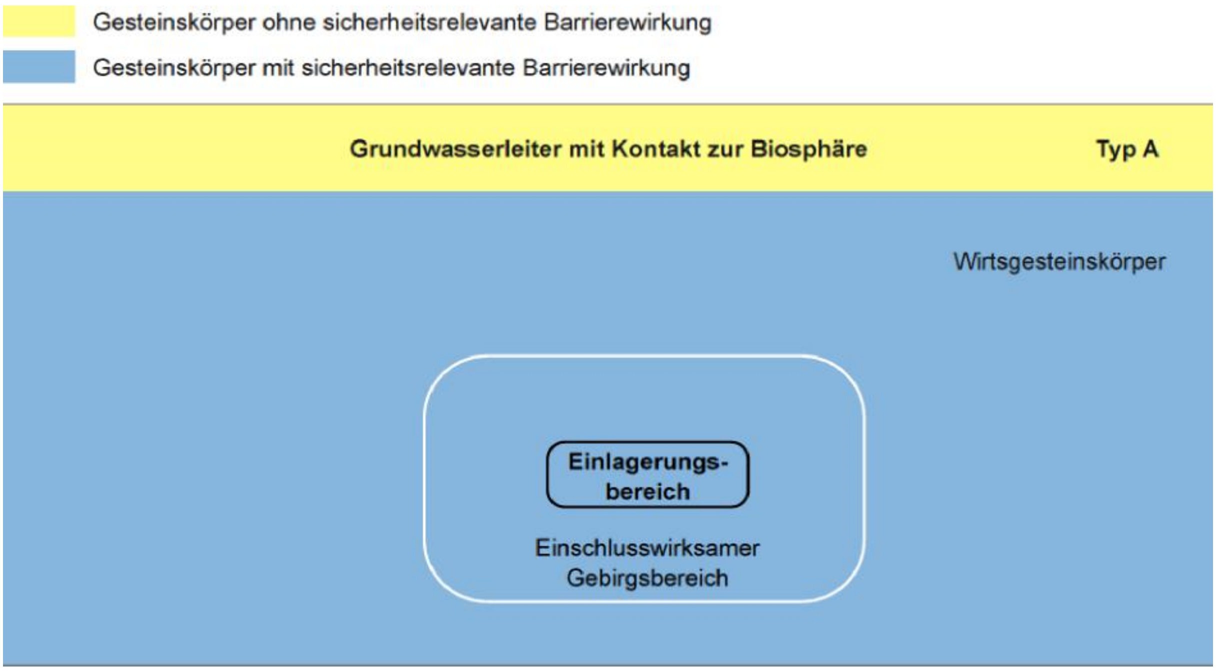
[946] See also Graphic 14. Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, pp. 122ff.

[947] See also Graphic 15. Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, pp. 122ff.

the groundwater in the host rock is able to participate in regional groundwater movement on account of the configuration.

A ‘favourable overall geological situation’ must be ensured all the more by the non-configuration-dependent conditions in a region and/or at a site, the greater the ‘openness’ of the arrangement of the host rock body and the isolating rock zone. Other conditions, e.g. great depth, and favourable hydraulic and hydrochemical conditions in the disposal facility’s emplacement zone, will then have to ensure the isolation of the waste materials in the disposal facility. A situation that corresponds to the ‘Bb’ configuration type could, e.g., be found where deep-lying crystalline host rock is overlaid by barrier-effective salt or claystone across wide areas.[948]

Graphic 14: Configurations between host rock and effective containment zone: Type ‘A’ and Type ‘Ba’[949]



Gesteinskörper ohne sicherheitsrelevante Barrierewirkung = Rock body without safety-relevant barrier effect

Gesteinskörper mit sicherheitsrelevante Barrierewirkung = Rock body with safety-relevant barrier effect

Grundwasserleiter mit Kontakt zur Biosphäre = Groundwater aquifer with contact to biosphere

Typ A = Type ‘A’

Wirtgesteinskörper = Host rock body

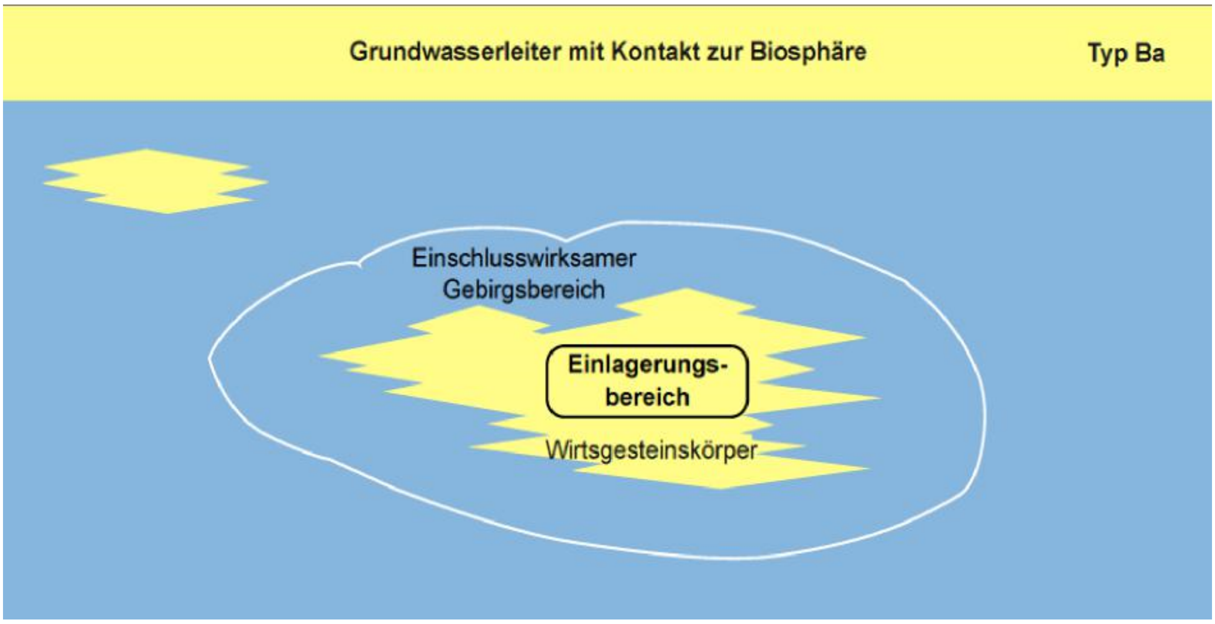
[948] See also Graphic 15.

[949] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): ‘Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites’, K-MAT 1, p. 126. Explanation of Graphic 14: Type ‘A’: The effective containment zone is part of a host rock body with a safety-relevant barrier effect. Type ‘B’: The host rock body does not have a safety-relevant barrier effect and forms different configurations with the effective containment zone. The diagram shows Type ‘Ba’: The host rock is completely enclosed by the effective containment zone. The diagram is schematic and unscaled.

Einlagerungsbereich = Emplacement zone

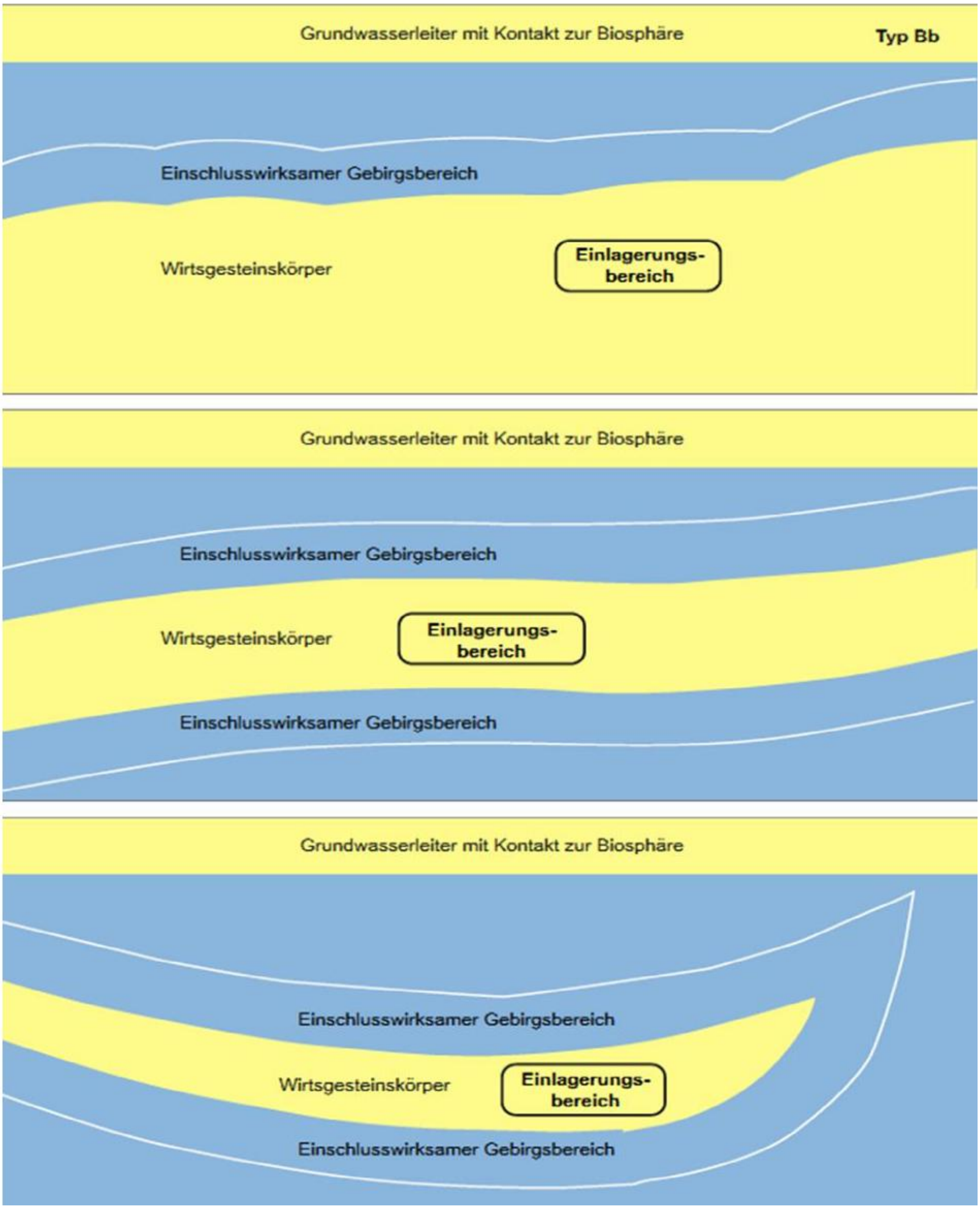
Einschlusswirksamer Gebirgsbereich = Isolating rock zone

Typ Ba = Type ‘Ba’



In Type ‘A’, the isolating rock zone is part of a host rock body with a safety-relevant barrier effect and completely encloses the emplacement zone. In Type ‘Ba’, the host rock body that surrounds the emplacement zone does not have a safety-relevant barrier effect and forms different configurations with the isolating rock zone. The host rock body is completely enclosed by the isolating rock zone.

Graphic 15: Configurations between host rock and isolating rock zone: Type 'Bb'



Gesteinskörper ohne sicherheitsrelevante Barrierewirkung = Rock body without safety-relevant barrier effect

Gesteinskörper mit sicherheitsrelevante Barrierewirkung = Rock body with safety-relevant barrier effect

Grundwasserleiter mit Kontakt zur Biosphäre = Groundwater aquifer with contact to biosphere

Typ Bb = Type 'Bb'

Einschlusswirksamer Gebirgsbereich = Isolating rock zone

Wirtgesteinskörper = Host rock body

Einlagerungsbereich = Emplacement zone

In Type 'Bb', the host rock body that surrounds the emplacement zone does not have a safety-relevant barrier effect and forms different configurations with the isolating rock zone. The host rock body is not completely enclosed by the isolating rock zone. Examples of Type 'Bb' are depicted in Graphic 15 above.

- Although constrained by the need to allow for depth-dependent rock-mechanical risks, the depth of the top of the required isolating rock zone should be as great as possible in order to guarantee the robustness of the disposal system against external natural influences on the isolating rock zone and safety reserves.
- There are depth-dependent rock-mechanical risks in the 'clay or claystone' host rock type in particular. Apart from depth-dependent increases in rock pressure and temperature, such risks are also influenced by the petrographic and mineralogical composition of the rock, its degree of consolidation and the local ground stress conditions.
- Region-specific influence scenarios are to be borne in mind, where relevant, when the criteria are applied. Any disadvantageous impacts they may have on isolation are then to be countered, as necessary, by the prescription of a regional maximum depth, which is to be coordinated in good time and, as far as the assessment-relevant property 'robustness and safety reserves' is concerned, by the prescription of a divergent regional minimum depth. One example of this is the creation of deep subglacial channels, which is to be feared in subareas of the north German lowlands in a future ice age.
- The isolating rock zone must possess a spatial extent that is greater than the mathematically required volume for the disposal facility. This will mean there is scope for a flexible facility design, among other things in order to be able to allow for retrieval concepts that require space, including separation distances. The variable from which the consideration of this issue will start is the area required for emplacement on a single level.
- At potential disposal sites with claystone as their host rock, the isolating rock zone may be underlaid and overlaid by water-bearing formations with elevated hydraulic head, what are referred to as 'sources of hydraulic head'.[950] Under certain circumstances, a hydraulic gradient caused by such an arrangement can lead to the induction and/or intensification of groundwater flow and therefore the transportation of radionuclides in the isolating rock zone as well. The

[950] See Graphic 16 below, 'Schematic diagram of areas with elevated hydraulic potential and the repository zone'.

displacement velocity of the groundwater that results from this must not exceed one millimetre per year in the isolating rock zone.[951]

- If possible sources of hydraulic head are present, the influence of the resulting gradients on groundwater movement and the transportation of radionuclides in the isolating rock zone is therefore to be appraised.

- Experience suggests, however, that a quantitative appraisal of the displacement velocity that will possibly be induced can only be carried out as part of preliminary safety analyses once appropriate information is available. Until then, the following indicators may be deployed – provided suitable data are available – for the (preliminary) appraisal of the possible induction and/or intensification of groundwater movement in the isolating rock zone and the comparative consideration of siting regions/sites as replacements:

Indicator: 'Source of hydraulic head'

Connection of water-bearing strata in the vicinity of an isolating rock zone made up of claystone to an area that that causes a high hydraulic head.[952]

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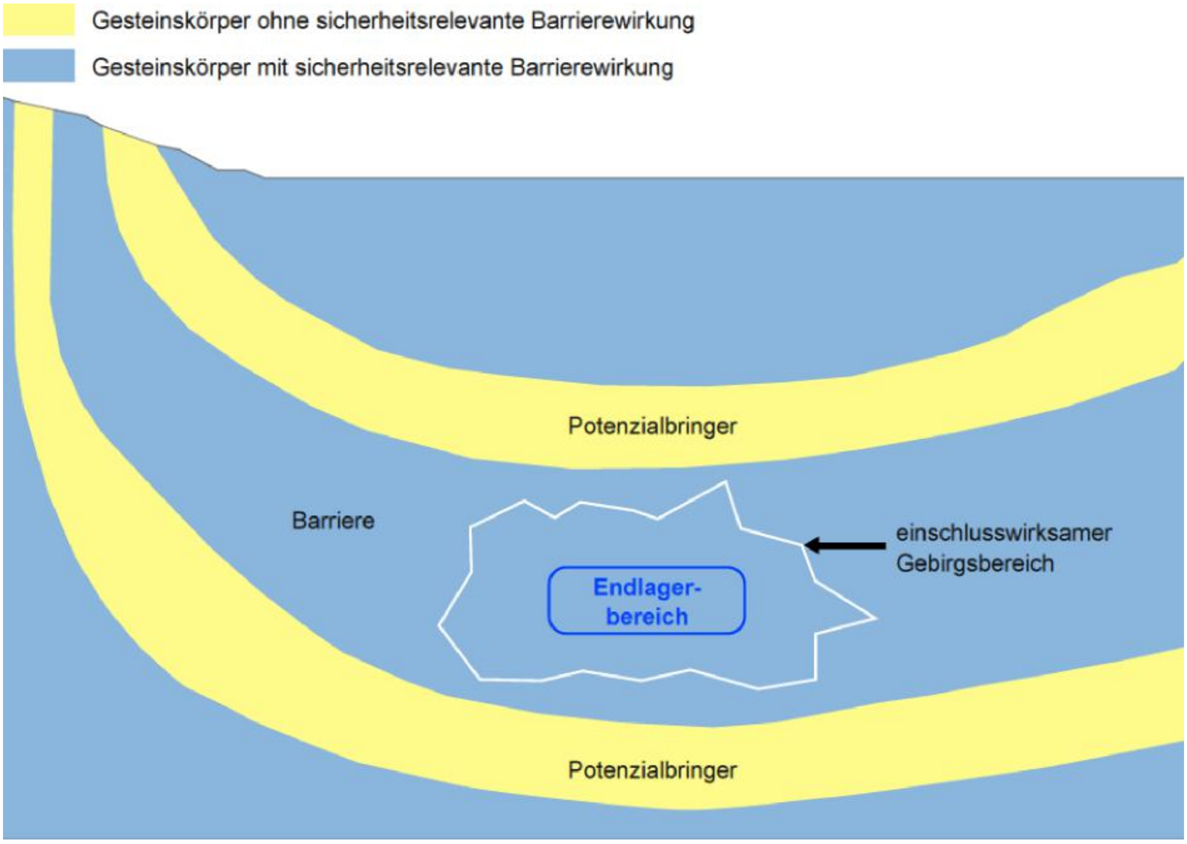
[951] See, on this issue, the criterion 'groundwater flow' in section 6.5.6.1.1

[952] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, p. 136.

Graphic 16: Schematic diagram of areas with elevated hydraulic potential and the repository zone[953]



Gesteinskörper ohne sicherheitsrelevante Barrierewirkung = Rock body without safety-relevant barrier effect

Gesteinskörper mit sicherheitsrelevante Barrierewirkung = Rock body with safety-relevant barrier effect

Potenzialbringer = Source of hydrostatic potential

Barriere = Barrier

Endlagerbereich = Disposal zone

einschlusswirksamer Bereich = Isolating rock zone

[953] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, p. 135.

Associated criteria:

- If possible, there should be no connection to an area of high hydraulic head. This is the case, in particular, if no water-bearing strata with high hydraulic head (and/or large differences in hydraulic head between them) are present in the immediate vicinity below and above the isolating rock zone and/or host rock body.
- The hydraulic resistance of the water-bearing stratum (strata) between the area that causes the high hydraulic head and the position of the repository should be large, i.e. the distance should be large and the rock permeability low.

Indicator: Anomalous levels of hydraulic potential:

Levels of hydraulic head in an isolating rock zone and/or host rock body made up of claystone that deviate anomalously from the anticipated distribution of hydrostatic potential levels and/or display clear differences from neighbouring groundwater-bearing rock bodies may be a pointer to low field permeability in the isolating rock zone and/or host rock body and therefore a favourable hydraulic barrier effect.

This applies when it can be shown that the current hydraulic conditions and the hydraulic conditions that existed in the more recent geological past (hydraulic properties of rock bodies, differences in hydraulic head) have not been sufficient in order to reduce anomalous levels of potential and/or differences in potential generated in the more distant geological past. The preconditions for such an interpretation are that the anomalies are found throughout the area required for the isolating rock zone and that their causes can be deduced plausibly.

Table 27: Favourable configuration of rock bodies: properties of, assessment variables and/or indicators and fulfilment functions for the criteria

Assessment-relevant property of the criterion	Assessment variable and/or indicator for the criterion (dimension)	Assessment group		
		Favourable	Relatively favourable	Less favourable
Barrier effectiveness	Barrier thickness (m)	> 150	100-150	50-100
	Degree of enclosure of the disposal zone and/or host rock body by the isolating rock zone	Complete, Types ‘A’ and ‘Ba’, see example in Graphic 14	Incomplete, Type ‘Bb’, small gaps, in non-critical positions, see example in Graphic 15, bottom	Incomplete; Type ‘Bb’, large gaps, in unsafe positions, see examples in Graphic 15, top and centre
Robustness and safety reserves (further to the	Depth of the upper boundary of the required isolating	> 500	300-500	

minimum requirements set out in section 6.5.5)	rock zone (m below the surface of the site)			
Volume of the isolating rock zone	Areal extent at a given thickness (multiple of the minimum area required (e.g. 3 km^2 for salt and 10 km^2 for clay))	>> 2 times	Approx. 2 times	<< 2 times
Indicator: ‘source of hydraulic head’ in claystone An area that causes high hydraulic head connected to water-bearing strata in the immediate vicinity of the isolating rock zone and/or host rock body	Presence of rock strata with hydraulic properties and hydraulic potential that may make the induction and/or intensification of groundwater movement in the isolating rock zone possible	No groundwater aquifer present in the immediate vicinity of the host rock/isolating rock zone as possible source of hydraulic head		Groundwater aquifer present in the vicinity of the host rock/isolating rock zone

6.5.6.1.3 Requirement 3: Ease of spatial characterisation

The reliable spatial characterisation of the main geological barriers directly or indirectly responsible for the isolation of waste materials, in particular the isolating rock zone and/or host rock body, is a precondition for reliable, considered decisions in the course of the selection procedure and reliable later safety assessments.

The ease of spatial characterisation is based on the **identifiability** of the relevant rock types and their properties and the **transferability** of these properties **to other situations** by means of extrapolation and/or interpolation. Both depend crucially on the conditions for the formation of the rock types and/or their later overprinting.

Associated criteria:
Identifiability:

- The **characteristic properties** of the **rock types** that form the isolating rock zone and/or host rock body[954] should display a **low range of variation** and be **distributed as evenly as possible spatially**.
- **In tectonically overprinted geological units**, there **should be as little overprinting as possible.** The scale of the overprinting will be deduced from the

954 If high-level radioactive waste materials are disposed of in salt domes in the north German lowlands, the host rock will consist of the ‘Hauptsalz’ of the Staßfurt sequence.

stratification conditions, with account being taken of **faulting and folding tectonics**. If possible, **salt structures** should display the folding of strata that have different mechanical and hydraulic properties over the largest possible areas.

Transferability to other situations:

- **Favourable conditions** are characterised by the fact that the rocks in the isolating rock zone and/or host rock body are **homogeneous or very similarly structured over large areas**.

- With regard to the homogeneity of the rock structure, there are clear differences between the various genetic rock groups (sedimentary, igneous and metamorphic). They therefore require different assessment criteria if they are to be assessed in greater detail. The conclusive specification of such criteria will not be possible until the rock types of the isolating rock zone and, where relevant, the host rock are known. In so far as this is the case, the specification of the assessment groups for sedimentary rocks and metamorphic rocks on the basis of the facies concept will be provisional.

Table 28: Ease of spatial characterisation: properties of, assessment variables and/or indicators and fulfilment functions for the criteria

Assessment-relevant property of the criterion	Assessment variable and/or indicator for the criterion	Assessment group		
		Favourable	Relatively favourable	Unfavourable
Identifiability of the rock types and their characteristic properties in the isolating rock zone/host rock body	Range of variation in the properties of the rock types in the isolating rock zone/host rock body	Low	Clear, but known and/or reliably surveyable	Significant and/or not reliably surveyable
	Spatial distribution of the rock types in the isolating rock zone/host rock body and their properties	Even	Continuous, known spatial variations	Discontinuous, insufficiently precisely predictable spatial variations
	Scale of tectonic overprinting of the geological unit	Largely undisturbed (disturbances at a distance > 3 km from the edge of the isolating rock zone, flat rock bed)	Slightly disturbed (disturbances at large intervals, distance of 100 m-3 km from the edge of the isolating rock zone), flexures	Disturbed (boudin blocks at short intervals, distance < 100 m), folded
Transferability of the properties of the isolating rock zone to other situations	Rock formation (rock facies)	Facies regionally homogeneous	Facies alternating in known pattern	Facies alternating in unknown pattern

6.5.6.1.4 Requirement 4: Good predictability of the long-term stability of favourable conditions

When favourable overall geological situations are appraised, it is not enough to identify and spatially characterise current conditions; rather, reliable forecasts about the future development of **geological** conditions must also be possible in order to identify and assess safety-relevant long-term changes. The requirement of good predictability is therefore an essential precondition for the provision of evidence about the long-term stability of favourable geological conditions. It relates to the whole disposal system. It therefore does not apply only for individual criteria, but for the entirety of the geoscientific criteria.

Forecasts for the desired isolation period of one million years require a retrospective analysis that covers far more than one million years. With regard to predictability, overall geological situations whose developmental history can be traced back over long periods of time and in which, in particular, no significant change in safety-relevant characteristics (the 'thickness', 'extent' and 'rock permeability' of the isolating rock zone) is to be registered are favourable.

Associated criterion:

- The safety characteristics important for the long-term stability of favourable conditions, in particular the 'thickness', areal and/or spatial 'extent' and 'rock permeability' of the isolating rock zone, should not have changed significantly for several million years.

Table 29: Good predictability of long-term stability: properties of, assessment variables and/or indicators and fulfilment functions for the criteria

Assessment-relevant property of the criterion	Assessment variable and/or indicator for the criterion	Assessment group		
		Favourable	Relatively favourable	Unfavourable
Long-term stability of favourable conditions	Change in significant safety-critical characteristics: 'thickness' of the isolating rock zone	No significant change in analysed characteristics over a period > 10 million years in the past	No significant change in analysed characteristics over a period of 1-10 million years in the past	No significant change in analysed characteristics over a period of up to 1 million years in the past
	Change in essential safety-critical characteristics: 'extent' of the isolating rock zone	No significant change in analysed characteristics over a period > 10 million years in the past	No significant change in analysed characteristics over a period of 1-10 million years in the past	No significant change in analysed characteristics over a period of up to 1 million years in the past
	Change in essential safety-critical characteristics, in	No significant change in analysed characteristics	No significant change in analysed characteristics	No significant change in analysed characteristics

	this case: the ‘rock permeability’ of the isolating rock zone	over a period > 10 million years in the past	over a period of 1 to 10 million years in the past	over a period of up to 1 million years in the past

6.5.6.2 Criteria group 2: Protection of isolation capacity

6.5.6.2.1 Requirement 5: Favourable rock-mechanical preconditions

From a geotechnical and/or rock-mechanical point of view, the objective associated with the demand for favourable rock-mechanical conditions means being able to design stable underground structures in the solid rock, with underground infrastructure facilities and emplacement chambers, without permanent damage to the surrounding rock (fissure formation), while expending as little effort as possible on technical stabilising measures (no supporting structures) for the operating life envisaged in each case.

In addition to this, no mechanical, thermal or hydraulic processes disadvantageous for the preservation of the barrier’s integrity should be induced (e.g. mechanically or thermally induced fissure formation, fluid flows) as a result of anthropogenic influences during the disposal facility’s operating life and post-operational phase. In particular, it is to be possible for **functioning geotechnical barriers,** such as drift dams or shaft sealing structures, to **be put in place subsequently** in accordance with the decommissioning concept **in a way** that long-term safety is guaranteed.

In consequence, a geomechanical situation is to be aspired to in which the consequent effects of the anthropogenic interference (excavation of shafts and galleries) in the rock, with the deconsolidation and loosening of the rock fabric and formation of secondary permeabilities during the construction and operating periods, are as small as possible over the course of time and, in addition to this, reduced again and finally eliminated in the areas around geotechnical barriers over the longer term after decommissioning, while the barrier’s integrity is to be preserved at all times. In order to derive appraisal benchmarks and/or indicators with which to review compliance with the demand for favourable rock-mechanical preconditions, circumstances will initially be identified that characterise a favourable situation in terms of safe isolation and can be used to identify appropriate rock conditions:

- Apart from near-face consolidation, no supporting structures should be required to ensure the underground workings are stable together with the dead load-bearing capacity of the rock.
- No secondary permeabilities that impair long-term safety should be created in the geological barriers as a result of the excavation of the repository and the construction of the supporting structure.
- The functional effectiveness of the geotechnical barriers (e.g. cross-sectional seals) should not be reduced beyond an unavoidable degree by near-face rock deconsolidation.

Taking these circumstances as the starting point, two indicators are formulated for the presence of what are, in these terms, favourable geomechanical conditions. The criteria discussed below are focussed on these indicators:

Indicator 1: The rock acts geomechanically as a major load-bearing element.

The rock is viewed as a **major load-bearing element** if it is able to absorb the stress imposed by excavation and operation without planned load-bearing supporting structures (apart from face consolidation, e.g., **very few** anchors and **very little** wire netting), while undergoing acceptable levels of deformation.

Indicator 2: There is no mechanically induced secondary permeability beyond an (unavoidable) deconsolidated near-face loosening zone

Beyond a near-face loosening zone, secondary permeabilities are not **detectable** without significant interventions in the rock and therefore cause additional uncertainties in later safety analyses, although they may, in principle, be avoided with appropriate planning. The predictability of the geohydraulic situation in the barrier-effective part of the rock is reduced as a result of this.

Where it is planned that rock deconsolidation and rock loosening will be limited to near-face areas, the spatial extent of the intact geological barrier may be characterised unambiguously (by means of calculations) and demonstrated with examples (by means of field studies), at least as far as its current status is concerned.

Rock deconsolidation that extends beyond the near-face zone must absolutely be avoided by means of appropriate planning of the repository.

Associated criterion:

- The tendency to the formation of mechanically induced secondary permeabilities in the host rock/isolating rock zone beyond a near-face loosening zone should be as low as possible

The action taken during the development of the criteria and the derivation of the appraisal benchmarks is described in detail in the AkEnd report and/or the studies on which it is based. According to these sources, if account is taken of particular rock type-related provisions, there is a connection between the depth of underground workings and rock strength that may be used to appraise the tendency to the formation of secondary permeabilities. When this consideration criterion is applied, a distinction will be drawn between rocks with elastic-brittle and elastic-low-plastic/low-viscous behaviour, on the one hand, and rocks with pronounced creeping behaviour, on the other hand.

6.5.6.2.2 Requirement 6: Low tendency to the formation of water flowpaths in the host rock body and the isolating rock zone

Pollutants may be released from the deep geological underground into the biosphere, in particular, by way of the migration of fluid phases, primarily via water flow paths that are already present in the rock, secondarily via water flow paths induced by anthropogenic intervention (the construction and operation of the disposal facility) or via water flow paths induced by future geogenic influences.

A favourable overall geological situation is therefore to be found, among other things, if the isolating rock zone fundamentally displays only a low tendency to the formation of water flow paths.

The loosening of the rock fabric as a consequence of thermomechanical stress (fissure enlargement, fissure formation) and the selective dissolution of bodies of rock as a consequence of the influence of solvent waters (geochemically reactive environment in the fissuring zone) may be mechanisms for the formation of water flow paths. Here, the development of the criteria remains limited to the mechanism of mechanically induced fissure enlargement/fissure formation. The **selective dissolution of bodies of rock** as a consequence of the influence of solvent waters (geochemically reactive environment in the fissuring zone) is not analysed here.

For the further specification of this requirement, it appears plausible to assume that both fundamental rock properties, and the relationship between the capacity to absorb stress without suffering damage and the existing and/or anticipated levels of rock stress are to be taken into consideration. The starting point for the further analyses is that additional fissure systems may also form in what are currently low-permeable to impermeable rock formations, to be precise if, under the influence of future geogenic and/or anthropogenic stresses,

- the rocks are not sufficiently capable of bearing loads in order to absorb the stresses imposed on them without their tensile strength, their dilatancy resistance and/or their fracture resistance being exceeded,
- the rocks do not display sufficient stress-relaxation capacity in order to absorb external loads without fracturing by means of a stress displacement process that reduces levels of stress and is accompanied by deformation, despite pronounced plastic-viscous behaviour,
- the rocks suffer stress- and deformation-induced loosening and deconsolidation of the rock fabric.

In all these cases, the rocks respond to external loads with the formation of new, and/or further development of already existing, fissures (micro to macrofissures). Once a sufficiently dense network has formed, these secondary fissures then cause the creation of a potentially unacceptable, high level of secondary permeability, even in a primarily low-permeable and/or impermeable rock.

Since the requirement ‘low tendency to fissure formation’ cannot be immediately translated into a measurable, quantifiable criterion and so one that is amenable to consideration, properties will initially be derived that cover individual aspects of this central requirement and for which criteria can then subsequently be formulated. For the more detailed delineation of the requirement, general information that is available about the properties of rocks under geotectonic and repository-relevant stress suggests the tentative formulation of the following circumstances as properties:

Associated criteria

- The **variability of rock permeability** should be **as low as possible**. To this end, the representative field permeability of the isolating rock zone should be the same as the representative rock permeability.[955]

- It should be possible to **deduce** the **barrier effect** of the rock formation against the migration of fluids or gases (under geogenic and also sometimes

[955] This means the rock must not display any joints/fractures that cannot be surveyed when the rock strength is determined.

anthropogenic stress) from geoscientific**, geotechnical or mining experience**. The following circumstances may be used for its assessment:

- Recent existence as water-soluble rock
- Fossil fluid pockets
- Underlying water-soluble rocks
- Underlying deposits of fluid or gaseous hydrocarbons
- Use as a hydrogeological protective layer at mines
- Preservation of the sealing function even under dynamic stress
- Use of cavities for the containerless storage of gaseous and fluid media

• Under in situ-conditions, the rock should geogenically display plastic-viscous deformability without dilatancy (assessment variable: ductility of the rock).

• When stress inversion (increasing isotropic stress and decreasing deviatoric stress) occurs, fissures/fissure systems in the rock should be sealed geohydraulically effectively (assessment variable: regression of secondary permeability as a result of the closure of fissures).

• Following the closure of the fissures, fissures/fissure systems in the rock should be healed geomechanically effectively (assessment variable: restoration of mechanical properties as a result of the healing of fissures).

Table 30: Low tendency to the formation of water flow paths: properties of, assessment variables and/or indicators and fulfilment functions for the criterion

Assessment-relevant property of the criterion	Assessment variable and/or indicator for the criterion (dimension)	Assessment group		
		Favourable	Relatively favourable	Unfavourable
Variability of current field permeability	Ratio of representative field permeability/ representative rock permeability (m/s)	< 10	≤ 100	> 100
	Experience on the barrier effectiveness of rock formations	The rock formation/rock type is directly or indirectly to be identified as low-permeable to geologically impermeable, even	In view of the lack of experience, the rock formation/rock type is not directly/ indirectly to be characterised as low-permeable to	The rock formation/rock type is directly or indirectly to be identified as insufficiently low-permeable, drawing on

		under geogenic or technogenic stress, drawing on one or several of the above-mentioned circumstances/ areas of experience	geologically impermeable.	experience in a particular area
	Ductility of the rock (since there are no specified boundaries that indicate the level of disjunctive deformation at which a rock is ductile or brittle, this criterion is only to be applied when sites are compared)	Ductile or highly plastic-viscous	Brittle-ductile to slightly elasto-visco-plastic	Brittle, linear-elastic
Reversibility of fissures	Regression of secondary permeability by fissure closure	In principle, fissures close completely due to ductile behaviour with surface roughness being compensated for	Fissures are closed by mechanical fissure reduction in conjunction with secondary mechanisms, e.g. swelling deformation	Only limited degree of fissure closure (e.g. where materials behave brittly, there is surface roughness, bridging)
	Restoration of mechanical properties by fissure healing	Fissure healing due to geochemically influenced processes with renewed activation of atomic bonding forces on fissure surface areas		Fissure healing only as a result of the geogenic supply and crystallisation of secondary minerals (mineralised pore and fracture water, secondary mineralisation)
Summary appraisal of the tendency to the formation of water flow paths on the basis of the assessment of individual indicators		Assessment mostly ‘favourable’: no marginal tendency to the formation of water flow paths	Assessment mostly ‘relatively favourable’: low tendency to the formation of permanent water flow paths	Assessment mostly ‘less favourable’: formation of permanent secondary flow paths to be anticipated

6.5.6.3 Criteria group 3: Further safety-relevant properties

6.5.6.3.1 Requirement 7: Good conditions for the prevention and/or minimisation of gas generation

Radioactive waste materials emplaced in a disposal facility may generate gases if they come into contact with water or solutions as a result of corrosion and radiolysis. During the post-operational phase of a disposal facility, gas generation may occur if fluid reaches the waste containers and they corrode. Gas generation may lead to a build-up of pressure in the isolating rock zone. The volumes of gas and gas generation rates must be assessed as part of the scenario analysis. As a result of the build-up of gas pressure, the integrity of the geological barrier may be threatened if the gas pressure exceeds the frac pressure.

In the context of safety analyses, impacts of two-phase flow on radionuclide migration and the migration of radioactive gases are also to be borne in mind. In the context of safety analyses, impacts of two-phase flow on radionuclide migration, dilatancy-controlled gas migration and the migration of radioactive gases are also to be borne in mind.

The maximum possible volume of gas that could be generated from the waste under final disposal conditions and the gas generation rate (volume per year) are of significance for the appraisal of the impact of gas generation on the safety of the disposal facility, in particular on the isolation function of the isolating rock zone and the associated geotechnical barriers. The volume of gas will be determined essentially by the type and constituents of the waste materials, the moisture levels in the waste packages and the supply of groundwater and/or brine to the packages. The gas generation rate will depend on the temperature, the moisture level and the chemical environment in the emplacement chamber and/or package.

Associated criterion:
- Gas generation from waste materials should be as low as possible under repository conditions.

Table 31: Good conditions for the prevention and/or minimisation of gas generation: properties of, assessment variables and/or indicators and fulfilment functions for the criterion

Assessment-relevant property of the criterion	Assessment variable and/or indicator for the criterion	Assessment group		
		Favourable	Relatively favourable	Unfavourable
Gas generation	Water supply in the host rock	Dry	Moist and impermeable (rock permeability $< 10^{-11}$ m/s)	Moist

6.5.6.3.2 Requirement 8: Good temperature resistance

The increase in temperature associated with the emplacement of heat-generating waste materials in a disposal facility (and the resultant temperature gradients) in the geotechnical barriers that surround the waste containers and the isolating rock zone and/or host rock can have complex impacts, which may be positive or negative depending on their type, intensity and range. This is dependent on many factors, such as the scale of the heat input, the host rock type and the form in which it occurs and/or its site-specific manifestation, the safety and storage concept that is being pursued, and further site-specific parameters.

E.g., positive expectations are associated with the fact that in the 'rock salt' host rock type an increase in temperature will lead to the acceleration of convergence and therefore to the more rapid isolation of the waste materials in the isolating rock zone. Nevertheless, an increase in temperature and subsequent cooling will cause tensions in the rock that lead to the creation or reactivation of water flow paths in the isolating rock zone and its surroundings, and may so impair the isolation capacity.

The host rock and, in particular, the isolating rock zone are therefore to have characteristics that ensure it is not possible for a loss of strength and the formation of water flow paths to result from temperature-induced changes in rock properties and heat-induced tensions in the rock due to the expansion of the rocks and their fluids when they initially warm up following emplacement and subsequently cool off.

Essentially, when appraising thermally induced changes, it is necessary to distinguish between the impacts on the rock-mechanical state of stress in the isolating rock zone and the surrounding rock, on the one hand, and mineralogical changes in the host rock, on the other hand:[956]

The processes that are discussed critically where there is an elevated emplacement temperature on account of their potential for the formation of thermally induced secondary permeabilities are related to thermomechanically induced fissure formation, thermally or radiolytically induced gas generation and the build-up of pressure induced as a result of this, as well as the migration of solutions/water vapour ('thermomigration') where there is elevated moisture input (e.g. as a result of salt grit backfilling; solution pockets). The formation of a temperature and pressure-induced pore network in rock salt as a result of static percolation cannot be ruled out at temperatures higher than 120 degrees Celsius.[957] This must be reviewed site-specifically in safety analyses. In claystone and bentonite, thermally induced gas generation in the standby phase before the rock closes around the packages, which may lead to the disintegration of the claystone or bentonite, is to be feared.

At the same time, secondary permeability may also increase due to mineral metamorphoses. These mineralogical changes include, in particular, the loss of crystallisation water from evaporite minerals, such as carnallite, kieserite and polyhalite, and illitisation in clay and bentonite, which brings about an impairment of their swelling capacity. In disposal concepts for claystone and crystalline rock, and in crystalline rock on account of the bentonite barrier, this impairment of swelling capacity generally leads to the limitation of the

[956] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, pp. 177ff.
[957] Cf. Gesellschaft für Anlagen- und Reaktorsicherheit (2016): 'Wärmeverträglichkeit/Gesteinsverträglichkeit: Gutachten im Auftrag der Kommission Lagerung hoch radioaktiver Abfälle', K-MAT 64, pp. 51ff.

temperature within the geotechnical barrier to 100 degrees Celsius. In view of this point, the advantages to be anticipated from a mineralogical point of view on account of the good temperature resistance of crystalline rock therefore cannot be exploited. For reasons connected with the loss of crystallisation water discussed above, compact deposits of these salt minerals are to be avoided when waste is emplaced in rock salt.

Since, the increase in temperature in the geotechnical barriers and the surrounding rock may trigger, accelerate or intensify processes with various negative or positive consequences for the safety of the disposal facility, the specification of host rock-specific or even generally valid temperature limits and their application for the reliable prevention of disadvantageous consequences for the safety of the disposal facility is only suitable to a limited degree. In practice, therefore, modelled analyses and/or (coupled) model calculations of the intensity and range of the thermal, mechanical and hydraulic impacts of the heat input are to be conducted in the context of preliminary safety analyses that are to be refined site-specifically in the course of the procedure so that their results can be used to control the heat input with the waste materials and it will be possible to manage its impacts.[958]

The resistance of the host rock and the buffers to the temperature that is arrived at on the outer surface of the waste package must be reviewed and substantiated. A safe gap between the temperature actually arrived at and the temperature at which critical states such as harmful mineral metamorphoses or long-term damage may occur must be complied with. Research activities on the maximum physically possible temperatures on the outer surface of waste packages where they are in contact with the host rock and the buffer are to be intensified. The maximum permissible temperature will have to be derived from the maximum physically possible temperature, providing there is compliance with a safe temperature gap. In this respect, account is to be taken of the proposals for future research made in the expert opinion from Gesellschaft für Anlagen- und Reaktorsicherheit gGmbH on heat generation and the heat resistance of rocks (May 2016).[959] These issues are to be clarified by the project delivery organisation by the end of Phase 1. Until then, the Commission recommends that, for precautionary reasons, a temperature limit of 100 degrees Celsius be assumed on the outer surface of the containers as long as the maximum physically possible temperatures in the individual host rocks have not been reliably specified on the basis of research studies.

Derivation of criteria: In the course of the site selection procedure, it must be ensured in a readily understandable fashion that the isolating rock zone and the overlying overburden (including the adjoining rock, where possibly affected) have characteristics that ensure temperature-induced changes in the rock properties and thermomechanical tensions in the rock do not lead to a loss of strength and the formation of secondary permeabilities. The derivation of criteria in the course of the site selection procedure will therefore have to involve assessing the formation of heat-induced secondary permeabilities and their

[958] This will not affect compliance with the separation distances around cavities within the underground facility specified in mining ordinances and regulations.
[959] Cf. Gesellschaft für Anlagen- und Reaktorsicherheit (2016): 'Wärmeverträglichkeit/Gesteinsverträglichkeit: Gutachten im Auftrag der Kommission Lagerung hoch radioaktiver Abfälle', K-MAT 64.

extent, and estimating the temperature stability of the host rock in the context of mineral metamorphoses.

6.5.6.3.3 Requirement 9: High radionuclide retention capacity of the rocks in the isolating rock zone

The ionic strength of and/or concentrations of complexing agents and colloids in the deep groundwater, and the mineral inventory of the rock are decisive for the retardation (retention) of radionuclides in the geosphere. Further retarding properties of a formation are matrix diffusion (and sorption on matrix particles) and a filtering effect on colloids.

The scale of the sorption depends both on the mineralogical composition of the rocks through which the water flows and the hydrochemical environment of the deep groundwater. Clay minerals, manganese, iron and aluminium oxides, hydroxides and oxihydrates, and organic matter (e.g. coal, peat) are good sorbents – at least under particular hydrochemical environmental conditions. Of the rock types of interest here that come into question for the host rock and/or isolating rock zone, this is true above all of claystone – on account of its composition. By contrast, granite, comparable crystalline rock types, and rock salt and most of the rock types that are associated with it display a generally low sorption capacity, while they may have advantages over different types of rock in other respects. The significance of the retention capacity is therefore to be appraised as part of the overall analytical consideration of disposal systems.

As far as the scale of sorption is concerned, there are complex relationships between nuclide-specific, rock-specific and environment-specific factors that do not allow the derivation of a generally applicable quantitative criterion beyond the discussion of the general connections that have been described. Rather, favourable geochemical conditions for sorption processes must be defined and appraised in later procedural steps as part of a complex, rock-specific, nuclide-specific, environment-specific, case-by-case analysis.

In safety analyses, the linear sorption coefficient Kd is conventionally used as a measure for the appraisal of sorption capacity. Where the absolute porosity of the rock is 0.15, a Kd value of 0.001 m^3/kg means that the transportation of radionuclides in groundwater is retarded by a factor of approximately 10-20 compared to the displacement velocity. Rock types that have the capacity to sorb long-lived radionuclides are advantageous for the final disposal of high-level radioactive waste materials.

Against the background of these connections, the following points may be deduced for the retention of radionuclides (see also Table 32):

Associated criterion:

- The **sorption capacity** of the rocks should be **as great as possible**; the sorption coefficient (Kd value) for the majority of radionuclides relevant over the long term should be greater than or equal to 0.001 m^3/kg.
- The rocks in the isolating rock zone should have the highest possible proportions of **mineral phases with large reactive surfaces**.
- In order to restrict and/or prevent the migration of radionuclides sorbed on colloids, the **ionic strength of the groundwater** in the isolating rock zone should be **as high as possible**, and the **widths of the rock pores should be in the nanometre range**.

Table 32: High retention capacity in the isolating rock zone: Properties of, assessment benchmarks and/or indicators and fulfilment functions for the criterion

Assessment-relevant property of the criterion	Assessment variable and/or indicator for the criterion (dimension)	Assessment group		
		Favourable	Relatively favourable	Less favourable
Sorption capacity of the rocks in the isolating rock zone	Kd value for the following radionuclides relevant over the long term ≤ 0.001 (m^3/kg)	Uranium, protactinium, thorium, plutonium, neptunium, zirconium, technetium, palladium, iodine, caesium, chlorine	Uranium, plutonium, neptunium, zirconium, technetium, caesium	-
	Mineral phases with large reactive surfaces	High proportions of mineral phases with large reactive surfaces, such as clay minerals, Fe and Mn hydroxides and oxihydrates		

6.5.6.3.4 Requirement 10: Favourable hydrochemical conditions

A geochemical assessment of potential disposal formations that is readily understandable in scientific terms will focus primarily on the influence of locally/regionally occurring deep groundwater and the solid mineral phases in the rocks on the solubility of radionuclides, and therefore their release and migration and/or retention, e.g. as a result of sorption and immobilisation. In addition to this, there are questions about possible chemical attacks on the material of the technical and geotechnical barriers, and possible changes in the hydrochemical conditions for the release and transportation of radionuclides caused by the container and structural supporting materials introduced into the disposal facility.

Favourable hydrochemical conditions in a geological formation are, among other things, characterised by a reducing geochemical environment, low concentrations of complexing agents and colloids, and neutral to slightly alkaline pH conditions with low CO_2 partial pressure. Under conditions of this kind, low solubilities of radionuclides are to be anticipated.

The Eh value, the presence of reduced solid phases, the levels of organic substances, the absence of free oxygen in the groundwater and, in addition to this, the pH value and buffering by any carbonate rocks that are present are regarded as possible indicators for the identification of favourable hydrochemical conditions. The concentrations of complexing agents and colloids (e.g. carbonate complexes or humic colloids) in the deep groundwater and the presence of sorption areas on mineral phases in the rock are decisive for the retardation of radionuclides (see, on this topic, Requirement 9). Another important indicator of favourable hydrochemical conditions is the presence of a geochemical equilibrium between the deep groundwater and the rock.

In the course of the development of the criteria, the AkEnd[960] examined the extent to which quantitative and/or qualitative criteria could be derived for the indicators that have been discussed on the basis of the data accessible at that time. When this was done, account was also taken of the phased approach to the selection of a site, and the knowledge and data available at each specific procedural step.

However, the current level of knowledge about the chemism of deep groundwater in Germany and the heterogeneous distribution of various groundwater types within small areas does not permit any across-the-board statements concerning the characterisation and appraisal of siting regions and sites on the basis of hydrochemical criteria. The knowledge about the hydrochemical conditions is too patchy for this, in particular with regard to the groundwater in the range of depths envisaged for the construction of a disposal facility. Reliable statements will therefore only be possible in a more detailed regional and/or site-specific analysis conducted on the basis of appropriate data.

At the same time, the following hydrochemical and geochemical parameters with influence on the solubility and transportation behaviour of radionuclides can be used as indicators of favourable hydrochemical conditions in terms of radionuclide solubility and transportation. The following points may be mentioned:

- The deep groundwater in the host rock/isolating rock zone is to be in chemical equilibrium with the rocks.
- The pH value should be 7-8 in the deep groundwater zone.
- There should be favourable redox conditions (anoxic-reducing environment) in the deep groundwater zone.

960 Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1.

- The levels of colloids in the deep groundwater should be as low as possible.
- The levels of complexing agents and the carbonate concentration in the deep groundwater should be low.

In summary, however, it is accepted that determining the property 'favourable hydrochemical conditions' will require the availability of site-specific knowledge and information about the disposal concept that can be supplied at late steps in the procedure.

6.5.6.3.5 Requirement 11: Protection of the isolating rock zone by the favourable structure of the overburden

A disposal system's isolating rock zone is of outstanding significance for its long-term safety. The integrity of the isolating rock zone is therefore to be protected against the direct or indirect impacts of exogenous processes, in particular erosion and subrosion. This can be fulfilled by the overburden of the isolating rock zone, i.e. the geological strata that overlie it up to the surface of the Earth.[961] In this respect, a first contribution to the protection of the isolating rock zone by the overburden will be made by compliance with the minimum requirement 'minimum depth of the isolating rock zone'. It corresponds to the desirable minimum thickness of the overburden. In the 'rock salt anticline' disposal system type, this is supplemented by a salt overburden of at least 300 metres above the isolating rock zone. In simplified terms, it is accepted that the isolating rock zone will be protected all the better against deep-seated erosion, the deeper it is located.

Apart from the thickness of the overburden, its structural arrangement and its composition will also contribute to the protection of the isolating rock zone. The performance of this protective function by the overburden and how it is taken into account in the comparative consideration of siting regions and sites will make a contribution to the favourable overall geological situation that is sought and therefore to the identification of the site with the best possible safety.

There are clear differences between the disposal system types[962] to be analysed in terms of the properties of the overburden that are crucial for its protective potential. They are due, firstly, to regional differences between the exogenous processes that are to be anticipated and subjected to safety analyses focussed on their type, the mechanisms by which they affect the system, their intensity and the probability of their occurrence within the reference period. They depend, secondly, on the sensitivity of the isolating rock zone, the host rock body and the overburden to such processes.

Depending on the regional situation of a possible disposal site, it is not to be ruled out that the protective function of the overburden will be impaired or lost as a result of deep-seated future erosion processes. This is to be expected in the

[961] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2010): 'Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste', p. 6: 'The geological strata overlying the isolating rock zone are known as the overburden.'

[962] In emulation of the definition of 'repository system' in the 2010 'Safety Requirements', disposal system types are characterised by the rock type of the host rock and/or the effective containment zone, the form in which it occurs, for instance salt anticline or flat salt bed, the associated disposal concepts and safety-significant geological strata that surround the effective containment zone or overlie it as far as the surface of the Earth.

north German lowlands, e.g., where the overburden could be removed in places or completely reshaped by the creation of deep subglacial channels during future ice ages within the reference period. Such developments are to be analysed in detail and assessed in the preliminary safety analyses. However, they will not occur at all potential sites, so the favourable structure of a disposal system's overburden may also continue to be retained and perform a protective function for longer periods of time.

With regard to the exogenous processes that may be influenced by the properties of the overburden and the isolating rock zone, a distinction is made here, in simplified terms, between the mechanical erosion that will affect all host rock types and/or disposal system types, and its consequences, such as decompaction in crystalline rock and, in particular, claystone, and subrosion in rock salt. These processes may lead directly or indirectly to the integrity of the isolating rock zone being impaired and are therefore regarded as important in view of their significance for the long-term safety of a disposala facility. On account of their occurrence in the geological past relevant for predictive statements, i.e. the last several million years, and the consequences associated with them, it is possible to identify the properties of the rocks of the overburden that are resistant to the effects of these processes. In a favourable case, they may provide the foundation for the use of the concrete properties of the rock series that form the overburden to derive criteria for the assessment of the protective function of the overburden against mechanical erosion, including decompaction and subrosion, as well as disadvantageous consequences for the integrity of the isolating rock zone.

Solely on account of the differences in water solubility between the rock types, a distinction is to be made between disposal systems with rock salt as their host rock and systems with clay, claystone or crystalline rock as their host rock. Such differences make it necessary for the appraisal of the protective capacity of the overburden to be differentiated by disposal system types. The possible safety impacts of the heat input into the rock as a result of the emplacement of the waste materials, such as fissure formation in the salt sequence or mineral metamorphoses in claystone, will continue to be disregarded here.[963]

Level of knowledge about the disposal system types to be analysed: With the exception of the 'rock salt anticline (salt dome)' disposal system type, for which system type-specific consideration criteria have already been derived,[964] the knowledge and information required for the development of appropriate consideration criteria are currently not available for all disposal system types with sufficient evidential value. The deficiencies in knowledge and information that stand in the way of the formulation of specific criteria for the individual disposal system types pertain in different ways and to different degrees to the properties of the individual disposal system types relevant for this question, the type and intensity of the exogenous processes to be taken into account regionally, and the properties of the overburden that reliably indicate its protective potential against their impacts. When it comes to the formulation of differentiating consideration criteria for the disposal system types to be analysed, there are currently clear, in some cases regional, differences in the understanding of the

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[963] See section 6.5.6.3.2, 'Requirement 8: Good temperature resistance'.

[964] Federal Institute for Geosciences and Natural Resources (1995): 'Endlagerung stark wärmeentwickelnder radioaktiver Abfälle in tiefen geologischen Formationen Deutschlands: Untersuchung und Bewertung von Salzformationen'.

process and knowledge about the protective effect of the geological properties of the disposal system types. These differences are to be borne in mind when the protective function of the overburden is appraised, and appropriate criteria are formulated and applied.

Work is currently being done on disposal system-related topics under various projects and research programmes, the results of which it will be possible to use, and/or will even be a precondition, for the development of differentiated consideration criteria. Examples include the KOSINA[965] and BASAL[966] projects, which are looking at the 'flat rock salt bed' disposal system type, and studies in the southern German foothills of the Alps on the depth of Ice Age channels relevant to the 'clay or claystone' disposal system type as an isolating rock zone and host rock. The project delivery organisation must be entrusted with assimilating the results that have already been arrived at, and/or are still being produced, by these projects on this issue when the criteria and/or indicators for the appraisal of the protective function of the overburden are specified in concrete terms, and initiating targeted studies and investigations to clarify specific questions.

Criteria and indicators: The consideration criteria formulated below for the protection of the isolating rock zone by the structure of the overburden are based on the criteria for salt domes developed by the Federal Institute for Geosciences and Natural Resources in 1995.[967] They are intended to map out the direction of travel for the consideration criteria-based comparative appraisal of disposal systems with a view to the protection of the isolating rock zone by the overburden, as long as differentiated criteria still cannot be derived and reliably applied. In preliminary safety analyses, these analyses are to be supplemented by the evaluative consideration of possible factors that influence the protective potential of the overburden with the help of suitable indicators and/or the already existing impacts of particular exogenous processes on a disposal system.

On the basis of the information that is currently available, depending on the disposal system type and/or host rock type, and with account being taken of particular regional features, the following superordinate requirement concerning the protection of the isolating rock zone may be derived:

The overburden of a disposal system should be structured in such a way that it protects the isolating rock zone as well as possible against erosion and subrosion and/or their indirect consequences, decompaction in particular. The following circumstances come into question as guiding criteria and/or indicators for the protection of the isolating rock zone by its overburden:

- the thickest possible complete covering of the isolating rock zone with groundwater-resistant rocks and the most continuous possible distribution of groundwater-resistant rocks in the overburden.

[965] KOSINA – Development of a Concept for a Generic Disposal Facility for Heat-Generating Waste Materials in Flat Salt Beds in Germany, and the Development and Review of a Safety and Evidence Concept.
[966] BASAL – Distribution and Properties of Flat Salt Beds in Germany.
[967] Federal Institute for Geosciences and Natural Resources (1995): 'Endlagerung stark wärmeentwickelnder radioaktiver Abfälle in tiefen geologischen Formationen Deutschlands: Untersuchung und Bewertung von Salzformationen'.

- The thickest possible complete covering of the isolating rock zone and the continuous distribution of particularly erosion-resistant rocks in the overburden over the widest possible area.
- If possible, no structural complications in the overburden (e.g. disturbances, keystone faults, karst structures) that are to be regarded as indicators for existing subrosive, hydraulic or mechanical impairments of the isolating rock zone or impairments of these kinds that might possibly have effects if relevant developments occur in future.
- **Table 33: Protection of the isolating rock zone by the overburden – properties of, assessment variables and fulfilment functions for the criteria**

Assessment-relevant property of the criterion	Assessment variable and/or indicator for the criterion (dimension)	Assessment group		
		Favourable	Relatively favourable	Less favourable
Protection of the isolating rock zone by the favourable structure of the overburden against erosion and subrosion, and their consequences (in particular, decompaction)	Covering of the isolating rock zone with groundwater-resistant rocks,[968] distribution and thickness of groundwater-resistant rocks in the overburden[969]	Complete, thick covering, continuous distribution of groundwater-resistant rocks in the overburden	Extensive, but patchy and/or incomplete covering, extensive, but patchy and/or incomplete distribution of groundwater-resistant rocks in the overburden	Lack of covering, absence of groundwater-resistant rocks in the overburden
	Distribution and thickness of erosion-resistant rocks[970] in the overburden of the isolating rock zone	Complete, thick covering, continuous distribution of particularly erosion-resistant rocks in the overburden over wide areas	Extensive, but patchy and/or incomplete covering, extensive, but patchy and/or incomplete distribution of erosion-resistant rocks in the overburden	Lack of covering, absence of erosion-resistant rocks in the overburden
	No	Overburden	Structural	Structural

[968] In simplified terms, non-saline rock types with low rock permeability (aquitards/aquicludes) are viewed here as groundwater-resistant (and at the same time subrosion-resistant).
[969] In disposal systems with rock salt as the host rock, in particular in flat rock salt beds, the non-saline rock bodies in the overburden are of particular significance for protection against subrosion.
[970] In simplified terms, voluminous to thickly banked, compact bodies of sedimentary rock and/or massive crystalline rock bodies (which would be preferred as the host rock), both with fracturing at wide intervals, are viewed here as particularly erosion-resistant. As the thickness of the banks and the distances between the fractures decrease, this results in decreasing resistance to erosion.

	manifestation of structural complications (e.g. disturbances, keystone faults, Karst structures) in the overburden[971] that could cause subrosive, hydraulic or mechanical impairments to the isolating rock zone	with undisturbed structure	complications, but without identifiable hydraulic effects, e.g. healed fractures/ disturbances	complications with potential hydraulic effects

Explanation: The information available at present on the properties relevant for the protection of the isolating rock zone by the overburden still does not possess the evidential value required for the development and application of criteria for all the disposal system types to be analysed. It is therefore not possible at the moment to carry out the necessary system type-differentiated, concrete specification of the consideration criteria and/or associated indicators on the basis of the characteristics of the various disposal system types, with attention being paid to exogenous processes whose probabilities and effects vary regionally. The formulation of criteria differentiated by disposal system types will therefore have to be entrusted to the project delivery organisation. Ongoing and/or already concluded research and study projects are to be evaluated and/or targeted studies conducted in order to improve the information situation.

The consideration criteria for the appraisal of the protection of the isolating rock zone by the structure of the overburden are therefore deliberately formulated in general terms. They are to prescribe the framework for a readily understandable, criteria-supported consideration process informed by real site conditions. In the course of the preliminary safety analyses, as information progressively becomes available, further indicative circumstances that contribute to the protection of the isolating rock zone against exogenous impairments of its integrity, contribute to the reliable comparative assessment of levels of protection and/or can be used to appraise the relevant circumstances will have to be factored into the analytical and consideration processes.

To a great extent, the information required for this purpose will only be compiled in the course of the site exploration. The findings and assessments performed on the basis of these findings are then to be compared with the criteria put in place to ensure that the overburden protects the isolating rock zone so it is possible to assess the overburden's protective potential against erosion, subrosion and their

[971] The structural complications to be examined in each case are to be derived from the characteristic properties of the disposal system types.

consequences (e.g. decompaction) in such a way that the overburden's potential to protect each individual disposal system and the differences between them in this respect can be understood from the geological conditions.

6.5.7 Site-specific examination criteria

6.5.7.1 Delimitation of site-specific examination criteria

The site-specific examination criteria set out in the Site Selection Act will be used to appraise geological circumstances whose particular significance for the safety of a site has been deduced from the results of preliminary safety analyses, which will have been conducted on the basis of the results of the exploration work available after previous exploratory steps. Unlike the geoscientific exclusion criteria, minimum requirements and consideration criteria proposed by the Commission, the site-specific examination criteria will only be derived and specified during the implementation of the selection procedure. Functionally, they will be site-specific exclusion criteria. The failure to fulfil them will have the consequence that parts of a site or a whole site will not be accepted for the next phase of the procedure.

This focus on selection-relevant geological aspects with safety relevance, and the timing of their derivation and application during the selection procedure distinguish the site-specific examination criteria from assessment instruments that may be required when the proposed site selection procedure is implemented or a disposal facility is constructed and operated at the selected site. During this process, it will presumably be necessary to review previously adopted decisions or specifications several times. This will in all likelihood involve clarifications of whether it is necessary at a particular point in the selection procedure to move back to an earlier stage, whether the design requirements for the disposal facility specified in the licensing procedure following the conclusive site comparison are being complied with or whether it will be necessary to retrieve waste materials from the facility. The creation of generally valid or site-specific assessment instruments, which will then possibly be referred to as 'examination criteria', may be required for these or other comparable purposes. The Commission wishes to emphasise that these or comparable provisions and assessment instruments will probably be needed in future, but has decided not to develop them in the absence of concrete information about the future parameters and foundations for their derivation and application. Accordingly, in contrast to the site-specific examination criteria dealt with below, no concrete provisions on these assessment instruments, which are mentioned as examples, are to be found in the Site Selection Act either.

6.5.7.2 Site-specific examination criteria in the Site Selection Act

Sections 15 and 18 of the Site Selection Act prescribe the elaboration of site-specific exploration programmes for the surface and underground exploration of the siting regions or sites selected for exploration in each case. Under the Act, furthermore, site-specific examination criteria are to be specified for the assessment of the results generated during the surface and underground exploration activities for the individual siting regions or sites. In this respect, it will contribute to the transparency and credibility of the site data that are to be obtained by the surface or underground exploration if the examination criteria for the assessment of the information that is gathered are drawn up before the relevant exploration activities are conducted.[972]

The site-specific exploration programmes and the associated examination criteria are accordingly to be proposed by the project delivery organisation[973] and specified by the BfE.[974] Under the Act, the proposals concerning the exploration programmes and examination criteria are among the 'information to be provided on which the public may comment,'[975] which is to be dealt with in accordance with the provisions set out in Section 10 of the Act. This is also true of the report on the results of the surface exploration, their assessment and the proposal based on this for the sites to be explored underground under Section 15 of the Act, the report that sets out the findings and assessments of the underground exploration conducted under Section 18, and the conclusive site comparison and proposal based on that report under Section 19.

With regard to the objective of, and questions addressed by, the exploration programmes and the associated site-specific examination criteria for the assessment of the results of the exploration activities, the explanatory memorandum to the Site Selection Act states that a distinction is to be drawn between surface and underground exploration:[976]

- During **surface exploration**, the site-specific examination criteria are to be used to assess the geoscientific findings from the exploration activities with a view to the necessary characteristic features of the isolating rock zone and the favourable overall geological situation at the site in question. The results of this assessment will be incorporated into the proposals for the 'objectively justified selection of sites for the host rock types covered by the further exploration, and associated programmes for underground exploration,'[977] which will be presented by the project delivery organisation to the BfE.[978]
- During **underground exploration**, by contrast, the exploration programme must be 'suitable to determine all site-specific geological data that are required for a reliable safety appraisal of, in particular, the long-term safety of a disposal facility at this site in accordance with the latest advances in science and

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972 German Bundestag (2013): Draft Act tabled by the parliamentary groups of the Christian Democratic Union/Christian Social Union (CDU/CSU), the Social Democratic Party of Germany (SPD), the Free Democratic Party (FDP) and Alliance 90/The Greens: Draft Act on the Search for and Selection of a Site for a Disposal Facility for Heat-Generating Radioactive Waste Materials and on the Amendment of other Acts (Site Selection Act – StandAG), Bundestag Printed Paper 17/13471.
973 Cf. Section 6 of the Site Selection Act.
974 Cf. Section 7 of the Site Selection Act.
975 Cf. Section 9 of the Site Selection Act.
976 German Bundestag (2013): Draft Act tabled by the parliamentary groups of the Christian Democratic Union/Christian Social Union (CDU/CSU), the Social Democratic Party of Germany (SPD), the Free Democratic Party (FDP) and Alliance 90/The Greens: Draft Act on the Search for and Selection of a Site for a Disposal Facility for Heat-Generating Radioactive Waste Materials and for the Amendment of other Acts (Site Selection Act – StandAG), Bundestag Printed Paper 17/13471.
977 German Bundestag (2013): Draft Act tabled by the parliamentary groups of the Christian Democratic Union/Christian Social Union (CDU/CSU), the Social Democratic Party of Germany (SPD), the Free Democratic Party (FDP) and Alliance 90/The Greens: Draft Act on the Search for and Selection of a Site for a Disposal Facility for Heat-Generating Radioactive Waste Materials and for the Amendment of other Acts (Site Selection Act – StandAG), Bundestag Printed Paper 17/13471.
978 Cf. Section 16 of the Site Selection Act.

technology.'[979] This demand establishes a link with the further developed preliminary safety analyses conducted on the basis of the results of the surface exploration that are provided for in Section 16 of the Site Selection Act.

The precise action to be taken when the examination criteria are derived and applied, and the mechanisms for their application are not regulated by the Act.

6.5.7.3 Aims and function of the site-specific examination criteria

The 'site-specific examination criteria' criteria type and the general rules on its application in the Site Selection Act go back to remarks in the report from the AkEnd that, for their part, were inspired by an approach to assessment developed in Switzerland with site-specific exclusion criteria for the Wellenberg disposal site for low and intermediate-level radioactive waste materials that was at one point being looked at in the Canton of Nidwalden.[980]

Under this approach, the site-specific examination criteria will be used to assess particular safety-relevant geological circumstances at a site, the type and significance of which have been identified as being significant for long-term safety from the results of preceding site-specific preliminary safety analyses based on the surface exploration activities. These circumstances will be appraised using site-specifically formulated examination criteria founded on the results of the underground exploration work done at the site in question.

The use of corresponding site-specific examination criteria as early as the appraisal of the results from the surface exploration was not considered by the AkEnd because, given the lack of results from the site exploration activities, the safety analyses available at that point in time would have a largely generic character and would only allow the identification of relevant site-specific, safety-relevant geological circumstances, as in underground exploration, in exceptional cases, if at all. In connection with the assessment of the results of the surface exploration, the AkEnd report talks in a general fashion of the 'specification of programmes for exploration from the surface and corresponding assessment criteria.'[981] Particular assessment instruments, e.g. criteria or safety analyses, are not discussed in this respect.

One significant reason for the development and application of site-specific examination criteria lies in the fact that, during the protracted underground exploration of a potential disposal site, no ongoing assessment of the findings obtained will take place with the aim of deciding transparently whether the site in question will continue to have a prospect of being suitable as a disposal site. It is only ever going to be difficult for outsiders or non-experts to understand the

[979] German Bundestag (2013): Draft Act tabled by the parliamentary groups of the Christian Democratic Union/Christian Social Union (CDU/CSU), the Social Democratic Party of Germany (SPD), the Free Democratic Party (FDP) and Alliance 90/The Greens: Draft Act on the Search for and Selection of a Site for a Disposal Facility for Heat-Generating Radioactive Waste Materials and for the Amendment of other Acts (Site Selection Act – StandAG), Bundestag Printed Paper 17/13471, p. 28

[980] The project was not implemented because the underground exploration of the site was rejected by a vote of Nidwalden's citizens. Cf., on the examination criteria applied at that time, Swiss Federal Nuclear Safety Inspectorate (HSK) (2000): 'Anforderung der HSK an das Projekt eines Lagers für schwach- und mittelaktive Abfälle (SMA) am Wellenberg unter Berücksichtigung der Empfehlungen der Expertengruppe EKRA', HSK-Bericht 30/15.

[981] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, p 72.

results of the conclusive integrated assessment of a site’s characteristics. What is therefore needed is a set of assessment instruments that promptly allows the unambiguous, easily comprehensible appraisal of safety-relevant geological circumstances with the help of specific findings from the underground exploration that have been obtained in a targeted fashion.

The development and application of the site-specific examination criteria and the appraisal of the results therefore essentially represent confidence-building measures. The confidence that is sought can, however, only be gained if these steps are accompanied by the comprehensive opportunities for public participation proposed by the Commission, which go as far as the involvement of the National Societal Commission for the clarification of contentious questions. This is required not least because the project delivery organisation has a particularly influential position when it comes to the derivation and application of the examination criteria. The site-specific examination criteria will be the only criteria in the selection procedure focussed on geological questions that have not been specified and discussed with the public prior to the beginning of the procedure.

Operatively, the examination criteria will be used to answer questions about whether it is justified for the underground exploration to continue in the light of the results from the exploration activities on the geological circumstances surveyed with the site-specific examination criteria. Functionally, they have the character of exclusion criteria. The circumstances to be examined must therefore be of such significance for the long-term safety of a disposal facility at the site in question that its exclusion would be justified if they were not fulfilled. Calling them ‘site-specific’ examination criteria serves to delimit them from the exclusion criteria developed by the AkEnd and the Commission. Depending on the spatial dimensions of the area in question, its exclusion due to a failure to fulfil the requirement connected with an examination criterion will have validity for the whole site or, in the case of an exploration programme broken down into several exploration areas, will only have validity for the area in question, provided enough areas worthy of exploration with spatial reserves for the construction of a disposal facility are still available.

Against this background, and based on the central principles adopted by the AkEnd and the provisions set out in the Site Selection Act concerning the derivation and application of site-specific examination criteria, their characteristics may be summarised as follows:

- Site-specific derivation and specification on the basis of the results from the surface exploration and further developed preliminary safety analyses in accordance with Section 18 of the Site Selection Act.
- Involvement of the public in the derivation of the criteria and the assessment of the results of their application in accordance with the proposals made by the Commission concerning participation during Phase 2 of the site selection procedure.
- Application to the results of the underground exploration activities.
- Derivation and specification of criteria prior to the beginning of underground exploration.

- Substantive limitation of the examination criteria to safety-relevant, reliably surveyable and appraisable circumstances identified as important by preliminary safety analyses.
- Prompt application in the context of underground exploration.
- Exclusion of the exploration area in question or, where there are no spatial reserves for exploration, the site as a whole if just one examination criterion is not fulfilled.

From the objectives that have been discussed and the foreseen timing of the application of the examination criteria, it is clear that the examination criteria demanded in Section 15 of the Site Selection Act for the assessment of the results from the surface exploration cannot relate directly to safety-relevant results from preliminary safety analyses because the preceding representative preliminary safety analyses would have to be conducted without exploratory findings being available. This means they lack a defining characteristic of examination criteria. The 'necessary characteristic features of the isolating rock zone and the favourable overall geological situation at the site in question' that are to be surveyed in the course of the surface exploration will be assessed with the exclusion criteria, minimum requirements and consideration criteria for which provision has been made. The geological core of these criteria is, in any case, to be taken into account comprehensively during the development of site-specific exploration programmes. To strengthen public participation in the management of the programme for the surface exploration work during this section of the procedure, the report from the AkEnd recommends that, together with the specification of the surface exploration programmes, the associated assessment benchmarks also be specified in consultation with the population.

Due to their immediate relevance to safety aspects and their derivation on the basis of findings from the surface exploration work and further developed preliminary safety analyses that draw on these findings, the examination criteria demanded in Section 18 of the Site Selection Act for the assessment of the results from the underground exploration will be examination criteria with characteristics that correspond to those defined in the report of the AkEnd.

6.5.7.4 Recommendations of the Commission

- The site-specific examination criteria for the assessment of the results from the underground exploration of the sites selected for this pursuant to Section 18 of the Site Selection Act conform with the approach taken by the AkEnd and the objectives for this type of criteria. Pursuant to the modified procedure proposed by the Commission, they are to be presented and reviewed simultaneously in a combined report with the proposal for the sites to be explored underground, as well as the exploration programmes and examination criteria.[982]
- By contrast, the site-specific examination criteria for the assessment of the results from the surface exploration of sites demanded in Section 15 of the Site Selection Act do not have the character of examination criteria because they do not yet relate to specific sites or their safety during this phase of the procedure.

[982] See sections B 6.3.1.2 and B 7.4.3.

The Commission recommends that this methodological approach not be pursued any further and the relevant formulations be deleted from the Act.

- Since the geological circumstances to be assessed with the exclusion criteria, minimum requirements and consideration criteria for the selection procedure proposed by the Commission in any case represent an extensive field of work for the surface exploration activities and the assessment of their results, an explicit demand for benchmarks with which to assess exploratory findings from the surface exploration is not required in the Site Selection Act. Specific examination criteria should therefore not be developed and applied in connection with the surface exploration activities.

6.5.8 Geoscientific data: information inventory and treatment of areas with inadequate geoscientific data

The data held by the State Geological Services of the Länder and the Federal Institute for Geosciences and Natural Resources (BGR) are to be used as the data basis for the search process during Phase 1 of the site selection procedure.[983] During Phase 1, excluded areas are to be designated on this foundation throughout Germany[984] with the help of the geoscientific exclusion criteria, and potential host rock deposits are to be identified and assessed with the help of the minimum geoscientific requirements,[985] consideration criteria[986] and preliminary safety analyses[987] so that, subject to the additional consideration of theoretical planning criteria,[988] Phase 1 will lead to a proposal with a selection of siting regions for surface exploration.

Pursuant to the Site Selection Act in its current form, the conduct of exploration work on the ground is not envisaged during this phase. In consequence, the data material that is available today and the structure of the geological underground in the area where the host rock deposits are located to be deduced from that material will be attributed great significance during Phase 1.

For this reason, the Commission asked the State Geological Services of the Länder and the Federal Institute for Geosciences and Natural Resources for information about the fundamental geoscientific data held by the Länder. In response, the data available that were relevant to the geoscientific criteria were drawn together by the authorities in the form of an overview.[989] As a summary of the results, which were deliberated on by Working Group 3 of the Commission, it was made clear that, in the opinion of the State Geological Services, although the current level of knowledge might make it possible to begin the site selection procedure, the density of the information about the deeper underground in Germany was not consistent, so that areas with high information density were to be distinguished from areas with lower information density.

[983] Cf. section B 6.3.1.
[984] Cf. section B 6.5.4.
[985] Cf. section B 6.5.5.
[986] Cf. section B 6.5.6.
[987] Cf. section B 6.5.2.
[988] Cf. section B 6.5.9.
[989] Cf. State Geological Services of Germany (2016): ‘Datengrundlagen für die geowissenschaftlichen Kriterien im Rahmen des Standortauswahlverfahrens’, K-MAT 53a.

Pursuant to the Mineral Deposit Act, all information about the substrate is bundled, archived and secured over the long term by the Geological Services of the Länder. This guarantees systematic and continuous data capture, appropriate quality assurance and the expert provision of information.[990] Here, there is therefore already an extensive stock of primary data and information about the deeper underground, the presentation of which is tailored to specific issues.

The primary data available today on the deeper underground are mostly based on boreholes that provide initially one-dimensional information about particular points in the geological underground, including material samples, and indirect geophysical studies from whose interpretation both the two and three-dimensional distribution of rocks and/or formations in the undergroundcan be derived, as well as certain selected, specific properties. As a matter of principle, the geosciences work with field data, i.e. information gathered at real sites/boreholes, and analogical inferences, in which known rock properties are applied to comparable rocks and then interpolated or extrapolated in two or three dimensions. This method of interpreting available information must be applied and documented carefully when the heterogeneity of the rocks and their spatial delimitation are being determined.

6.5.8.1 Available fundamental data and their quality

The density of the data on the geological underground that are available, in particular data from depths of several hundred metres, is very heavily dependent on the use of the subsurface in Germany and is consequently concentrated on the deep geological basins linked with economic interests such as the North German Basin, the Thuringian Basin, the Upper Rhine Rift and the foothills of the Alps, as well as the classic mining regions (e.g. hard coal and salt mining regions). This kind of data on the deeper underground is largely absent in other places. Apart from the inhomogeneous distribution of data across the country, the numbers of exploratory boreholes and other geoscientific studies, and therefore the level of knowledge, decrease continuously with increasing depth.[991]

Data on the physical, chemical and mineralogical properties of the rocks in the deeper substrate and their stratification conditions have been, and are, overwhelming gathered by industry – work that has been driven ahead, in particular, by the search for raw materials. These data have mainly been studied and evaluated to answer questions of concern to industry. This means, e.g., that drilling data, material samples or geophysical measurements may be available for a region, but that the evaluations demanded for the site selection procedure, e.g. of rock properties and geoscientific criteria, in particular the consideration criteria, have still not been conducted to date.

Looked at across the whole of Germany, it is therefore to be noted that the density and quality of information about the geological substrate as a whole are

[990] Cf. State Geological Services of Germany (2012): 'Geologische Informationen und Bewertungskriterien für eine Raumplanung im tieferen Untergrund: Positionspapier für den Bund-Länder-Ausschuss Bodenforschung'.

[991] Federal Institute for Geosciences and Natural Resources (2014): 'Der tiefere geologische Untergrund von Deutschland: Kurzübersicht über Verteilung und Dichte geowissenschaftlicher Daten und Informationen', K-MAT 11.

heterogeneous and inadequate when many questions about local uses are looked at. The public sector has conducted explorations and gathered data in only a very few, exceptional cases, in particular in the deeper substrate. Furthermore, it is to be remarked that the data inventory, which has been gathered over long periods of time with the most various methods, varies widely in quality, and not all data are available in digital forms from all services.

As a consequence of this, the studies and projects carried out to date on the Federal and Länder levels on the deeper underground have essentially produced 'assessments of potential'. The areas and spaces in the geological underground delimited by means of interpretation and estimation therefore do not necessarily display suitable features or favourable preconditions for particular uses at a detailed level, but are usually areas that are assessed as being 'worthy of further investigation' for particular uses. On the basis of what is known today, areally or spatially comprehensive representations of the potential for uses of underground space are therefore merely possible on a small scale. Only where the subsurface is already being used are higher resolutions possible thanks to locally available geoscientific information, but this is limited to particular regions.

It is therefore to be noted that the State Geological Services of the Länder and the Federal Institute for Geosciences and Natural Resources hold extensive data inventories, some of them quite old, that will have to be made available for the selection of a disposal site, although account is to be taken of their limitations as far as this procedure is concerned, which are discussed above. They include not only documents and records of all kinds, but also core samples and material samples held by the authorities. These are to be evaluated expediently in the light of the geoscientific criteria. At the same time, it remains to be remarked that the information density and quality of the geoscientific data and their spatial distribution are inhomogeneous in relation to individual geoscientific criteria (above all the consideration criteria) and/or host rocks, and there are significant differences between the individual Länder and/or regions as far as both their data inventories and the presentation of their data (digital/analogue) are concerned.

Modern procedures today permit very sophisticated descriptions of the deeper geological underground, but areally or even spatially comprehensive information with the resolution and quality desired for the search process during Phase 1 are only available from limited areas of the Federal Republic of Germany, in particular regions where prospecting activities are being, or have been, carried out by industry.[992] As a matter of principle, the geoscientific data and information available in these places offer a good basis for the application of geological exclusion criteria and minimum requirements.

With a view to the phases of the site selection procedure, however, it is open to discussion whether it would be possible to move beyond Step 1 and, potentially, Step 2 of Phase 1 if only the available data were taken as the basis for the work done.[993] In order to further narrow down the siting regions for surface exploration while applying the geoscientific consideration criteria, it would therefore have to be examined on a case-by-case basis how far the fundamental data and

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[992] Cf. State Geological Services of Germany (2012): 'Geologische Informationen und Bewertungskriterien für eine Raumplanung im tieferen Untergrund: Positionspapier für den Bund-Länder-Ausschuss Bodenforschung'.

[993] Cf. section B 6.3.1.1.

information available for all the remaining areas could be expanded with justifiable effort by using additional data and core sample evaluations or by conducting studies of available material samples, while drawing on archived raw data and the archives of core samples held by the State Geological Services of the Länder or industry and, where necessary, also carrying out isolated new field studies.

In this respect, the aspiration to use available information to characterise siting regions during Phase 1 for the purposes of the site selection procedure relates exclusively to deposits of the three potential host rock types (rock salt, claystone and crystalline rock). The task during Phase 1 will therefore be to refine the geological characterisation of the potential host rock deposits in Germany and, to this end, to conduct a comprehensive consultation and evaluation of available information from documents, data records and core samples, including information that has merely been archived, then use this to elaborate a coherent, three-dimensional characterisation of the deeper substrate in areas where there are host rock deposits to which the criteria of the site selection procedure can be applied. During Phase 1 of the site selection procedure, opportunities for the extrapolation of spatial descriptions and analogical inferences from comparable geological processes are also to be used, provided this is technically justifiable, so that well founded statements can be made about host rock deposits and geoscientific criteria for areas with lower information density as well.

6.5.8.2 Treatment of areas with inadequate geoscientific data, participation of the National Societal Commission

The Commission is aware of the dilemma that, in the site selection procedure, which has the aim of finding a site for a disposal facility with the best-possible safety, it will not be possible during Phase 1 to ensure an equally good level of data quality throughout Germany with regard to the deeper substrate in the areas where there are potential host rock deposits. This would only be feasible with significant effort because a far-reaching exploration of the substrate in German territory would be necessary.

It is therefore possibly to be expected during Phase 1 that, in the course of its evaluations, the project delivery organisation will come to the conclusion that in some regions, the available geoscientific data are insufficient for being able to appraise these areas in the light of the geoscientific exclusion criteria, minimum requirements and consideration criteria.

The project delivery organisation must clearly acknowledge information deficits of this kind and separately designate regions that, on account of a lack of information, it does not feel it is in a position to categorise as qualifying for exploration, deferral or exclusion once the geoscientific criteria have been applied.

It cannot be foreseen at present whether the project delivery organisation will have to designate areas with information deficits as a result of its evaluations during Phase 1, or whether it will be able to categorise all areas as qualifying for exploration, deferral or exclusion once the geoscientific criteria have been applied. The number and size of these areas are not foreseeable either, and will only become apparent from the evaluations conducted by the project delivery organisation. For this reason, an approach is to be specified in case the project delivery organisation has to designate such areas.

The starting point for all ideas about the treatment of areas with insufficient data must be the search for the site with the best-possible safety. In line with this approach, areas must not be excluded from the search process purely because too little is known about them, provided it is not to be ruled out that there is a site among these areas that fulfils the criteria better than any of the sites in all the regions with sufficient data. In consequence, regions with insufficient data must not be deferred either. This would have the consequence that they would only be taken into account in the selection process again if it had failed to find a site in the areas with sufficient data. Here, it would also be possible for these areas not to be paid any further attention solely on account of the randomness of the data density (i.e. because a site had already been found among the areas with sufficient data density) and not due to the failure to fulfil criteria during the selection process.

In order to avoid reanalyses, the first step will therefore be for all the geological data held by public and private institutions to be gathered together by the project delivery organisation. In view of the principle of equal treatment, the exclusion of areas with insufficient data solely for this reason cannot be justified. Nevertheless, this issue marks a dilemma thrown up by the competing aims of resolving the issue of disposal of high-level radioactive waste materials as fully as possible and dealing with these matters during the present generation. From a contemporary point of view, account is to be taken of the random distribution of the available geoscientific data.

A Germany-wide survey that would encompass field studies and, in particular, drilling activities as well in order to ensure an approximately comparable and, as far as the criteria are concerned, adequate level of data everywhere would take far longer than any of the time frames envisaged – in particular that of the Site Selection Act – and therefore undermine the aim of ensuring responsibility for radioactive waste is assumed by the current generation. However, reanalyses[994] would, in principle, be acceptable within this timeframe. Nor does it rule out individual field studies if they were to prevent the unequal treatment of regions solely on account of the data available. However, field studies are only to be provided for if there are well founded expectations of a positive forecast for the area and it cannot be assessed with the help of analogical inferences. The absence of data alone is insufficient as a motive for a field study. Ultimately, it will therefore be a question of how much effort is necessary in order to close the gaps in knowledge about the areas with insufficient data before the procedure is continued.

In particular, this dependence on the size of the gaps and the additional effort associated with the gathering of data shows that – in abstract terms – the various objectives cannot yet be reconciled practically, but that this will only be possible once the size of the 'blind spots' is actually known. Nevertheless, cases are also conceivable in which the project delivery organisation will hold enough data and information in order to be able to categorise all areas using the prescribed criteria. The question of whether areas with insufficient geoscientific data are to be treated differently from areas with sufficient data density in the further procedure

[994] Cf., on this issue, section B 6.5.8.1.

leaves the level of the pure application of the criteria, and means aspects of fairness and the acceptance of the site selection procedure are also being addressed. A crucial role in the appraisal of such areas should therefore be assigned to the National Societal Commission in the context of its function ensuring there is public interest-oriented supervision of the site selection process.

Against this background, it is proposed that, together with its designation of any areas with insufficient data density, the project delivery organisation presents a proposal to the National Societal Commission via the BfE that sets out how these areas should be treated. The project delivery organisation will be predestined for this because, in the course of its assessment of the regions, it will have familiarised itself with them and the data available for each one in detail. Grounds are to be set out for the proposal, which must reconcile as far as possible the aims of the Site Selection Act discussed above. It is to be set out in concrete terms whether further measures to obtain data are still felt to be required and feasible by the project delivery organisation without the site selection procedure suffering significant delays and, where applicable, what those measures would be.

In particular, the following aspects may be factored in:

- The number and size of the areas with insufficient data density
- The number and types of the criteria in question (which cannot be assessed with any certainty for these areas at present)
- The types and scale of the field studies that will potentially be required with the grounds for conducting them
- The amount of effort to be estimated for this work.

The project delivery organisation’s proposal for the treatment of these areas is to be communicated at the latest with its proposal for the regions to be explored from the surface. The National Societal Commission will comment on the proposal and deliver a recommendation on whether it is to be followed. Otherwise, it will deliver recommendations on what is to be done with the designated regions. The BfE will decide what further action is to be taken on the basis of these recommendations; when doing so, it will have to examine whether the question is to be presented to the German Bundestag for it to decide on. This will always be the case if not insignificant field studies are regarded as being required; for such studies will have to be legitimated by the Bundestag.

In this respect, from a contemporary point of view, the Commission recommends that there be no overlaps with Phases 1 and 2 of the site selection procedure, which means the further treatment of the areas with insufficient data density is to be clarified conclusively before the surface exploration commences. The Commission sees the interaction of the project delivery organisation, the BfE and the National Societal Commission as a system of ‘checks and balances’. The Commission hopes that, as a result of this, it will be ensured the procedure is as fair, equitable and comprehensible as possible in accordance with the current level of knowledge. Should no agreement be reached at this procedural step and the unjust treatment of different regions due to the gap between the two aims of having equal densities of data and compliance with a set time horizon not be overcome, this matter is therefore to be referred to the Bundestag for it to decide on.

6.5.9 Spatial planning criteria

6.5.9.1 Status of the spatial planning criteria

Pursuant to Section 1(1) of the Site Selection Act, a ‘site for an installation for the final disposal of […] radioactive waste [is to be found] that guarantees the best possible safety for a period of one million years.’ The Commission has confirmed this objective and specified that long-term safety will have priority over other considerations that might also be factored in when the sites are being narrowed down.

Pursuant to Section 4(2) of the Site Selection Act, ‘water management and regional planning exclusion criteria and minimum requirements’ for the site selection procedure are also to be elaborated by the Commission. If the priority of safety is assumed, however, these criteria may only be of secondary significance. Following the application of the geoscientific criteria, they will be used to narrow down the subareas and/or siting regions that are to be regarded as equivalent geologically. Due to the priority of safety, however, the Commission believes the spatial planning criteria may not be considered if this means overriding the geoscientific criteria.

The Commission therefore uses the term ‘spatial planning criteria’ to make it clear that these are not components of a regional planning procedure and that these criteria have a secondary status. The terms used in the Site Selection Act, ‘water management’ and ‘regional planning’ criteria, are to be understood as subsets of the ‘spatial planning criteria’.

6.5.9.2 Theoretical planning criteria proposed by the AkEnd

The AkEnd (2002) proposed both spatial planning exclusion criteria and consideration criteria:

Table 34: Theoretical planning exclusion criteria pursuant to the AkEnd (2002)

Field of appraisal	Criterion	Legal basis	Notes
Nature and countryside protection	Various types of area protected on the basis of the Federal Nature Conservation Act	Protected pursuant to Sections 23-25, 28-30 of the Federal Nature Conservation Act	Case-by-case assessmentfor areas protected under Sections 24, 25, 28-30 of the Federal Nature Conservation Act
Farming and forestry	Protective forests, natural forest reserves	Forestry laws of the Länder, e.g. Section 22 of the Hessian Forestry Law	Länder-specific provisions, case-by-case assessment
Water use	Fixed, provisionally	§ 19 para. 2 WHG, water laws of the	At least Protection Zones I and II

	secured and planned drinking water reserves and spas	Länder	
Flood areas	Fixed, provisionally secured and planned flood areas	§ 32 para. 2 WHG, water laws of the Länder	

Here, case-by-case assessment means examining whether and/or what proportions of the areas in question are so heavily protected that they will have to be excluded.

Table 35: Theoretical planning consideration criteria pursuant to the AkEnd (2002)

Field of appraisal	Criterion	Legal basis
Nature and countryside protection	Nature reserves, natural parks, biosphere reserves, etc., priority areas and precautionary natural and landscape areas	Sections 26, 27 of the Federal Nature Conservation Act (BNatschG) Sections 25, 29, 30 of the Federal Nature Conservation Act* Regional and Land-level planning provisions
Farming and forestry	Forest areas with special functions, priority and precautionary areas for farming and forestry, agriculturally valuable areas (e.g. special cultivations)	Federal Forest Act, forestry laws of the Länder* Provisions of regional planning and development
Recreation	Priority and precautionary areas for recreation	Provisions of regional planning and development
Archtectural conservation	Structural, cultural or archaeological monuments, natural monuments, movable monuments	Architectural conservation laws of the Länder*
Water use	Priority and precautionary areas for water extraction	Provisions of regional planning and development
Exploitation of resources	Priority and precautionary areas for near-surface and deep resources	Provisions of regional planning and development
Competing use of the underground	Priority areas for infrastructure, energy	Provisions of regional planning and development

	supply , waste disposal	
Infrastructure	Transport connections, supply and disposal networks, priority sites for special uses (e.g. power generation, waste treatment), protectedareas around airports, military installations, and the like	Provisions of regional planning and development
Housing and settlements	Distance to housing and settlement areas	E.g. North Rhine-Westphalian Distance Decree

* if case-by-case assessment finds that they do not fall under the exclusion criteria.

The AkEnd did not envisage any minimum requirements in the context of the theoretical planning criteria.

The criteria proposed by the AkEnd are to be criticised because they do not differentiate between surface and underground installations. Furthermore, the protection of humans is to have a lower status as a consideration criterion than nature conservation areas, and particular forest and woodland areas that are granted an exclusion function. Nor is it clearly defined in what individual cases the exclusion of a site is to be disregarded. Furthermore, water protection areas and flood plains were not analysed in a differentiated fashion with a view to their significance and relevance for the planned installations (surface or underground).

The Commission has therefore come to the conclusion that the systematic organisation and weighting of the criteria proposed by the AkEnd will have to be revised, and/or a new set of criteria drawn up.

6.5.9.3 Differentiation by surface and underground planning aspects

Regional planning has traditionally been an instrument deployed for the planning of surface spaces in order to coordinate and regulate the demands made on space by different existing uses or planned projects. The AkEnd notes that, ‘With each wide-ranging measure – permanent disposal being one of them – it is highly likely that conflicts will arise with existing or planned areas designated for special land use or as protected areas. This potential conflict will normally be restricted to the areas considered for the surface installations or the repository since most of the areas for special land use or protected areas are thus designated with reference to the use of the surface area itself or of near-surface resources or protected targets, including surface water and groundwater.’ (AkEnd (2002)).

In addition to this, the question of competing uses of underground space has also been raised in various ways over the last few years. In this respect, geological final disposal will, in principle, be competing against projects for the extraction of raw materials, the use of geothermal energy (deep geothermal boreholes) and the storage of carbon dioxide underground (carbon capture and storage, CCS).

When spatial planning criteria are drawn up, it is therefore necessary to differentiate between

- criteria that relate to competing or conflicting uses of underground space and are therefore to be analysed for the location of the underground emplacement zones, and
- criteria that relate to competing or conflicting uses of surface space and are therefore to be analysed for the location of a deep repository's surface installations.

With regard to surface spatial planning criteria, it is to be taken into account that:

- Access to a repository therefore does not inevitably have to be provided via a shaft in the immediate vicinity of the emplacement zones, which has implications for the arrangement of the surface installations. It will also be possible to access the facility via a ramp whose entrance area could be located within a radius of a few kilometres around the underground emplacement zone.
- The emplacement zone itself, which will lie at a depth of several hundred metres, will have no effects on the activities that take place above it on the surface, so that this use will not conflict with settled areas, nature conservation areas or forestry and agricultural uses.

6.5.9.4 Identification of relevant catalogues of criteria

When it comes to geoscientific criteria, three categories of criteria have been used and defined: minimum requirements, exclusion criteria and consideration criteria.

Minimum requirements pursue the purpose of establishing particular properties that make a site appear particularly suitable for the desired use if absolute indicators are applied (e.g. the minimum geoscientific requirements). The application of minimum requirements does not involve managing competing concerns by means of consideration procedures of the kind typical of spatial planning. The introduction of minimum requirements is therefore not expedient when the spatial planning criteria are developed for a disposal facility, particularly against the background of the priority of safety. The Commission has not introduced any minimum spatial planning requirements.

The decision about whether exclusion criteria are also to be defined in the context of theoretical planning criteria will require careful consideration, in which the demand for the primacy of the safety of the disposal facility over one million years will play a central role.

In Switzerland, it is not possible for areas to be excluded from the site selection procedure for a deep geological repository on account of spatial planning criteria (Swiss Federal Office of Energy (SFOE) 2008): 'While decisions relating to safety are relevant for very long time periods , socio-economic and spatial planning aspects have a short to medium-term impact,i.e. they are important mainly for the planning, construction and operational phase and for the post-operational phase up to repository closure. Spatial planning and socio-economic aspects should be taken into account in site selection when the sites for selection are equivalent in terms of safety.'

If the approach were to be taken to its logical conclusion, e.g., a decision to apply theoretical planning exclusion criteria could result in a geological formation that would offer the best-possible safety from a scientific/technical point of view not coming into question because its surface installations would have to be located within a nature conservation area (with protected status under the Habitats Directive) or a drinking water protection area.

In principle, cases are also conceivable in which the preferred geology is located close to a major industrial installation or a densely settled conurbation. In these cases too, it would be a central question whether the facility's surface installations could be positioned at a sufficient distance from the existing buildings and uses by means of the construction of a ramp. Should this not prove possible, such a site would only be imaginable subject to massive interference in property rights, and the social and economic relationships in the region.

The primacy of long-term safety sets narrow limits on the definition of exclusion criteria that are not primarily safety-related. How restrictively these limits are to be drawn with regard to spatial planning exclusion criteria is essentially to be decided by society and policymakers. From a scientific/technical perspective, this decision can be underpinned with information, e.g. about the possible spatial decoupling of surface and underground installations or their environmentally relevant impacts and interactions. The Commission has come to the conclusion that no exclusion criteria should be specified.

The effects of the consideration criteria are, by their nature, not as far-reaching as those of possible exclusion criteria. Nonetheless, they too are to be defined carefully prior to the beginning of the site selection process in order to guarantee a solid foundation for decision-making and the most transparent possible approach.

6.5.9.5 Spatial planning criteria

On the basis of the discussion summarised above, the Commission has developed a set of spatial planning consideration criteria that distinguishes between surface and underground planning aspects and, as a matter of principle, takes account of the possible spatial decoupling of the surface installations from the underground emplacement zone that would entail access via a ramp. In this respect, the Commission has not followed the findings of the AkEnd with regard to all questions. In particular, it is emphasised more strongly that the consideration of the spatial planning criteria will tend to result in sectoral planning decisions comparable to those taken in federal sectoral planning under the Grid Expansion Acceleration Act (NABEG), which are taken by the Federal Government and designate areas for development with binding force, and will be less indebted to classic regional planning. Apart from this, a number of concerns raised by the AkEnd report were not taken up.

To supplement this, an expert opinion[995] was drawn up on behalf of the Commission that confirms the legal status of the spatial planning criteria and the systematic organisation of the developed consideration criteria. Additionally, the

[995] Schlacke, S., Baumgart, S., Greiving, S., Schnittker, D. (2016): 'Planungswissenschaftliche Abwägungskriterien: Gutachten im Auftrag der Kommission', K-MAT 65.

authors of the report recommend a multicriteria assessment matrix with numerical weighting factors for Phases 1 and 2, for which the individual criteria would have to be weighted in advance by the legislature. The Commission is, however, of the opinion that the specification of numerical weighting factors would be problematic and, furthermore, would limit the transparency of the considered decision that is taken. By contrast, a reasoned consideration of the individual spatial planning criteria in a pairwise comparison would increase the comprehensibility of the site selection procedure and is therefore to be preferred.

6.5.9.6 Spatial planning consideration criteria –surface and underground

In emulation of the systematic organisation of the geoscientific criteria, various weighting groups are differentiated within the consideration criteria. The aim of the weighting groups is to structure the consideration criteria hierarchically and therefore to do justice to their differing significance in the consideration process:

- Weighting group 1: Protection of humans and human health
- Weighting group 2: Protection of unique natural and cultural assets from irreversible degradation
- Weighting group 3: Other competing uses and infrastructure

6.5.9.7 Weighting group 1 –Protection of humans and human health

The protection of humans is of the greatest significance. Nevertheless, constellations of circumstances could arise in which several spatial planning criteria clash, making it necessary for the relative significance of these criteria to be considered and, in view of the particular significance of the interest in the establishment of a suitable final disposal facility, this interest is given precedence. In consequence, the criteria that have been mentioned are also consideration criteria.

Table 36: Criteria for surface planning aspects, weighting group 1

No.	Criterion	Assessment group		
		Favourable	Relatively favourable	Less favourable
1.1	Distance from existing built-up land in residential and mixed-use neighbourhoods	Distance > 1,000 m	Distance 500-999 m	Distance < 500 m
1.2	Emissions (noise, radiological and conventional	Lower than precautionary values	Higher than precautionary values during	Higher than precautionary values during

	pollutants)		particular phases while complying with limits	particular phases
1.3	Near-surface groundwater reserves for the extraction of drinking water	None	Use potentially possible, but potential alternatives	Existing use, potential alternatives only feasible with considerable effort
1.4	Flood plains	None		

No spatial planning consideration criteria are to be assigned to weighting group 1 for underground space.

6.5.9.8 Weighting group 2 - Protection of unique natural and cultural assets from irreversible degradation

Table 37: Criteria for surface planning aspects, weighting group 2

No.	Criterion	Assessment group		
		Favourable	Relatively favourable	Less favourable
2.1	Nature conservation areas and Natura 2000 sites	None		
2.2	Significant cultural assets (e.g. UNESCO World Heritage Sites)	None		

Table 38: Criteria for underground planning aspects

No.	Criterion	Assessment group		
		Favourable	Relatively favourable	Less favourable
2.3	Deep groundwater reserves for the extraction of drinking water	None	Use potentially possible, but potential alternatives	Existing use, potential alternatives only feasible with considerable effort

6.5.9.9 Weighting group 3 – Other competing uses and infrastructure

Table 39: Criteria for surface planning aspects, weighting group 3

No.	Criterion	Assessment group		
		Favourable	Relatively favourable	Less favourable
3.1	Installations subject to the Hazardous Incident Ordinance	No installations at risk of hazardous incidents	Existing installations at risk of hazardous incidents could be relocated	Existing installations at risk of hazardous incidents could not be relocated

Table 40: Criteria for underground planning aspects, weighting group 3

No.	Criterion	Assessment group		
		Favourable	Relatively favourable	Less favourable
3.2	Extraction of mineral resources, including fracking	No deposits	No use of existing deposits/ unfavourable conditions for extraction	Existing or planned uses/favourable conditions for extraction
3.3	Geothermal use of the subsurface	No potential		Existing or planned use
3.4	Use of geological formations as underground storage facilities (compressed air, CO_2 compression, gas)	No potential		Existing or planned use

6.5.10 Socio-economic potential analysis

With regard to the analysis of the potential for socio-economic development that is required and the indicators to be examined for this purpose, the Commission has adopted the principle of the methodology previously proposed by the AkEnd.[996]

996 Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, section 4.2.3.

During the process, socio-economic potential analyses will be required for the first time once the selection has been narrowed down to the level of the siting regions, i.e. with the beginning of Phase 2. They are to be conducted at the level of all the counties or county boroughs that are immediately affected by the designation of siting regions for surface exploration.

The socio-economic potential analysis will serve various purposes during the site selection procedure. Initially, it will be an instrument with which to establish the socio-economic *status quo* in the relevant siting regions so as to assist the population there in their dealings with the project delivery organisation. Its results will then have to be taken into account when equally well suited siting regions and/or sites are considered from safety points of view, although these results will be secondary to the safety aspects in each case. Finally, it will provide points of reference for the future compensation of the socio-economic disadvantages suffered by the region that ultimately provides the site. The analysis will therefore be connected with the fairest possible distribution of burdens.

During Phase 3 of the site selection procedure, the socio-economic studies associated with this process will be updated in the counties and county boroughs that are still affected by the designation of sites for underground exploration.

The socio-economic potential analysis is to be initiated by the project delivery organisation; the relevant regional conferences[997] are to be involved intensively when this is done.

The socio-economic criteria to be taken into account during the analysis are based on the idea that the long-term development of a siting region is not to be harmed as a result of the construction of a disposal facility. The individual criteria relate to the potential development of the labour market, regional investment, regional tourism, the housing market and agricultural characteristics, subject to the assumption that a disposal facility will be constructed. The conduct of a potential analysis will obtain the general and location-specific data required in order to be able to identify deviations.

As a matter of principle, a siting region's potential for development is to be understood as the result of determining mental and material factors, i.e. a weakening or strengthening regional identity will have an impact on potential developments as a mental factor, while changes in the natural environment and transport infrastructure will have impacts as material factors. These factors, some of which are quantifiable, some qualitative, determine the potential for development, and are to be specified by a potential analysis for the individual siting regions.

The foundations will be laid by expert opinions on regional development that are to be produced and academically supervised by institutions with expertise in this field. The potential analysis is to contain a general part standardised for all siting regions in order to both ensure comparability between the siting regions that are studied and capture the particular features of each individual siting region. In addition to this, specific forms of potential are to be surveyed in the individual siting regions. These could be formative historical developments and experiences that have shaped mental structures. However, they could also be regionally

[997] Cf. section B 7.3.2.

specific economic sectors, such as the brewing industry, or unique regional landscape features that are of significance for the region's further development. A region's image, something that would be influenced by a potential disposal facility, is constituted by a form of potential that considers both mental and economic structures. When the research institutions that conduct the analyses are appointed, it will be necessary to bring about agreement between the project delivery organisation and the siting region in question once the matter has been discussed by the regional conference.

Table 41: Subjects examined for the standardised part of the socio-economic potential analysis

Area of development	Indicators	Method
Labour market	Anticipated development of unemployment Anticipated net migration Anticipated development of purchasing power	Analysis of regional potential for development
Investment	Anticipated development of investment rates Anticipated strengthening or weakening of structures due to the development of important sectors	Analysis of regional potential for development
Tourism	Anticipated development of the tourism sector Anticipated impact on the specific regional character crucial for tourism	Analysis of regional potential for development
Housing market	Anticipated housing occupancy rate Anticipated development of building land prices and/or leasehold rents	Analysis of regional potential for development
Agriculture	Anticipated	Analysis of regional

	development of agricultural production and typical agricultural products Anticipated impacts on the marketing of agricultural products with regional character	potential for development

As far as possible, quantitative threshold values are also to be set in the potential analyses that highlight positive or negative deviations relative to a previously agreed comparison region. This comparison may, e.g., discuss the average development of the administrative district to which the siting region belongs, or even that of the Land or the whole German Federation. As a rule, a region that is located geographically in the vicinity of the site should be used for comparison, e.g. the administrative district. Social scientific studies offer the following threshold values for the measurement of deviation:

- Significant deviation (+/-10 %)
- Relevant deviation (+/-15 %)
- Serious deviation (+/-20 %)

The Commission recommends the application of these threshold values.

Further to the standardised potential analysis, the forms of potential that are specific to a siting region must also be surveyed.

The potential analysis is to produce a qualitatively weighted and, wherever possible, quantitatively based statement about whether the implementation of a disposal facility in the siting region would result in positive, negative or neutral development opportunities being anticipated.

The results of the potential analysis will be assessed by members of the community and the project delivery organisation. Should these assessments deviate strongly from one another, the Commission proposes that another expert opinion, for which the National Societal Commission would be responsible, clarify the contentious issues.[998]

In order that this does not lead to a never-ending series of further expert opinions, both the project delivery organisation and the regional conference should be involved in the definition of the contentious issues and the selection of the authors of the expert opinions. Nevertheless, if no agreement is reached, the National Societal Commission will take these decisions.

6.6 Requirements concerning the emplacement of further radioactive waste

6.6.1 Priority: Final disposal of high-level radioactive waste

The statutory aim[999] of the site selection procedure is the selection of a site for a disposal facility for, in particular, high-level radioactive waste materials. In this

[998] Cf., on the National Advisory Group, section B 7.4.1.
[999] Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553, Section 1(1).

respect, it is not ruled out that low and intermediate-level radioactive waste materials too will additionally be considered for final disposal at the site to be selected. In consequence, at the request of the Federal Environment Ministry, the Commission agreed to also formulate necessary parameters for the final disposal of low, intermediate and high-level radioactive waste materials at a disposal site. This was to be done in the light of the National Programme adopted by the German Federal Government on 12 August 2015[1000] and the need discussed in the Programme to dispose of particular low and intermediate-level radioactive waste materials alongside the high-level radioactive waste materials at the site to be selected.[1001] The Commission adopted the following resolution on this issue at its 17th meeting on 19 November 2015:

'In particular, the selection criteria for a site for high-level waste will be set out in the report. It will also deal with recommendations for the storage of waste from the Asse mine, waste from uranium enrichment and other "non-Konrad-suitable" low and intermediate-level radioactive waste. This will also involve making statements on which parameters will have to be fulfilled in order that these wastes may be disposed of with the high-level radioactive waste materials.'[1002]

In the opinion of the Commission, the selection of a site for a disposal facility for high-level radioactive waste materials therefore enjoys priority: in comparison to the resolution of this problem, the Commission views the additional final disposal of low and intermediate-level radioactive waste materials at the same site as secondary. In particular, it must not lead to a lowering of the level of safety for the high-level radioactive waste or the exclusion of sites suitable for the storage of high-level radioactive waste on account of a lack of space for the low and intermediate-level radioactive waste materials that are not foreseen for the Konrad mine.

It follows from this that it is primarily the suitability of sites for the final disposal of high-level radioactive waste that will be examined during the site selection procedure, and the siting options will gradually be narrowed down until a decision is taken on the site. The procedure described in sections B 6.3 to B 6.5 above and the criteria to be applied for this purpose will primarily serve this end. As part of the consideration of sites that are suitable for the final disposal of high-level radioactive waste, it is then additionally to be examined whether a site also fulfils the parameters for an additional disposal facility or emplacement zone for low and intermediate-level radioactive waste.

As the result of its deliberations, the Nuclear Waste Management Commission (ESK) published a discussion paper[1003] on the same topic in May 2016 that deals

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[1000] Cf. Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (2015): 'Programm für eine verantwortungsvolle und sichere Entsorgung bestrahlter Brennelemente und radioaktiver Abfälle (Nationales Entsorgungsprogramm)', http://www.bmub.bund.de/fileadmin/Daten_BMU/Download_PDF/Nukleare_Sicherheit/nationales_entsorgungsprogramm_a ug_bf.pdf, last accessed: 24 February 2016; translation: 'Programme for the responsible and safe management of spent fuel and radioactive waste', http://www.bmub.bund.de/fileadmin/Daten_BMU/Download_PDF/Nukleare_Sicherheit/nationales_entsorgungsprogramm_en_bf.pdf.

[1001] See also section 1.3.

[1002] Commission on Storage of High-Level Radioactive Waste, 'Beschluss der Kommission vom 19. November 2015: Weiteres Vorgehen im Hinblick auf das Nationale Entsorgungsprogramm', K-Drs. 145.

[1003] Cf. Nuclear Waste Management Commission (2016): 'Diskussionspapier zur Endlagerung von Wärme entwickelnden radioaktiven Abfällen, abgereichertem Uran aus der Urananreicherung, aus der Schachtanlage extensively with the technical/scientific demands of the final disposal of low and intermediate-level radioactive waste at the site of a disposal facility for high-level radioactive waste. The Commission took this discussion paper as the basis for its deliberations on this topic.

6.6.2 Low and intermediate-level radioactive waste for potential final disposal at the same site

The National Programme and the Nuclear Waste Management Commission's discussion paper mention the following types of waste, and roughly estimated volumes of low and intermediate-level radioactive waste for which the Konrad disposal facility does not come into question, and for which final disposal at the disposal site for high-level radioactive waste materials is therefore to be examined:[1004]

- Waste from uranium enrichment (up to 100,000 cubic metres)
- Waste to be retrieved from the Asse II mine (up to 220,000 cubic metres)
- Other waste materials that cannot be emplaced at the Konrad facility (> 6,000 cubic metres)
- The estimated figures cited above convey the order of magnitude of the volumes of waste to be anticipated. From a contemporary point of view, the detail of these figures is vague:
- The volume of waste from uranium enrichment will be dependent on how long the installation at Gronau is operated, what capacity it is operated at during its whole operating life, how depleted the batches of uranium are and, apart from this, what proportion of the depleted uranium that accumulates is directed to recycling by the installation operator. Here, the volume of waste will only be certain once the operation of the installation has been discontinued.
- Furthermore, the actual amounts of waste from the Asse II mine are only to be forecast with great uncertainty, both in terms of their volume and also in terms of their characteristics, and will not be certain until all the Asse waste has been retrieved and conditioned.
- Ultimately the volume of other waste not suitable for the Konrad disposal facility will only become apparent in the course of the product control of the waste foreseen for the Konrad disposal facility. Where it proves to be the case that waste cannot be successfully product-controlled, it will therefore become other waste not suitable for the Konrad disposal facility.

In consequence, there will definitely be a large quantity of such waste, many times the estimated amount of the high-level radioactive waste, although the precise volume is still uncertain. It will have decisive impacts on the area

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Asse II rückzuholenden Abfällen und sonstigen Abfällen, die nicht in das Endlager Konrad eingelagert werden können, an einem Endlagerstandort', K-MAT 60.

[1004] Classified in greater detail in: Nuclear Waste Management Commission (2016): 'Diskussionspapier zur Endlagerung von Wärme entwickelnden radioaktiven Abfällen, abgereichertem Uran aus der Urananreicherung, aus der Schachtanlage Asse II rückzuholenden Abfällen und sonstigen Abfällen, die nicht in das Endlager Konrad eingelagert werden können, an einem Endlagerstandort', K-MAT 60, 'Tabelle 1'.

required for the disposal facility, as far as both the emplacement zones underground and the operating facilities above ground are concerned.

Furthermore, its material composition is highly complex. As a result of interreactions among the waste materials and with their environment, they may have impacts that range from the input of CO_2 from the decomposition of organic components, the input of hydrogen from metal corrosion and changes in pH values to the input of soluble salts, complexing agents and further substances that have still not been identified with greater accuracy as yet.[1005] Conversely, the emplaced waste materials may come under the influence of the heat input emitted from the high-level radioactive waste and respond to it with varying chemical reactions and/or reaction speeds. These impacts would pose risks for the disposal facility that would have to be minimised in such a way that they did not impair operational and long-term safety in any way.

6.6.3 Ruling out cross-influences on safe final disposal: requirements concerning the site, and the conditioning of low and intermediate-level radioactive waste materials

In its discussion paper, the Nuclear Waste Management Commission (ESK) mentions two central categories of measures[1006] that will serve to minimise or prevent negative interactions: the conditioning of low and intermediate-level radioactive waste, and the spatial separation of the emplacement zones such that it is possible to rule out reciprocal influences between the different types of waste. From the point of view of the Commission, both categories of measures are indispensible if high-level, and low and intermediate-level radioactive waste are to be disposed of at the same site.

In this case, in particular, very stringent requirements are to be placed on the requisite conditioning of low and intermediate-level radioactive waste that, furthermore, will be specific to the host rock typical of the site in question and the associated disposal concept. As a matter of principle, the radioactive waste will have to be made largely inert. This will be intended, in particular to prevent gas generation, which would call the quality of the isolation into question. The Nuclear Waste Management Commission discussion paper[1007] mentions the durability and corrosion resistance of the waste containers, the immobilisation of the radionuclides in the waste matrix, and the water content and levels of organic compounds in the waste as relevant parameters here. Appropriate conditioning measures would be the drying, pyrolysis, etc. of organic substances, the melting of metallic components, the vitrification of mineral substances or their sequestration in ceramic materials. In addition to this, salts would be separated in advance where necessary (in particular for waste from the Asse II mine), while

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[1005] Nuclear Waste Management Commission (2016): 'Diskussionspapier zur Endlagerung von Wärme entwickelnden radioaktiven Abfällen, abgereichertem Uran aus der Urananreicherung, aus der Schachtanlage Asse II rückzuholenden Abfällen und sonstigen Abfällen, die nicht in das Endlager Konrad eingelagert werden können, an einem Endlagerstandort', K-MAT 60, 'Tabelle 1'.

[1006] Nuclear Waste Management Commission (2016): 'Diskussionspapier zur Endlagerung von Wärme entwickelnden radioaktiven Abfällen, abgereichertem Uran aus der Urananreicherung, aus der Schachtanlage Asse II rückzuholenden Abfällen und sonstigen Abfällen, die nicht in das Endlager Konrad eingelagert werden können, an einem Endlagerstandort', K-MAT 60, section 7.

[1007] Nuclear Waste Management Commission (2016): 'Diskussionspapier zur Endlagerung von Wärme entwickelnden radioaktiven Abfällen, abgereichertem Uran aus der Urananreicherung, aus der Schachtanlage Asse II rückzuholenden Abfällen und sonstigen Abfällen, die nicht in das Endlager Konrad eingelagert werden können, an einem Endlagerstandort', K-MAT 60, p. 12.

easily soluble radionuclides would be retained, recovered and conditioned separately.

The price of combined final disposal would therefore be very extensive conditioning. Like the Nuclear Waste Management Commission,[1008] the Commission is of the opinion that the installations required for this would have capacities far larger than those of conventional conditioning facilities today.

This does not mean that these conditioning facilities would have to be built at the same site as the disposal facility; nevertheless, it would of course imply at least some need for additional storage and handling capacities in the surface installations at the disposal site.

Depending on the conditioning methods, the required volume of waste packages to be disposed of would become apparent at the end of the process. One or several suitable emplacement zones would have to be designated for this waste at the shared site. No thermally determined minimum distance between the packages is to be taken into account when low and intermediate-level radioactive waste materials are disposed of, as in the case of high-level radioactive waste materials. Nevertheless, the space required for this waste would markedly increase, probably by several times, the required volume of the disposal facility.

The spatial separation of the high-level radioactive waste from the low and intermediate-level radioactive waste required apart from this would, firstly, be intended to minimise the influence of heat from the high-level radioactive waste. Secondly, the Commission views the isolating rock zone as the concept that is to be preferred for high-level radioactive waste materials.[1009] In this respect, the provision of evidence about the integrity of the isolating rock zone would hardly make the combined final disposal of all waste materials possible in a single isolating rock zone; certainly, an aim of this kind would crucially restrict the site selection procedure. From the perspective of the quality of the isolation, disposal in emplacement zones that were independent from one another at the same site would be more realistic, where necessary up to the construction of two disposal facilities that would be completely separated from one another. This would also offer the opportunity to designate emplacement zones for low and intermediate-level radioactive waste that were better tailored to the specific properties of these materials (e.g. corrosion and the potential for gas generation) than the isolating rock zone designated for high-level radioactive waste. In this respect, it would also have to be examined whether low and intermediate-level radioactive waste could be emplaced at the same depth or at a lesser or greater depth in the specific case, and therefore even in a completely different host rock. Irrespective of this, the consistent separation of the containment zones would, in any event, have an influence on the area required for the disposal facility.

Ultimately, the final disposal of all types of waste at one site touches on the question of the recoverability of high-level radioactive waste following the sealing of the facility.[1010] While probably it can be shown that it will be possible

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[1008] Nuclear Waste Management Commission (2016): 'Diskussionspapier zur Endlagerung von Wärme entwickelnden radioaktiven Abfällen, abgereichertem Uran aus der Urananreicherung, aus der Schachtanlage Asse II rückzuholenden Abfällen und sonstigen Abfällen, die nicht in das Endlager Konrad eingelagert werden können, an einem Endlagerstandort', K-MAT 60, p. 13.

[1009] See section B 5.5.4.

[1010] The 'Safety Requirements' issued by the Federal Environment Ministry in 2010 do not formulate requirements concerning the retrievability or recoverability of low and intermediate-level radioactive waste to retrieve high-level radioactive waste during the facility's operation thanks to appropriate operational measures, in particular the separation of material flows in surface and underground handling, the demand for recoverability for a period of 500 years after the sealing of the facility will clearly restrict the designation of emplacement zones for low and intermediate-level radioactive waste materials: the excavation of an access gallery for the recovery of high-level waste[1011] would have to be possible at the site without this being precluded by the low and intermediate-level radioactive waste that would be stored alongside, above and/or below it.

6.6.4 A transparent procedure: taking account of and communicating the options for the emplacement of further radioactive waste materials from the beginning

The site selection procedure will predominantly be focussed on a site suitable for high-level radioactive waste materials. However, in the interests of the transparency of the procedure, the possibility that a large volume of low and intermediate-level radioactive waste materials will additionally have to be disposed of at the ultimately determined site as well is also to be taken into account from the outset when the actors communicate with the public about the site selection process and in the public participation. It would not be consistent with the ethos of the procedure to select a disposal site for high-level radioactive waste materials and only discuss the options for the emplacement of further waste materials once this had been done. After all, additional burdens would be imposed on the region in question as a consequence of the construction of the repository, including its surface facilities, and the transport, storage and handling of low and intermediate-level radioactive waste materials.

The task addressed in the site selection procedure is therefore to be formulated clearly from the beginning in terms that encompass low and intermediate-level radioactive waste materials, and that are more explicit than the opening clause *insbesondere* ('in particular') in the Site Selection Act:[1012] a site is to be selected that is suitable for the final disposal of high-level radioactive waste materials, and at which low and intermediate-level radioactive waste materials could additionally be disposed of on an optional basis without the safety of the disposal facility for high-level radioactive waste materials or their recoverability being compromised. In this respect, it is to be taken into account that a suitable site for high-level radioactive waste materials must not be excluded because it lacks space for the low and intermediate-level radioactive waste materials not foreseen for the Konrad mine.

If the priority of the final disposal of high-level radioactive waste materials is to be emphasised, the site selection procedure could certainly arrive at the following outcomes with regard to low and intermediate-level radioactive waste materials and the consequences they would entail:

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materials, should they be disposed of at a combined facility. Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2010): 'Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste', K-MAT 10.

[1011] Cf. sections B 5.5.2 and B 6.3.5.

[1012] Cf. Site Selection Act of 23 July 2013, Federal Law Gazette I, p. 2553, first sentence of Section 1(1).

- A site is selected at which, apart from high-level radioactive waste materials, low and intermediate-level radioactive waste materials are to be disposed of as well, as envisaged in the National Waste Management Programme.
- A site is selected at which, apart from high-level radioactive waste materials, only a certain proportion of the low and intermediate-level radioactive waste materials may also be disposed of, whether this is due to spatial limitations or a restriction to particular types of waste. Another site is then to be selected for the remaining waste materials or types of waste.
- No site is found for the final disposal of all types of waste, instead of which a site is selected exclusively for high-level radioactive waste materials. In consequence, another site is then to be selected for low and intermediate-level radioactive waste materials.

6.6.5 Conclusion

In the opinion of the Commission, the selection of a site for a disposal facility for high-level radioactive waste materials will have priority over the additional final disposal of low and intermediate-level radioactive waste materials in the site selection procedure. As a matter of principle, it would be conceivable to also designate areas for the final disposal of low and intermediate-level radioactive waste materials at a site for a disposal facility for high-level radioactive waste materials. For this purpose, it would be necessary to rule out reciprocal influences with negative safety implications, on the one hand as a result of the heat output from the high-level radioactive waste materials, on the other hand as a result of the chemical composition of, and gas generation from, the low and intermediate-level radioactive waste materials. The key measures for this purpose would be the effective, long-term spatial separation of the disposal zones, and the conditioning of the low and intermediate-level radioactive waste materials, with which these materials would be made largely inert in terms of their potential for gas generation, chemical gradients and temperature stability. At the same time, the recoverability of the high-level radioactive waste materials must not be compromised. Compliance with these parameters will have significant impacts on the size of the repository underground, the geometry and positioning of the emplacement zones, the conditioning of the low and intermediate-level radioactive waste materials, and the installations required on the surface at the site.

In the opinion of the Commission, it is not to be ruled out that a site suitable for all waste materials will not be found in the course of the selection procedure for a disposal site for, in particular, high-level radioactive waste materials. Should it prove during the course of the site selection procedure that no sites can be included in the shortlist at which capacities for the final disposal of low and intermediate-level radioactive waste materials could also be constructed, this would have consequences for the plans for final disposal at a shared site. The Commission believes the implementation of a disposal facility for high-level radioactive waste materials will have priority in any event. A separate final disposal solution would then have to be arranged for the low and intermediate-level radioactive waste materials listed in the National Waste Management Programme that are not foreseen for the Konrad mine.

The decision on whether, or to what extent, final disposal at the same site can be adhered to may be taken during any phase of the site selection procedure. In consequence, this question will also have to be dealt with regularly by the project delivery organisation's reporting and, above all, feature on the public participation agenda from the beginning.

6.7 Requirements concerning documentation

The documentation of data is a central safety measure for the whole nuclear waste management chain and, in particular, for a disposal facility. Whenever questions arise during this long process, they will often only be answered if it is possible to fall back on relevant data and documents from earlier periods. The resolution of questions that come to be asked in the future may make it necessary for newly gathered data to be compared with data gathered far earlier – decades or centuries before. Or it will have to be understood what exactly was done, and where it was done, a long time ago in a particular part of the interim storage facility, the processing facility or the deep repository. Or in the distant future it will be necessary to know the precise composition of the waste in the facility in order to appraise new findings in the biosphere or geosphere, and ascertain whether and how they are connected with the waste in the facility. This will be true not least if retrieval is intended or recovery necessary, as shown by the example of the Asse II mine.

All this will demand the high-quality preparation of both the data and documents that exist today, and the new data and documents generated during the future disposal pathway, and their preservation in a suitable form for the future.

The foundation for the compilation of high-quality, permanently available documentation will initially be the listing and analysis of all situations imaginable from a contemporary point of view during the long process of nuclear waste management in which recourse would have to be had to documented information. In addition to this, experience that has been gained from previous long-running projects of a similar character is to be drawn on. Examples include earlier disposal projects that have run into problems (e.g. Asse II), decommissioning projects at nuclear installations, rehabilitation projects at sites where explosives or toxic organic substances were produced decades before and historic mines or overburden dumps.

However, the analysis would not go far enough if it were to be restricted purely to questions that are conceivable today. For future generations may face previously unforeseen questions, the resolution of which will require data or documents that will not have been identified in the analyses discussed above. For this reason, it will be necessary for all the data that are available today and are generated in future to be documented, even if they are of secondary relevance from a contemporary point of view. What is also essential, however, is that the data are deposited in a systematic form that allows them to be located later.

6.7.1 What data will be required when in the process?

From a contemporary point of view, an analysis of the nuclear waste management chain from the interim storage necessary over the longer term through the search for a site, the safety analysis (studies), planning and licensing, construction, operation and decommissioning to the disposal facility's post-operational phase highlights the following situations in which the following data and documentation will be required **as a minimum**:[1013]

Data and documents for the safety of longer-term interim storage:

- General information (storage containers, position, type of storage, owner, date of emplacement)
- Waste-specific information (at the time of emplacement, total activity, radiologically and chemically comprehensive description of the contents of the containers, thermal properties, criticality safety, surface dose rate and surface contamination)
- Any damage to, or anomalies on, containers and the measures taken
- Results of the Periodic Safety Review (PSR)

Data and documents on the establishment of the requirements concerning the site and its suitability taken as a basis for safety analyses and analyses during the disposal facility's exploration, planning, licensing and construction phases:

- Information about the geological and hydrogeological structures of the site; complete results of the surface and underground exploration activities,
- Where relevant, information about historic mines and old boreholes that are present
- Where relevant, additional information about the surrounding environment that becomes apparent from the operation of the disposal facility and the requirements of long-term safety at the time when the site is found and appraised.

Data and documents that will be required during the disposal facility's operating life, for the Periodic Safety Review and for decommissioning:

- Extensive information about the packaging of the radioactive waste materials in the disposal containers (what waste is contained in which waste package), radiation exposure during the handling of the packages in the disposal facility, associated quality assurance documents
- The precise location where each individual disposal package is emplaced, linked with its contents
- The backfilling around the disposal packages in the emplacement zone, including its geometry, the emplacement procedure and the associated quality assurance documents
- Where relevant, the structure of individual sealing structures (e.g. seals on individual emplacement chambers) that are constructed during the facility's operating life, results from the monitoring of the sealing structures and their immediate surroundings, and the associated quality assurance documents
- The precise structure of the deep repository, including any changes it undergoes, underground survey data, operating log

[1013] The requirements concerning documentation set out in the 'Safety Requirements' were taken into account in this list. Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2010): 'Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste', K-MAT 10.

- Data on technical installations, any changes they undergo in the course of their operating life and the associated quality assurance documents
- The results (evaluation and documentation) of all measurements taken within, and in the environs of, the deep repository in parallel to operations
- Comparative analyses of previous and current measurements
- The results of Periodic Safety Reviews and updated long-term safety analyses, including documented delta analyses that compare earlier and current analyses

Data and documents that will be required during the disposal facility's decommissioning and sealing phases:

- Information about the design of all sealing structures installed in an eligible manner in emplacement zones, the results of the monitoring of the built structures and their immediate surroundings, and the associated quality assurance documents
- Information about the backfilling and sealing of all open cavities outside the emplacement zones (infrastructure zones, shafts, ramps), as well as the dismantling of surface installations
- The results (evaluation and documentation) of all concomitant measurements within, and in the environs of, the deep repository
- Comparative analyses of previous and current measurements
- The results of updates to the Periodic Safety Analyses and long-term safety analyses, including documented delta analyses that compare earlier and current analyses

Data and documents that will be required following the sealing of the repository:

- The results (evaluation and documentation) of all concomitant measurements taken in the environs of the deep repository; should data be obtained with measurement procedures that are then possible within the sealed repository as well, their results too
- Updates to the comparative analyses of earlier and current measurements
- Updates to the long-term safety analyses, including documented delta analyses that compare earlier and current analyses

Data and documents that will be required if a decision is taken to recover waste and must be preserved from the earlier operation and sealing of the repository:

- The local geological data from which the foundations for the precise geometrical location of the new access gallery to be constructed for the recovery of waste can be derived
- Data on the precise locations of all emplaced packages
- Data on containers and the inventory of the packages to be recovered

6.7.2 What data will have to be stored for how long?

As a matter of principle, all data and documents are to be stored permanently, for it is also foreseeable today that many of the data and documents will be required at least until the sealing of the repository has been concluded. However, a whole range of them will be required after the repository has been sealed as well, as a comparative basis for the monitoring that is to be continued in any case. Further data will also be required so that the waste can be recovered successfully if a decision is subsequently taken to do this.

Permanent storage, however, does not mean simply depositing these data in an archive somewhere. For this will mean they will only be permanently accessible by chance, i.e. if someone looks for them in this archive.

Rather, the data and documents must be reviewed proactively again and again to ascertain their quality and usefulness, then passed on. This presupposes that an organisation directly engaged with the matter preserves these data and documents, and has an institutional ‘awareness’ of their safety significance. This is why normal archival organisations, in which these data would be just another bundle of papers, are fundamentally unsuitable for this function. However, it is conceivable that this function will be pooled with (further) specific archiving functions consequent upon the decision to phase out the use of nuclear energy (e.g. the gathering of power plant data from operators and supervisory authorities about possible contaminated sites in a ‘nuclear archive’). At the moment, the archiving of data that relate to repositories is the task of the operator and/or its supervisory authority.

During interim storage, the search for a site and the operation of the disposal facility, the obviously suitable organisations will be the project delivery organisation/operator, on the one hand, and the competent supervisory authority, on the other hand. However, it will be necessary for dedicated organisational units to be in charge of running the archives and the archiving work within these organisations from the beginning to the end. These organisational units will have to be granted an active right to make demands concerning the imperatives of their archiving duties; it could be said they will have to function, and be capable of functioning, as the mind and conscience of the process by which the data will be preserved and passed on.

Once the repository has been sealed, these functions will have to continue to be performed. It would be futile to specify precise organisational forms here because it cannot be foreseen what the organisational, societal, technical and political environment will be like when the material is passed on following the sealing of the repository. From a contemporary point of view, it is only possible to formulate requirements here. In this respect, it will remain central that the disposal facility’s documents must not become forgotten bundles of paper, but that a form is found that allows an awareness of the active function of preserving these data and handing them down from one generation to the next to be upheld, and makes it possible for this function to be performed.

There has frequently been urgent discussion of questions such as, ‘How can we guarantee that someone will still be able to read these data in 500 years?’ Implicitly, however, a question like this is rooted in the assumption that no one will look after the files for 499 years, then someone will happen to need them in 500 years time and actually find them as well. As the studies conducted for the OECD/NEA Keeping Memory project show, however, the real challenge is a different one, i.e. how to maintain continuity when information is handed down from one generation to the next. The chain along which it is passed must function, none of its links must break.

This means it is the task of each generation, on the one hand, to store the data and documents safely, preserve their legibility and accessibility, and uphold the awareness of the importance of the data and documents. On the other hand, it must pass on these data and documents to the next generation in a form and with organisational arrangements that allow their legibility, their accessibility and the awareness of this responsibility to be handed down successfully.

Since comparable requirements will also arise in relation to the final disposal of non-heat-generating waste materials,[1014] it would be advisable to conduct an in-depth examination of the concentration of all nuclear-specific documentation and archiving functions in an organisational unit (based at the federal level) that would specialise in these functions (e.g. an organisational unit within the BfE).

6.7.3 Storage locations

With regard to the choice of the storage locations for the data and documents dealt with here, the requirement set out in the 'Safety Requirements' applies as a matter of principle: 'Complete sets of documents must be stored in at least two different suitable locations.'[1015]

When the suitable locations are chosen, account will also have to be taken of ways in which the documents and data that are stored might be intentionally of unintentionally destroyed. Other important aspects are the long period for which the documents will have to be stored and the preservation of their physical accessibility.

As far as the preservation of legibility is concerned, certainly a distinction has to be made between central documents at the one hand, the legibility of which will have to be reviewed at regular intervals, e.g. every five or ten years. If their easy legibility is threatened by technical changes or ageing processes, they will have to be 'transcribed' onto future-proof data media and converted into new forms of information. This will be required because it is likely the actors will require frequent, rapid access to central documents.

In the case of less central documents, of which there will probably be large quantities, the aim is not to be as ambitious. Here, it will be a matter of preserving legibility; it may only be possible for them to be made legible with a considerable amount of effort.

The distinction between the central documents and the less central documents will have to be drawn carefully. However, it will be necessary to do this if the amount of effort involved in the documentation work is to be manageable. For it will be impossible to continually guarantee the easy legibility of all the documents that are to be stored, in particular when the ongoing technical conversion of data is the precondition for the preservation of easy legibility.

[1014] Cf., for, instance the report of the Working Group on the Prevention of Damage during the Storage of Nuclear Waste Materials of the Schleswig-Holstein Nuclear Supervisory Authority (2015), 'Vermeidung von Korrosionsschäden an Fässern für nicht Wärme entwickelnde, radioaktive Abfallstoffe in Schleswig-Holstein einschließlich Lagerstättenkataster', 23 March 2015, section 7.5.2, p. 117.

[1015] Cf. Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (2010): 'Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste'.

6.7.4 What data are to be gathered on a precautionary basis?

It is apparent from the points discussed above in this section that all data and documents will have to be stored for which a necessary or possible use can be discerned in the future. This will mean 'stockpiling' an enormous range of data, a great many examples of which could be cited. For purely illustrative purposes, mention may be made here of measurement data, which it will be possible to compare with measurement data gathered in the future so that changes in the underground facility or its environs can be detected. Another example are data on the precise geometry within the underground facility that will be of importance to the specifications made for later backfilling works.

It will also be important, however, not to destroy any other data that accumulate, but to store them in a suitable fashion.

6.7.5 Rules on access to, consultation of and ownership of data

It has been shown above that highly diverse data will be needed and have to be handed down to future generations. During the immediately forthcoming search for a site and the later periods of the disposal facility's construction and operation, the data and documents will be held, on the one hand, by the project delivery organisation/operator and, on the other hand, by the supervisory authority.

The rules on access to, consultation of and ownership of the data, which are already in place now, are important for the current situation. Here, there are problems in some cases with access rights that will need to be regulated by legislation.

An important subset in this respect are the data on the waste to be emplaced. The data and documents on their properties, and the relevant calculations and 'life stories' of individual waste that underpin these data must be passed on physically and placed in the possession of the project delivery organisation and the supervisory authority. This will not affect the fact that the previous data holders will also continue to retain possession of such data. The current data holders are the operators of the nuclear power plants. In addition to this, further data held by the Land supervisory authorities and the Technical Support Organisations are also to be integrated into the archives. In the current situation, it is unclear in what form and how long the current data holders will continue to exist. In consequence, it is not possible to have confidence in the permanent availability of the data at the current data holders, but their permanent physical availability at the project delivery organisation and the supervisory authority will have to be ensured as soon as the emplacement of the relevant waste in an interim storage facility has been concluded.

Much the same applies for the data on the interim storage containers. On account of the schedule that is envisaged, it cannot be ruled out at present that the current interim storage containers may, or will have to, be used as disposal containers. For this reason, the permanent physical availability of these data and documents at the project delivery organisation and the supervisory authority is to be ensured here as a precaution.

A third complex of data are the geological data that will be factored into the appraisal of the disposal site and, at an earlier stage, the appraisal of the sites analysed in the procedure to find a site. These data will also include the records kept on their acquisition (drilling logs and profiles, etc.). The permanent physical availability of these data and documents too is to be ensured at the project delivery organisation and the supervisory authority.

No particular aspects of the rules on access, consultation and ownership are salient in relation to other types of data since these data will in all likelihood be generated by the project delivery organisation and/or supervisory authority or on their behalf. It is to be ensured that they are physically available in all cases.

With regard to the rights to consult data granted to individuals and institutions other than the project delivery organisation and the supervisory authority, the rights to consult data will be valid that apply statutorily and under the procedural rules for the final procedure for the search for a disposal site (which are yet to be specified).

In the opinion of the Commission on Storage of High-Level Radioactive Waste, the existing legislative and sublegislative provisions (Atomic Energy Act, Radiation Protection Ordinance, Site Selection Act) are not sufficient to fulfil the requirements set out above concerning the operators' duty to promptly and regularly provide the data and documents that are to be held in safekeeping, and the collection, storage and updating of these data and documents by a central state agency. The existing provisions are either limited to duties to report to the Länder, or serve other purposes in relation to the gathering of data by the German Federation, or the data have merely been made available voluntarily by operators in the course of research projects.

The Commission on the Storage of High-Level Radioactive Waste therefore makes the following recommendations to the German Bundestag:

- An amendment of the Atomic Energy Act to put in place already today binding legislative provisions that take account of the requirements concerning the gathering and archiving of data discussed above.
- The introduction of in the power to issue an ordinance in order to authorize the central state agency to gather and store concrete, detailed data and information for particular reasons and purposes, and to undertake the finer-grained configuration of the duties stipulated by the legislation (waste materials surveyed, types and organisation of data storage, data capture standards, access to stored data, disclosure duties when changes are made).

The authorities' duty to gather, archive, administer and publish these data corresponds with the obligation placed on operators to supply such data. When they are implemented, mergers and/or interfaces with already existing databases in the field of radioactive waste materials (e.g. DORA, BIBO) should be examined.

6.8 Requirements concerning containers for final disposal

As inferred in section B 5 and explained at greater length in section B 5.5, the Commission has prioritised final disposal in an underground facility. The Commission has pursued this aim in the consciousness that imponderables are also associated with it that will have to be minimised by taking account of options for the retrieval and/or recovery of the containers within limited periods of time. In this context, the container represents an essential technological barrier, the significance of which will vary during the different stages of the final disposal procedure. The Commission has therefore looked intensively at the requirements concerning containers for the final disposal of high-level radioactive waste and, in this context, gathered information about recent developments in the debate, among other things by presentations by two experts.[1016]

The container will therefore have to satisfy requirements in several fields throughout the process. During emplacement in the repository, which will be open at this point in time, the container will be assigned the crucial protective function. In the sealed emplacement zone, the protective function of the container will have to be retained in order to make retrievability possible over several decades. During the post-operational phase, the integrity of the container will have to continue to be retained over several hundred years, at least, so that the waste materials can be recovered if it becomes necessary to correct errors.

The extent to which barrier and recovery functions will be required beyond this period will depend on the storage medium, the disposal concept, and the chemical, physical and radiological parameters.

6.8.1 Protection targets

Regulatory requirements concerning waste containers for the final disposal of heat-generating radioactive waste materials are in place in Germany in a generic form in the 'Safety Requirements' issued by the Federal Environment Ministry in 2010.[1017] So far, however, the 'Safety Requirements' contain no detailed definition of the requirements in this field. It will only be possible for this task to be concluded once a disposal concept has been developed and defined, and a preliminary safety analysisanalysis for the site in question has been drafted because some of the requirements concerning containers are to be specified depending on the concept.

Irrespective of the site, however, it is possible to derive fundamental requirements concerning the protective functions of a waste container that can be used during the various stages of final disposal to ensure compliance with the protection targets 'isolation of radioactive substances', 'prevention of unnecessary radiation exposure', 'limitation and control of radiation exposure of operating personnel and the population', 'dissipation of decay heat' and 'maintenance of subcriticality':

The requirement 'isolation of radioactive substances' must guarantee the long-term impermeability of the container in terms of the release of radioactive aerosols and safely prevent the waste materials from having direct contact with their surroundings. Thanks to the shielding function of the container, a large

[1016] Cf. K-Drs./AG3-47, K-Drs./AG3-49, K-Drs./AG3-51 and the minutes of the 14th meeting of Working Group 3.
[1017] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2010): 'Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste'.

proportion of the radiation emitted from the radioactive waste materials will be absorbed in its walls and therefore reduced to the necessary level.

The container’s capacity to dissipate heat will ensure that decay heat is dissipated into its surroundings to a sufficient degree and distributed as evenly as possible. The maintenance of subcriticality means that the design of the container and how it is filled are to keep the nuclear fuels it contains safely in a subcritical state.

6.8.2 Requirements during the operational phase of the disposal facility

During emplacement, the disposal container, where necessary in additional transport containers, will be transported by the operating personnel into the deep repository and underground as far as the location where it will be emplaced. The handling of the containers underground will require them to be loaded and unloaded onto/off transport vehicles and placed in the final emplacement chamber, which will, e.g., involve tilting, rotating and raising procedures. Following the emplacement of one or several containers, the emplacement chamber will be backfilled.

These operational procedures will impose requirements concerning ease of handling and transportability under the parameters of the disposal facility, which will also encompass retrieval and repair operations, where required. One fundamentally important requirement will be the minimisation of the operating personnel’s radiation exposure. Further requirements will be determined by the host rock. For instance, the stability of the cavities in the host rock will influence the later configuration of the underground emplacement facility and the possible handling technologies underground. Where relevant, these will limit the dimensions and mass of the container, and are to be taken into account when it is designed.

The requirements that relate to the components of the disposal container will be concerned, in particular, with the sufficient stability, corrosion resistance and shielding effect of the body of the container and its dissipation of heat. These requirements will be fulfilled by a suitable choice of materials, the thickness of the container’s walls and the geometry of its body. The requirements concerning the closure system will result above all from the safe isolation of the radioactive substances during every handling phase, as well as in a major accident. Container inserts will have to meet requirements concerning their stability and immobilise the waste inventory. However, these requirements will also relate to the dissipation of heat and subcriticality, which will have to be guaranteed by the geometrical structure and the choice of materials.

These fundamental requirements will be valid both during normal operations and if design-relevant major accidents occur, e.g. fire, falling of containers, unanticipated pressure or temperature conditions, or collision.

6.8.3 Requirements concerning the long-term behaviour of the containers in the repository

Following its emplacement and the backfilling of the emplacement cavity, the actual final disposal stage will begin for each container. Specific requirements concerning the long-term behaviour of the containers will result, in particular, from the host rock and its properties, as well as the disposal concept. The requirement that determines how long the barrier function of the containers in the disposal facility will have to be retained for is quite essential in this respect.

In disposal concepts that are based on the designation of an isolating rock zone (salt, claystone, specific crystalline configurations), the isolating rock zone is to completely take on the function of safe isolation; over the long term, i.e. during the reference period, the safety of the disposal facility will not have to be based on the function of the container. In disposal concepts based on crystalline rock without an isolating rock zone, by contrast, safe isolation will require the interaction of the technical and geotechnical barriers to be demonstrated for the reference period. As a consequence, the crystalline rock concept will impose markedly more stringent requirements concerning the long-term integrity of the container.

Depending on the host rock type and disposal concept, different requirements concerning the capacity to dissipate heat are to be taken into account. Claystone displays poorer heat conductivity than salt, which means the design of containers for claystone must take greater account of the absolute heat input and the transfer of heat from the container to the backfilling material and host rock. In salt, emplacement cavities converge more rapidly, which leads to an earlier rise in the rock pressure on the container, and is to be assessed in connection with the backfilling of the cavity and the retention of the container's integrity.

Depending on the host rock and backfilling material, different geochemical environments will have impacts on the container surface, and corrosion will occur as a consequence of this. In order to keep corrosion processes to a minimum, recourse will have to be had to different, host rock-specific materials or surface coatings. One consequence of corrosion is gas generation, which is to be assessed with a view to the safety of the facility.

The protective functions that have been discussed and the requirements derived from them are to be complied with at each disposal site, while each host rock will impose different quantitative requirements. In an adapted form, they are valid already for the preceding interim storage phase. The containers are, however, to be designed specifically for each site, depending in particular on the host rock and the disposal concept.

6.8.4 Requirements of retrievability and recoverability

Retrievability during the operation of the disposal facility (until it is sealed) and recoverability from the sealed facility will demand that the containers' long-term stability, and therefore their ease of handling and transportability last much longer than in final disposal without these requirements. The container's functions must continue to be wholly or partially retained over the period for which this is to be guaranteed. The safety requirements specified by the Federal Environment Ministry in 2010 demand that the containers be retrievable during the operational phase of the facility until the sealing of the shafts or ramps. This is likely to last for up to approximately 100 years.[1018] To allow for probable developments, the waste containers' ease of handling should they be recovered

[1018] Cf. K-Drs./AG3-47, p. 3.

from the decommissioned, sealed disposal facility will have to be assured for a period of 500 years.[1019] These matters are not dealt with in greater detail by the Federal Environment Ministry's 'Safety Requirements'.

If the waste materials are retrieved, it may be assumed that it will be possible to fall back on the technology used for their emplacement. This will be available at the site of emplacement.

With regard to the preservation of its protective functions, this means that the container will have to withstand the strains imposed by radioactive radiation, rock pressure, the temperature conditions in and around the container, corrosion and handling procedures for 100 years. The site-specific stresses will be dependent on the host rock and the disposal concept, and will have to be forecast as precisely as possible. This will give rise to parameters that relate to the mechanical stability of the container and its corrosion resistance. The suitable container material and the container design are to be specified, depending on the host rock and the disposal conditions that are to be anticipated. In this respect, it is to be taken into account that the requirement of greater stability (wall thickness) of the containers may be disadvantageous in relation to other requirements placed on the storage system (gas generation as a result of steel corrosion).

The feasibility of retrieval must be underpinned by a retrieval concept and demonstrated with a safety case. The retrieval concept will potentially have to provide for retrofitting measures or concepts for the repair of the containers as well.

The recovery of waste containers from the sealed disposal facility is to be distinguished from their retrieval from the facility while it is still accessible. To date, recovery has fundamentally been viewed as an emergency option.[1020] If the containers are recovered, it is to be assumed that the emplacement technology will no longer be in place. In consequence, the know-how, the concept for the recovery technology and knowledge about the waste materials will have to be kept available.

Furthermore, with a view to recoverability, it is to be taken as the basis for the container design that, when they are recovered, the containers will have been exposed to up to 500 years of radioactive radiation, the temperature that results from the inventory's heat output and rock pressure.

Chemical interactions with the container material will be caused by minerals in the backfill materials and host rock, and the supply of water, where relevant, in conjunction with microorganisms. As far as corrosion is concerned, account is to be taken of probable developments described in the long-term safety case. In order to make recovery possible, the essential protective functions of the container must remain preserved for 500 years, the recoverability period set by the current version of the Federal Environment Ministry's 'Safety Requirements'. These functions are the isolation of the radioactive inventory, the maintenance of the integrity of the containers and the maintenance of subcriticality. The container must be designed in such a way that the impacts of corrosion damage

[1019] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2010): 'Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste', K-MAT 10, p. 17.
[1020] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2010): 'Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste', K-MAT 10, p. 6.

remain as small as possible under anticipatable conditions. The prevention of releases of radioactive aerosols is mentioned in the Federal Environment Ministry's 'Safety Requirements' as a further requirement.[1021]

The extension of the reference period for recoverability means larger safety margins will be required. The requirements concerning container stability will be supplemented, in particular, by requirements concerning the container closure system and its sealing effect. It is to be defined what level of impermeability of the container and its components is sufficient for recoverability. The retrievability and recoverability of the waste container are to be demonstrated in each case. This will represent a challenge on account of the periods of time that are to be predicted. Furthermore, the different host rocks will impose different requirements so that, where necessary, a dedicated container concept may be required for each host rock. The Commission recommends that sufficient time be allowed for this purpose.

6.8.5 Latest advances in technology

There is a great deal of experience of the development of containers for transport and surface storage available in Germany. A range of different containers are currently used for the interim storage of heat-generating waste materials. Transport and storage containers of the Castor and TN families are used for the transport and interim storage of spent fuel elements and high-level radioactive waste materials from fuel reprocessing. Apart from this, two container concepts for final disposal were developed in Germany in the 1980s: the Pollux type and, as an alternative to it, the BSK3 fuel rod canister concept. These container concepts are oriented towards the reference concepts prescribed at the time of their development.

With regard to the further development of these systems, the current situation offers the options of upgrading the Castor container types, further developing the Pollux and/or BSK3 container concepts or developing host rock-specific container concepts.

Both the Pollux reference concept and the alternative BSK3 concept were specifically developed for final disposal in rock salt. Adaptations or completely new designs for containers would have to be developed for other host rocks. The available reference concepts no longer accord with the latest advances in science and technology, and will have to be revised, in particular against the background of the current or additional safety requirements. At the hearing where this issue was discussed, adaptation to current requirements was felt to be feasible in principle, but not necessary worthwhile for all concepts.

The development of new waste containers would hold out the advantage that the container concept(s) could be fine-tuned to satisfy current safety requirements. In particular, the requirements concerning retrievability and recoverability would have to be translated into an appropriate container design. Furthermore, on account of the host rock-specific requirements, the development of at least three waste container concepts, one for each host rock, modified as necessary for gallery and borehole disposal, would initially be required. Apart from this, the

[1021] Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2010): 'Safety Requirements Governing the Final Disposal of Heat-Generating Radioactive Waste', K-MAT 10, p. 17.

use of a new container would require an appropriate processing and/or transfer facility. Additional secondary waste materials, and the transport and storage containers used would have to be disposed of.

Apart from the experience built up in Germany, recourse may be had to international knowledge (e.g. Scandinavian or Swiss container concepts) when containers are developed for various host rocks.

For instance, the development of the Swedish container concept[1022] has largely been concluded. The disposal site, including the disposal concept, is in its licensing phase. The disposal container has been developed for final disposal in crystalline rock. Under the KBS-3 concept, the spent fuel is placed in an inner container made of spheroidal graphite cast iron, which is in turn welded into a thick-walled copper container. The copper container is intended to protect the contents from corrosion. The package is embedded in bentonite in the emplacement chamber, which seals the chamber against ingressing water.

In Switzerland, it is defined as a requirement for the storage containers that they ensure the complete isolation of radionuclides for a thousand years as of their emplacement.[1023] The corresponding evidence is to be provided by the waste producers. At present, under the parameters of final disposal in claystone, the favoured option is a container made of carbon steel. The Swiss regulatory authority considers this material to be suitable, but is demanding further studies on gas generation. Thought is also being given to an adaptation of the Swedish copper container as an alternative to steel containers.[1024]

6.8.6 Scheduling and implementation of container development

The development of suitable container concepts takes time. At least five to seven years are estimated in Commission Printed Paper K-Drs./AG3-51. With a trial phase and the provision of the evidence of suitability that is required, it will take markedly longer until the containers have been approved. Indeed, several decades may be required for this to be completed.

The Commission sees the necessity to have host rock-specific disposal concepts available at an early point in the site selection procedure. These will also include appropriate container concepts, which are to be iteratively further developed in the course of the site selection procedure. The Commission therefore recommends that this process be got underway as soon as possible. In doing this, it is to be set out clearly which actor will take on which role.

The central actor in this respect will be the project delivery organisation, which will develop assumptions for its waste management concept at the beginning of the procedure and derive concrete requirements for the container from them. The implementation, i.e. the development and construction of the containers, will then be carried out by the waste producers, who are under an obligation to deliver

[1022] Cf. Swedish Nuclear Fuel and Waste Management Company (SKB) (2016): 'The barriers in the KBS-3 repository in Forsmark', SKB Public Report, 18 January 2016.
[1023] Cf. Swiss Federal Nuclear Safety Inspectorate (ENSI) (2009): 'Spezifische Auslegungsgrundsätze für geologische Tiefenlager und Anforderungen an den Sicherheitsnachweis: Richtlinie für die schweizerischen Kernanlagen', ENSI-G03, April 2009; translation: 'Specific design principles for deep geological repositories and requirements for the safety case', ENSI-G03/e.
[1024] Cf. http://www.ensi.ch/de/technisches-forum/behaeltermaterial-fuer-radioactive-abfaelle/.

waste for final disposal. In this respect, the waste producers will have to provide evidence that their containers satisfy the relevant requirements and will also be recoverable 500 years later.

The precondition for the development or adaptation of any container is the availability of the most concrete possible requirements based on the current ‘Safety Requirements’ and the design required for compliance with them. In turn, this design will be determined by the disposal concepts that are envisaged. It is the task of the project delivery organisation to present host rock-specific disposal concepts and coordinate them with the regulatory authority. The designs for the containers arrived at as a result are then to be specified in enough detail for them to be developed and constructed. In parallel, it should also be examined how far it is possible to draw on experience of interim storage with existing transport and storage containers, as well as international developments.

Since both the future exploration of the site and the development of the containers will generate further-reaching findings, the procedure should be set up as an iterative process that allows the further development of concrete container concepts in line with the evolving levels of scientific and technological knowledge, even after a decision on the site has been taken.

It cannot be ruled out that the decision in favour of a host rock will not be taken until the final decision on the site. It will only be once this decision has been taken that the development of the containers can be brought to a conclusion. An assessable container concept, however, must be supplied as part of the preliminary safety analysisanalysis for the decision. It is partly for this reason that it seems obvious to conduct an iterative process in which, where applicable, host rock-specific requirements concerning containers for all three rock types will initially be pursued in three parallel concepts.

6.9 Requirements concerning research and technology development

In the opinion of the Commission, there will be a need in future for research projects on final disposal conducted under the auspices of different participants in the procedure and institutions that are independent of the procedure.

In this respect, the responsibility for the generation of scientific findings and technical developments directly required for the site selection procedure will naturally lie with the project delivery organisation itself, for which purpose it will have to be equipped with the competences necessary to carry out its own research and development work, as well as funds to commission studies on specific questions from external parties.

A further essential pillar will be the funding of research independent of the project delivery organisation, which will be intended to ensure the regulatory authority has appropriate project-related expertise. This research is therefore to be based in the authority.

In consequence, the project delivery organisation and the regulatory authority are both to run their own research funding programmes that will be independent of one another. The aim is that the project delivery organisation should be able to take account of the specific needs of the site selection procedure while the supervisory authority cultivates its own expertise, ensuring it will not be uncritically dependent on information from the project delivery organisation in its work.

The societal bodies engaged in the site selection process will also wish to make contributions to the research agenda in future as further drivers of research and development. Here too, opportunities will have to be created to build up and cultivate critical, but objective competences that are useful for the procedure. The societal bodies will require adequate resources for this purpose so they can take independent decisions about such research.

Another aspect of precautionary research is the funding of projects that are focussed on fundamental issues not covered by the provisions in place for the selection procedure and, apart from this, serve to promote young researchers.

Not least, it will also be the task of all the institutions and funding providers involved in disposal research to put in place attractive parameters for the training of the young researchers who will be urgently required in the years to come.

The new start of the site selection procedure therefore confronts German disposal research with fresh challenges that will clearly expand the scope of the research and development activities pursued up until now. These challenges will be rooted in the requirements of the selection process itself:

- The commitment to the design of the process as a self-interrogating system[1025] that, as a learning procedure, will analyse successes, but also undesirable developments in the past and draw conclusions from them for the future, that will bear within itself the possibility of interrogating accepted wisdom, that will permit decisions to return to earlier stages in order to correct errors and, where necessary, embark on new pathways, and that will be subjected to comprehensive quality control, e.g. in the shape of peer reviews by academics who are not involved in the projects.

- The breadth of the approach, with three types of host rock and corresponding disposal concepts, development work on containers, safety and evidence concepts, and the comparatively recent requirements concerning the putting-in-place of precautions for the correction of errors, including the retrievability and recoverability of disposal containers.

- The duration of the procedure which, on the one hand, will lead to research and development topics that are, by their nature, urgently needed today for the first phase of the site selection procedure being prioritised in the scheduling and, on the other hand, will make it necessary for competences to be preserved in structured forms and, as a corollary, adequate measures taken to promote young researchers. Furthermore, the longer interim storage times necessary until the construction of the disposal facility are to be analysed and attention sustained on the effects connected with the aging of the containers and inventories.

- The ambitious aspiration to a broad culture of participation, in which the public and affected parties are to involve themselves individually or through the bodies established for this purpose, and in which space will be allowed and appreciation shown for critical science, as well as a culture of discussion in which

[1025] See also section B 6.4 of the present report.

conflicting opinions will be accepted as a necessary professional challenge and not ignored as disruptive factors.

The Commission believes disposal research in Germany has built up a good level of scientific expertise, on the basis of which specialist scientific issues can be addressed in connection with the site selection procedure. However, the current situation demands a new approach. What is necessary is a complementary, transdisciplinary research alliance that, on the foundation of internationally recognised competence and its own research output, acts independently, neutrally and holistically to make a constructive societal contribution. In this respect, all serious options for the safe storage of radioactive substances and their retrieval must continuously be scrutinised scientifically, including the possible radiation exposure of humans and the environment.

The project-funded research and development work done on the management of radioactive waste in Germany is oriented towards the relevant research-policy frameworks and the national programmatic parameters for waste management. Germany has been concentrating on final disposal in deep geological formations since the 1960s. R&D measures have been financed out of federal funds with this in mind. From the mid-1960s to the end of the 1980s, rock salt was preferred as the host rock for final disposal. During this period, about 85 per cent of the funding was spent on questions relating to rock salt as a host rock (exclusively salt domes), and 15 per cent on crystalline rock and non-host rock-specific issues. In the subsequent period from 1990 to 1998, project-funded research on claystone, crystalline rock and non-host rock-specific issues grew together to take approx. one third of the total funding. At the same time, the proportion of research funding devoted to rock salt declined to approx. two thirds of the total amount disbursed. During the years from 1999 to 2014, a further increase in research funding on non-saline rocks was to be noted. 35 per cent was spent on claystone, eight per cent on crystalline rock and 27 per cent on non-host rock-specific issues; approximately 30 per cent of the funding was still going to work on rock salt. When it comes to the current research projects that are receiving non-site-specific project funding approved since 2014, approximately one third of the R&D funding has been deployed for work on each rock salt and claystone, and one third on crystalline rock and non-host rock-specific questions. As a new R&D priority alongside the development of sets of instruments for systemic analyses of clay and crystalline rock as host rocks, the current project funding rules provide for the clarification of questions concerning final disposal in flat-bedded salt formations, to which little attention has been paid to date. In addition to this, the impacts of extended interim storage periods on waste materials and containers, as well as socio-technical questions have been introduced as new research priorities for R&D project funding since 2015.

Significant research issues have therefore been studied intensively with a view to a disposal system in a salt dome. The competences built up during this work, the experience gained and the gaps in knowledge identified will be of significance during the site selection procedure. There is experience available of claystone as a host rock for corresponding disposal systems from collaborations with Swiss, Belgian and French researchers at their underground laboratories, Mont Terri, Mol and Bure, which may be drawn on for work on German claystone deposits in the course of the site selection procedure. There has been collaboration on crystalline rock with Swiss and Swedish researchers at the Grimsel and Äspö underground laboratories. The Commission sees a need for an expansion of the research activities in this field. By contrast, research on disposal concepts in crystalline host rock has been not funded systematically in Germany to date, but only in a piecemeal fashion. Here, the Commission sees a need to catch up, in particular with regard to the disposal systems in crystalline rock that are conceivable in Germany, and the information required on crystalline deposits for them to be assessed and considered appropriately.

In future, disposal research in Germany will have to be focussed, in particular, on making contributions to the solution of issues that have still not been adequately clarified in the site selection procedure. In this respect, scientific/technical research will have to supply answers to concrete questions about:

- the characterisation of host rock deposits,
- the development of minimal-invasive or non-destructive investigative methods for this purpose,
- the development of reference disposal concepts for the selection of a disposal site and their further development in the course of the process,
- the development of precautions for the correction of errors, including the retrievability and recoverability of disposal containers, and appropriate requirements concerning containers and their inventories.
- the development of host rock-specific safety and evidence concepts,
- the development and further development of methods for long-term forecasting in relation to disposal systems,
- non-host rock-specific research to supply and review suitable instruments for the modelling of processes that unfold over the long term, and reciprocally coupled thermal, hydraulic, mechanical and chemical processes,
- the development and further development of methods for the comparison of sites, in particular if the sites have different host rocks.

In so far as this is the case, the Commission wishes to draw attention to the extensive analysis of the research needs in this field that has been conducted by the Nuclear Waste Management Commission.[1026]

The duration of the procedure also makes it necessary to keep a closer eye on the parameters for the interim storage that will be necessary and will last longer than has been planned to date. The Commission recommends that the need for research and development on the following aspects already addressed by the Nuclear Waste Management Commission[1027] be examined on an ongoing basis, and that appropriate studies be initiated:[1028]

- safety cases for containers and inventories for extended interim storage,
- the study of, and provision of evidence about, the long-term behaviour of container components (e.g. metal seals) and inventories (e.g. the integrity of fuel rods) for extended interim storage,

[1026] Nuclear Waste Management Commission (2016): 'Endlagerforschung in Deutschland: Anmerkungen zu Forschungsinhalten und Forschungssteuerung', K-MAT 63.
[1027] Nuclear Waste Management Commission (2015): 'Diskussionspapier zur verlängerten Zwischenlagerung bestrahlter Brennelemente und sonstiger Wärme entwickelnder radioaktiver Abfälle', K-MAT 41.
[1028] On this topic, see also section B 5.7.

- the behaviour of fuel elements in the transport and storage containers over longer periods of interim storage, and the consequences for the storage process itself and the conditioning methods that will prepare waste successfully for disposal.

Future social-scientific and socio-technical aspects constitute another priority to which noticeably more resources are to be devoted in comparison to current research funding. In this context, research projects will have to examine the particular connections between the problem of final disposal and the various levels of society, take account of the long, multigenerational duration of the process and tackle the participation procedure, the chronological and spatial dimensions of which are unprecedented. The central research tasks and topics in this field are:

- concomitant research on participation in a democratic rule-of-law state, the development and implementation of methods and measures that permit the involvement of all participating groups on a level playing field,
- interdisciplinary and transdisciplinary approaches when technical and non-technical disciplines cooperate with societal actors,[1029]
- questions about a no-blame culture, the societal treatment of undesirable developments and opportunities for the correction of errors,
- questions about knowledge management,
- questions about data preservation, how to pass on the knowledge about the disposal facility that will be important for later generations over long periods of time, and how to ensure the comprehensibility of data and knowledge,
- the critical historical analysis and reappraisal of the use of nuclear energy and disposal research in Germany, its opponents and advocates, and the associated societal and political processes.

The aspiration for the overall process that all actors feel committed to a self-interrogating system[1030] is only to be achieved if there is a maximum of transparency about the academic studies. Transparent procedures for the award of research funding are necessary. In this respect, the complete publication of all research results is a self-explanatory, indispensible parameter for the requisite transparency and the dialogue desired between different, academically founded points of view. This is true irrespective of whether the results support, or are opposed to, the pathway to the implementation of a disposal facility that has been embarked upon.

It is indispensible that all German waste management and disposal research projects, whether they are R&D projects on the concrete implementation of a disposal facility initiated by the project delivery organisation or scientific studies produced independently of the project delivery organisation, should be surveyed and discussed in a research programme that is to be regularly updated. In future,

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[1029] In Germany, the ENTRIA project has broken new grounds in interdisciplinary cooperation and is building up relevant research competences. Several collaborative interdisciplinary projects have been conducted within the framework put in place by European research funding. Attempts to build up interdisciplinary cooperation between the social sciences, natural sciences and engineering sciences, an approach in tune with the socio-technical nature of the challenge of final disposal, have only made progress over the last few years and are still generally in their infancy.

[1030] See also section B 6.4.

it will also be necessary to formulate and discuss research questions and projects together with the siting regions or sites and the National Societal Commission in the course of the site selection process.

7 SITE SELECTION IN DIALOGUE WITH THE REGIONS

7.1 Representative democracy and community participation

The Site Selection Act is predicated on the assumption that a successful search for a site for the disposal of radioactive waste will require new and extended forms of community participation. Several major construction projects over the last few years have shown that, in contemporary society, the representatives of different socio-political interests more rapidly cease to feel bound by the decisions taken through elected institutions, preferring to pool and deploy their forces to assert their own interests directly.

This lack of acceptance for democratic decisions, in particular difficult ones, is not a specifically German phenomenon. We observe a similar loss of acceptance for the legitimated bodies of representative democracy in many European states. This development has been influenced by factors such as the increasing dominance of particular interests, a creeping loss of acceptance for public interest-oriented structures, a significant strengthening of populist parties and policies, and ever more rapidly diminishing respect for democratic bodies and office holders, which has been manifested not only in a rise in personal threats against politicians but even in physical attacks on them.

Greater participation is not a panacea against this development. However, it offers a possible way of dealing with complex, highly contentious fields of policy in a fashion that allows broadly accepted, public interest-oriented results to be achieved. And it may help to ensure direct, argumentative, but respectful discourse again comes to be accorded the significance it needs to have in society if our democracy is to enjoy strong acceptance that will endure in the future. Successful, viable policymaking should therefore grasp and encourage it as an opportunity that there is an increased willingness among ordinary citizens to engage with the issues during the planning phases of major projects, and so integrate and discuss different points of view and options at an early stage. This will require new forms of institutionalised collaboration between policymakers, state institutions, the business community, academia and society; in short: an extended form of democratic stakeholding in political opinion-formation and decisions beyond elections.

The Commission on Storage of High-Level Radioactive Waste supports new opportunities for democratic stakeholding and therefore wishes to propose that democracy be strengthened with innovative participation procedures. In this respect, representative democracy and direct community participation are not viewed as opposites, but as phenomena that complement each other. The political responsibility for the decisions that are taken will remain with elected delegates, but they will understand the new forms of participation as opportunities to revitalise politics and polity.

The Commission is convinced that people's willingness to accept responsibility will be all the more pronounced, the greater the transparency and openness of the procedures, and the more opportunities ordinary citizens have for direct participation, and that such an approach promises a gain in democratic legitimation. More participative procedures demand clear rules and principles so that the different actors are able to encounter each other on an equal footing, two-way communication can take place between citizens and their representatives, and it is possible for citizens' submissions to exert some influence.

Daring more participation:

Many examples from the last few years show that it is not sufficient for the legitimation of major projects if parliamentarians who have been elected by majorities take decisions by majorities in state bodies. Growing sections of the population want to be involved and not just to have to acquiesce in decisions to which, as a result of practical constraints, there is allegedly no alternative. They want to have opportunities for involvement from the beginning, and to familiarise themselves with all the important costs and risks. The Commission on Storage of High-Level Radioactive Waste views community participation as something that complements representative, parliamentary democracy. It is not a method that makes major projects more expensive and drags them out but, on the contrary, the precondition if such challenges are to be dealt with responsibly.

The democratic public has rights to be heard, to consult files, to be treated with openness and to receive professional assistance. Transparency about decision-making processes and greater equality of opportunity for all participants are fundamental preconditions for effective community participation. They build the trust that is necessary for the successful implementation of projects. At the same time, successful community participation means more than the retrospective legitimation of decisions that have already been taken; rather, it means an open 'process because the results cannot be calculated in advance and must not be prescribed.'[1031]

The Commission is convinced that it is only through greater transparency and the early, comprehensive involvement of ordinary people in the authorities' planning activities, an approach that complements parliamentary democracy with forms of direct community participation – at all levels –, and the assertion of the primacy of politics that the search for a disposal site will be successful and trust in democracy will be strengthened. The new forms of participation that will bear fruit in the search for a disposal site must be established as norms by legislation. The determined opening of society to alternatives holds out opportunities to overcome the narrowness of some perspectives and interests, and tap into people's imagination and understanding of the facts so as to arrive at constructive solutions. It will be a matter of expanding, not replacing, parliamentary rights and principles.

7.2 Aims and substantive issues for public participation

The decades of arguments about the disposal of radioactive waste have shown that decisions to designate sites that are prepared intransparently and communicated to the wider public after the event provoke insurmountable resistance. In the light of the experience gained at the Morsleben and Asse sites, and the conflicts over Gorleben, a new approach focussed on societal

[1031] Sommer, Jörg (2015): 'Bürgerbeteiligung – Wer beteiligt wen?', in: Jörg Sommer (ed.): Kursbuch Bürgerbeteiligung, p. 63.

participation and transparency will be necessary when the procedure is re-launched.
What is at stake is a new quality of community participation, the aim of which will be to ensure the population's active involvement in the process by which a site for high-level radioactive waste is selected. To this end, qualitative improvements to political decision-making are to be initiated and the close linkage of the authorities' actions with public participation processes guaranteed in order to achieve better societal legitimation for the whole site selection procedure.
The highest priority in the search for a disposal site is to ensure the best-possible safety. Consequently, the levels of acceptance in the siting regions cannot be used as a selection criterion when the sites are narrowed down. This also means the aim of the public participation will not be to measure or even foster acceptance. Rather, the undoubtedly high level of critical energy that will be unleashed in every potential siting region should be harnessed and exploited to aid the examination of all aspects of the matter. Regional actors, in particular, will have to be granted effective rights in this examination process. There is a realistic chance that this readily understandable expansion of rights and opportunities will foster corresponding levels of tolerance for the permanent storage of radioactive waste in the siting region.
The loss of societal trust that has been experienced as a result of the treatment of criticism and resistance during previous attempts to find a disposal site demands particular attention. A new procedure to find a disposal site will have little prospect of success if it does not learn from the errors made in the past[1032] in relation to the management of radioactive waste, the causes of those errors and the socio-political fault lines to which they have given rise. It will hardly be possible to gain acceptance among the people who will be directly affected. However, if the procedure is perceived to be truly fair and equitable, people may come to understand why it is their own region that finds itself taking responsibility for the permanent storage of radioactive waste .
The more firmly the wider public is convinced of the objective justification and fairness of the procedure, the better the chances will be that subsequent generations will continue along the path that has been embarked upon by their parents and grandparents.

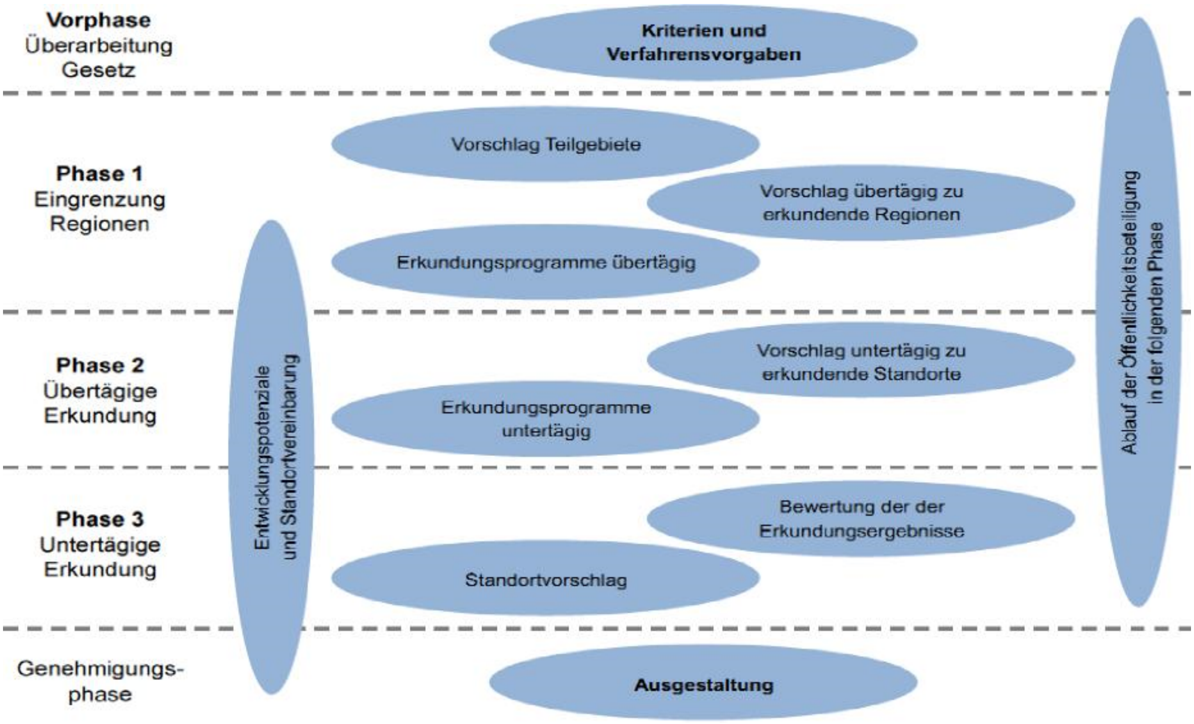
7.2.1 Substantive issues and depth of involvement

The question of which substantive decisions public participation is to influence will have to be answered clearly at the beginning of the procedure so that no false expectations are awakened, and it is possible for the procedure to be perceived as fair and equitable. In short, the answer is: It will be able to influence all the main decisions taken during each phase, informally by means of the arguments that are put forward and formally by means of the re-examination requests that are issued. However, this influence will always be exerted within the constraints set by the decisions taken during the previous phases.
The whole approach to the selection of a disposal site is based on the principle that the site with the best-possible safety will be found in a procedure that

[1032] Cf., on this topic, 'Sammlung und Auswertung der Ergebnisse der Öffentlichkeitsbeteiligung durch die Kommission', Commission Printed Paper K-Drs. 259, entries JE1561 and RE3836.

reduces the possible options ever further as it goes through a sequence of decisions. With regard to the substantive issues addressed by the public participation, this means that each key decision in this sequence will also be a matter for public discussion and may be subject to possible interventions. By contrast, it will no longer be possible for decisions that have already been taken to be addressed substantively under the participation process, unless new information leads to a fundamental reassessment and therefore prompts a return to an earlier stage in the procedure.
Graphic 17 shows the sequence of topics on which decisions are to be taken and that are therefore essential to the public participation process.

Graphic 17: Main substantive issues addressed by participation under Section 9(3) of the Site Selection Act



Phase 1 = Phase 1
Eingrenzung Regionen = Narrowing-down of regions
Vorschlag Teilgebiete = Proposal for subareas
Vorschlag übertägig zu erkundende Regionen = Proposal for regions to be explored from the surface
Erkundungsprogramme übertägig = Surface exploration programmes
Ablauf der Öffentlichkeitsbeteiligung in der folgenden Phase = Public participation process during the following phase
Phase 2 = Phase 2
Übertägige Erkundung = Surface exploration
Entwicklungspotenziale und Standortvereinbarung = Potential for development and siting agreement
Vorschlag untertägig zu erkundende Standorte = Proposal for sites to be explored underground

Erkundungsprogramm untertägig = Underground exploration programme
Phase 3 = Phase 3
Vorphase = Preliminary phase
Überarbeitung Gesetz = Revision of Act
Kriterien und Verfahrensvorgaben = Criteria and procedural provisions
Untertägige Erkundung = Underground exploration
Bewertung der Erkundungsergebnisse = Assessment of exploration results
Standortvorschlag = Proposal of site
Genehmigungsphase = Licensing phase
Ausgestaltung = Configuration

This graphic merely gives an overview of the main substantive issues. More detailed accounts of these topics will be found in Sections B 6 and B 7.5. If substantive issues are conclusively decided on at the end of a phase, they may also feature on the agenda again in subsequent procedural steps. However, this will only involve the provision of information about these issues, which are not to be renegotiated. E.g., information will be provided about the criteria and procedural provisions again and again throughout the procedure, so that the steps that build on them are comprehensible and verifiable.
The sequence of topics makes it clear that public participation will always focus on 'how' the next few steps are to be taken. For subsequent decisions will be determined by these operative issues (e.g. the application of criteria, exploration programmes). The actors will therefore have to be given sufficient opportunities for involvement in order to enable them to direct their attention to the questions that are due to be decided during each phase. This approach will offer the best options to influence the site selection procedure with the support of independent expert witnesses. At these points in time, public actors will have opportunities to use informal persuasion or formal re-examinations to influence decisions at the federal level. Public participation is intended to significantly improve the quality of the site selection procedure, but not to call the whole project into question.
Depth of involvement: In public participation practice, the depth of involvement is often described by assigning it to one of the three stages of participation, 'information", 'consultation' and 'cooperation'.[1033]
It goes without saying that information, i.e. comprehensive, public-facing communication materials presented in forms appropriate to different target groups, will be the basis for public participation in the site selection procedure.
Consultation means that participants are able to comment actively. Tried-and-tested formats that are clearly defined in legal terms, such as the comments procedure and hearings, are to be deployed to facilitate this type of involvement in the site selection procedure.
In cooperation, participants are granted definable rights to take part in decision-making. The spectrum of these opportunities to have input is enormous and ranges from heavily circumscribed rights to intervene to direct democratic measures such as referendum procedures. For the site selection procedure, it was necessary to find a solution that allowed a great depth of involvement – in particular for the people in the affected regions –, but without running the risk of endangering the whole procedure by blocking it entirely. The Commission envisages, above all, that the regional conferences and the Council of the Regions

[1033] Federal Ministry of Transport and Digital Infrastructure (2014): 'Handbuch für eine gute Bürgerbeteiligung − Planung von Großvorhaben im Verkehrssektor', pp. 12-14.

Conference, which are described in detail in the present report, will contribute to this aim. In addition to this, with their rights of re-examination, the regional conferences will be given opportunities to identify defects and request action to rectify them. However, the actual considered decision will be prepared by the Federal Office for the Safety of Nuclear Waste Management (BfE), and presented to the Bundestag and Bundesrat for them to vote on. Once this milestone has been reached, the substantive questions raised during the phase will be conclusively answered. The federal act will then form the foundation for the following phase, and it will not be possible for the bodies involved in the public participation to amend the legislation.
In the social-scientific debate, the depth of involvement is also characterised by whether purely deliberative, dialogue-oriented procedures are deployed or whether greater use is made of forms of direct democracy. As set out in a report published by the Bertelsmann Foundation and the Baden-Württemberg State Ministry, this distinction is 'less clear-cut than it may appear at first glance,' because there are numerous hybrid forms of participation that combine informal dialogues with binding rights to intervene.[1034]
The Commission recommends that the regional conferences be equipped with statutorily defined rights to intervene. Re-examination is an instrument that will ensure legally that the information compiled during dialogue-oriented procedures is given the attention it demands during the consideration process.[1035]

7.2.2 Long-term agreement on the strengthening of regional potential

The Commission's recommendations concerning public participation are based on the thesis that two essential conditions have to be fulfilled if a region's citizens are to be able to tolerate the construction and operation of the disposal facility with a clear conscience: Firstly, convincing scrutiny will have to be exercised to ensure the selection of the disposal site and implementation of the disposal facility are consonant with the concept of the best-possible safety. Secondly, the region will have to be in a position to compensate effectively and permanently for the burdens imposed by the construction of the facility and the transport of the containers. Action will also have to be taken to counterbalance any negative labelling of the region by developing a compensation concept.
The strategies for delivering this compensation are to be developed individually in each region. The economic, historic and social potential of the regions is to be studied closely for this purpose, and fitting long-term strategies are to be both drawn up and validated. The aim here cannot merely be to provide compensation in the form of a short-term financial package; rather, potential lines of long-term development for the regions in question are to be elaborated that will offer a sophisticated response to the construction of the disposal facility. When this is done, it will be necessary to both look at the concerns expressed by the current population and, at the same time, factor in expert knowledge and predictions about future developments.
Back in 2002, the Committee on a Site Selection Procedure for Repository Sites (AkEnd) delivered recommendations concerning the participation of the public in

[1034] Bertelsmann Foundation, Baden-Württemberg State Ministry (2014): 'Partizipation im Wandel – Unsere Demokratie zwischen Wählen, Mitmachen und Entscheiden', p. 19.
[1035] See section B 7.4.3 of the present report.

the search for a disposal site. This independent committee appointed by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety took up its work in 1999 and had the task of delivering recommendations for a site selection procedure on the foundation of science-based criteria. The results of its work, which took three years, were presented to the Federal Minister for the Environment in the form of a final report. Public participation is also dealt with in the Committee on a Site Selection Procedure for Repository Sites report and has been discussed by the Commission on the Storage of High-Level Radioactive Waste.

Many of the recommendations on public participation drawn up by the AkEnd have been taken over from its report; others were further developed or finally discarded after they had been considered. The development of a compensation concept was described in detail by the AkEnd, whose proposal serves as the foundation for the recommendations made here on strengthening regional potential.

In its report, the AkEnd described the following features of meaningful support:[1036]

- The promotion of long-term opportunities instead of the creation of short-term advantages
- Support that encourages actors to take the initiative; the development concept must be implemented by the region's enterprises, associations and institutions.
- All grants are awarded for limited periods until the momentum of development becomes self-sustaining.
- Clarity about who will provide funding and secure support over the long term.
- Phased implementation of regional development planning with starter and pilot projects as early as the underground exploration.

The Commission has followed these recommendations. The concrete regional conditions, especially, will have to be factored in and closely studied when a strategy for regional development is elaborated. The regional bodies proposed below will be able to perform these functions and so guarantee the development concepts are secured over the long term.

The Council of the Regions Conference (section B 7.4.4) will have the task of roughly outlining a non-site-specific strategy for the promotion of regional development. During Phase 2, as part of the socio-economic potential analysis, the Federal Office for the Regulation of Nuclear Waste Management (BfE) will compile the fundamental data that will also be deployed for the consideration process (section B 6.5.10). The further the site selection procedure progresses, the more concretely the remaining regional conferences (section B 7.4.3) will examine how they can strengthen the development of their individual regions. At the latest during Phase 3, the focus will be on the question of what support the region will receive so it is able to implement over the long term the strategies that have been elaborated, and how a binding agreement on the provision of this support can be put in place.

The options to gain legal redress will not be negatively affected by an agreement of this kind.

[1036] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, pp. 214-215.

The parties to such an agreement should, on the one hand, be the Federal Republic of Germany and, on the other hand, the local authorities of the region where the selected disposal site is located. It will only be possible to conclusively define the boundaries and legal form of such a region during Phase 3.
The subject matter covered by an agreement could be:

- the configurable key elements of the installations (e.g. transport links, surface installations, emissions control, parameters for the emplacement process, waste capacity),
- long-term commitments during the operational and post-operational phases,
- compensation measures with multigenerational effects that would strengthen the regions' potential for development and compensate for the possible negative side effects of the disposal facility.

Partly on account of the character of this agreement, which will be intended to last in perpetuity, its legal implications will be extensive and will have to be studied at an early stage.

7.2.3 Principles of participation and constellations of actors

Just like the Commission, the AkEnd was convinced that the controversies about, and criticism of, the search for a disposal site frequently met with among the population can only be dealt with if communities are involved comprehensively in the solution of the problem in line with their different interests. In this respect, the AkEnd distinguished four complementary forms of participation.[1037]
The four forms of participation distinguished by the AkEnd are briefly described below. It is clarified what they have in common with the Commission's proposals, as well as how they differ. Furthermore, the actors that could implement these principles are presented. The actors that take part in the selection procedure are either formally defined in the Site Selection Act or will exercise influence in their own interests. The description of the relevant bodies in section B 7.4 therefore does not give a complete list of all the actors involved in the procedure, but merely those on whom defined rights and duties in relation to the public participation will have been bestowed beforehand. This basic constellation of actors will create constructive starting points and scenarios for action for all the other actors. The four fundamental principles of participation posited by the AkEnd report are briefly outlined below.
a) Participation needs comprehensive information:
An essential element in the provision and dissemination of information is the independent information platform proposed by the AkEnd. The independence of this medium was emphasised in the Committee's report. Although the platform may be administered by the organisation that delivers the public participation, it will simultaneously permit other actors (regional bodies, the National Societal Commission) to influence editorial decisions. These actors are to collaborate actively on the compilation, processing and checking of information. As a result, the platform will be able to reflect conflicting and diverse interests, and achieve the necessary credibility. The information services will have to be designed

[1037] Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, p. 197.

'comprehensively and systematically',[1038] and presented appropriately for their target groups. The Commission wishes to underline the significance of this participative element and has further developed it in the present report. E.g., the networking of the platform with the actors involved in the procedure has been described in greater detail. A more exhaustive account is given in sections B 7.3.4 and B 7.3.5.

b) Participation in the design of the procedure:

The AkEnd advocated the establishment of a neutral control committee.[1039] This would examine whether the selection procedure was being implemented in conformity with the rules that had been set and would continuously monitor the work of the project delivery organisation. The control committee would be characterised by its high level of expertise in scientific/technological matters and the high standing of its members among the public. At the end of each phase, the control committee's observations would be fed directly into the decision-making of the legislative bodies by means of a report on the results at which it arrived.

The necessity of such a body was also discussed by the Commission. Furthermore, Section 8 of the Site Selection Act provides for the establishment of a societal advisory group that would have functions similar to those of the neutral control committee proposed by the AkEnd. The two bodies' features have been taken up in the Commission's proposal for a National Societal Commission and are described in section B 7.4.1.

c) Participation in the representation of regional interests:

The involvement of bodies at the national, supraregional and regional levels in the decisions that are taken forms the heart of the concept put forward for public participation in the search for a disposal site. The AkEnd too looked at regional representation and, in its final report, proposed the establishment of a citizens' forum with a centre of competent experts[1040] for each of the regions affected. The citizens' forum would serve as a body in which to discuss all the regional development issues that were connected with the search for a disposal site. The provision of appropriate financial resources would additionally enable the citizens' forums to set up their own competence centres. The experts employed by these centres would monitor the application of natural-scientific and social-scientific criteria, and advise the citizens' forums.

The idea of organisations that would represent regional interests and be supported by experts from various disciplines is central to the proposal for public participation elaborated by the Commission. Nevertheless, it goes much further than the remarks in the report by the AkEnd. Section B 7.4 sets out the possible functions, composition, and rights and duties of the regional bodies in detail.

d) Participation in decision-making:

The AkEnd introduced the concept of 'willingness to participate'. This reflects the whole range of factors that lead to a region's population overseeing the search process for a disposal site and being willing to get involved in the concrete configuration of this process, or at least not opposing it.

[1038] Cf. Section 9(1) of the Site Selection Act and K-Drs./AG1-58, section 2.

[1039] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, p. 195.

[1040] Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, p. 198.

In its final report, the AkEnd advocated that the willingness to participate of the communities in the potential regions be surveyed at several points and that the exploration of the sites in a region be discontinued if there was a loss of the willingness to participate there.[1041] Following thorough consideration, the Commission recommends a procedure that is derived from this approach, but also differs from it.
Participation in decision-making is also favoured in the Commission's proposal, but this is not to be measured using a binary survey with a Yes/No question.
A *de facto* right of veto for directly affected parties would ignore the justified interests of the general public and could result in the mandate from the whole of society to guarantee the final disposal of radioactive waste in Germany being blocked.
Instead of this, decision-making is to be supported by the appointment of legitimated, civil-society bodies. These will make it possible for criticism and suggestions from the regional population to be presented with greater sophistication and a stronger focus on practical solutions, thus allowing such criticism and suggestions to be fed into the procedure.
The whole process followed by the Commission when it considered the ideas about willingness to participate put forward by the AkEnd is described in the text box 'Arguments for and against a survey' in section B 7.4.3.6.

7.3 Structure of public participation

Brief summary: The Commission recommends two fields of action for public participation. The first field of action will encompass the basic forms of public participation, with options to obtain legal redress offered in accordance with the Commission's proposals. In the second field of action, expanded participation institutions will be created. Their existence and options for action will also be legally legitimated, but it will be possible for them to be designed more flexibly and dynamically by the participants at the supraregional and regional levels as far as their processes are concerned. This will create both legal security and a broad, open culture of discussion.
The Federal Office for the Regulation of Nuclear Waste Management (BfE) is the organisation that will deliver the participation procedure. It will guarantee its implementation in both fields of action. The National Societal Commission established immediately by federal legislation when the Commission's report is delivered will observe the participation procedure as an independent actor and intervene in conflicts in a mediating role. At the end of each phase, a decision will be taken on the basis of all the results in the form of a federal act.

7.3.1 One procedure – two fields of action

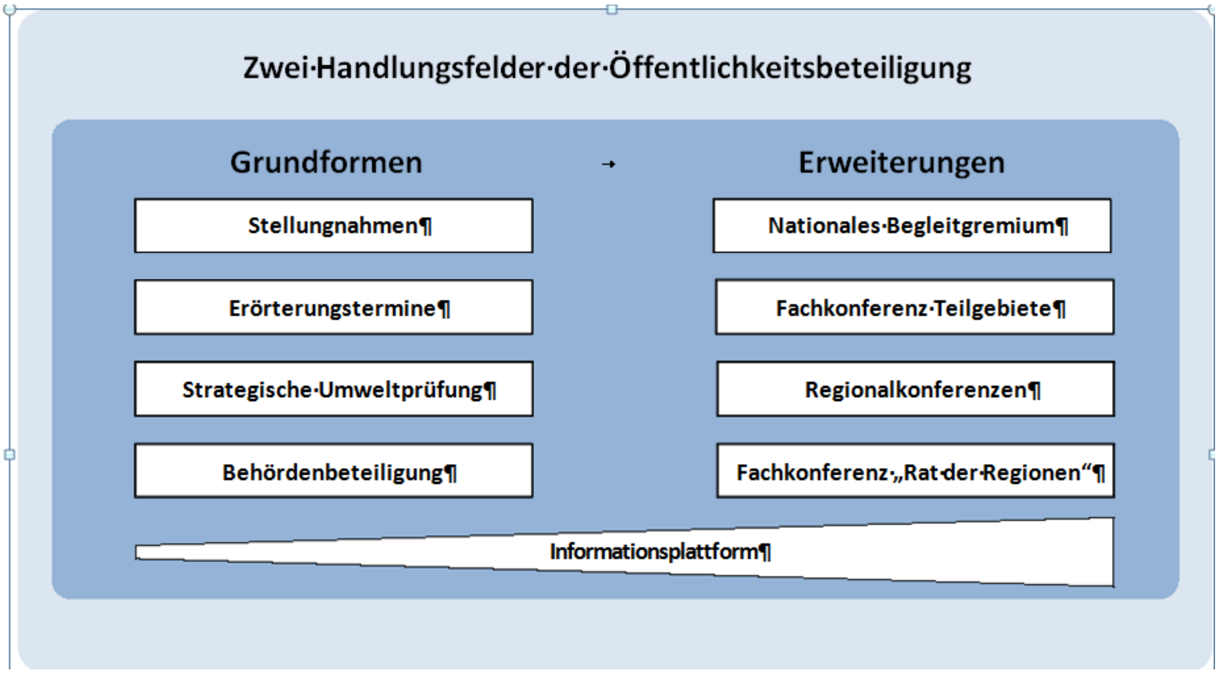
In its current version, the Site Selection Act describes an approach to public participation modelled on the procedure laid down in the Administrative Procedure Act. It outlines the elements required if affected individual citizens,

[1041] Cf. Committee on a Site Selection Procedure for Repository Sites (2002): 'Site Selection Procedure for Repository Sites: Recommendations of the AkEnd – Committee on a Site Selection Procedure for Repository Sites', K-MAT 1, p. 70 and pp. 200-202.

associations, public agencies and neighbouring states are to be given the hearing to which they are entitled by the law. These elements will have to be specified in concrete terms and supplemented with another field of action.
The particular type of task that is being set will demand novel forms of participation if the citizens of the regions to be studied are to be involved in the preparation of the decisions early on using dialogue-oriented methods. Although this participation is to be statutorily anchored, it will be organised outside legally prescribed routines. As a result, it will be possible for local peculiarities to be taken into account and also for flexibility to be allowed during phases of participation that are marked by conflict.
Decisions are not only to be legitimated retrospectively. Rather, the affected regional and supraregional publics are to be encouraged, and placed in a position, to elaborate proposed solutions themselves and improve the procedure continuously. This may prove successful if the structures that are necessary for an approach of this kind – e.g. bodies established specially for this purpose and provided with appropriate financial resources – are available as early as possible. It is only in this way that it will be possible to ensure the community participation is marked by new levels of quality and fairness, and allows the regions that come into question to oversee the process of selecting a disposal site competently with expert technical advice at their disposal. Within a framework defined in this way, it will then be possible to deploy participation and conflict resolution methods that have proven to be expedient in informal participation situations, and open up the necessary room for manoeuvre for all the actors.
As depicted in the graphic, the two fields of action will complement each other. The prescribed forms of public participation will be backed up with options to gain legal redress in accordance with the Commission's proposals. The rights of affected parties will be secured in the spirit of these proposals. The disadvantage of this field of action is the high level of formalisation it entails, which makes it more difficult in practice to deal flexibly with preliminary findings at an early stage.
In consequence, the expanded participation formats are to be defined by legislation, but designed to offer a great deal of room for manoeuvre. Additionally, the regional and supraregional public will be granted further rights through these bodies, in particular the right to request re-examinations.[1042] The different forms in which the two fields of action are to be configured will be explained in detail in the following sections.

[1042] Cf. section B 7.4.3 of the present report.

Graphic 18: Two fields of action for public participation



Zwei Handlungsfelder der Öffentlichkeitsbeteiligung = Two fields of action for public participation
Grundformen = Basic forms
Erweiterungen = Expanded elements
Stellungnahmen = Comments
Nationales Begleitgremium = National Societal Commission
Erörterungstermine = Hearings
Fachkonferenz Teilgebiete = Subareas Conference
Strategische Umweltprüfung = Strategic environmental assessment
Regionalkonferenzen = Regional conferences
Behördenbeteiligung = Participation of authorities
Fachkonferenz „Rat der Regionen“ = Council of the Regions Conference
Informationsplattform = Information platform

7.3.2 The authorities' capacity for dialogue

The expanded participation elements will need to have a dialogic character. This means that a permanent dialogue is to take place between the authorities and an extremely heterogeneous public, which will also include, e.g., groups critical of the nuclear industry with their background shaped by long experience of the conflicts in this field. Such a dialogue, for which there have not hitherto been any successful models, will be associated with major communicative challenges. This gives rise to two fundamental requirements for the participating authorities: Firstly, the process of selecting a disposal site will demand that all the participating authorities have the will and capacity to participate in, and design, the process, particularly the Federal Office for the Regulation of Nuclear Waste Management as the organisation that delivers the public participation. They must grasp what is, in many respects, a demanding participation process as an essential

component of their actual functions that will contribute to the quality of the preparations made for the decisions that are taken and, ultimately, society's toleration of the results. These attitudes, and professional and participative capacities will be needed for the difficult dialogue processes that are to be conducted. They are to be promoted and built up at all levels within the participating authorities by means of personnel development measures designed for the long term. The necessary quality of the dialogue processes will have to be ensured by a suitable organisational structure and suitable organisational processes. At the same time, it is to be guaranteed that all staff – especially those who are concerned with technical questions – are given the skills to take part in the participative processes by coaching and other measures.
Secondly, carefully developed, viable designs for dialogue processes are indispensable. It may be helpful to make use of external assistance for this purpose.

7.3.3 Delivery organisations

7.3.3.1 Role of the Federal Office for the Regulation of Nuclear Waste Management

The organisation that delivers public participation in the site selection procedure will be the Federal Office for the Regulation of Nuclear Waste Management (BfE). It will organise the participation procedure in the fields of action described above. In particular, the BfE will be responsible for ensuring regional participatory bodies are established and provided with sufficient resources. At the same time, it will also be able to bring in external service providers so that different approaches and up-to-date methods of participation can be deployed in the spirit of a continuously learning procedure. This will include, e.g., the facilitation of meetings, events, etc. by external personnel in order to guarantee that roles are allocated credibly.
In its role as the organisation that delivers the public participation, the BfE will guarantee that the central results from the participation procedure are heard immediately by the organisations concerned with the technical aspects of the matter – the Agency for the Disposal of Nuclear Waste (Bundes-Gesellschaft für kerntechnische Entsorgung, BGE) and the BfE in its role as the regulatory authority –, and that suggestions can be examined as early as possible in the work process. This approach has already proved its worth during the public participation on the Commission's work because ambassadors from the Commission witnessed the discussions at the events and were able to feed the results directly into the deliberations of the working groups.
The BfE has the function of documenting all the results of the participation process, presenting them for decision-makers and taking them into account in its report with the proposals for eligible siting regions.
As the regulatory authority, the BfE will have a continuing duty to account for its actions to the participation bodies, provide and explain documents, and take account of the knowledge gained from the discussions that take place during the administrative procedure. The BfE will establish its credibility as a neutral partner on the basis of the reliability, openness and competence with which this dialogue is conducted.

7.3.3.2 Role of BGE

The Agency for the Disposal of Nuclear Waste (BGE) too will be called upon in its role as the project delivery organisation to undertake intensive information work. It should understand this function as imposing an obligation to take proactive measures. When it comes to the revision of the Site Selection Act, however, BGE should not be assigned a role as the organisation that delivers public participation.
The company's work will be a central issue for the public participation: Its proposals and analyses will be essential foundations for the BfE's publications. BGE will be available to the National Societal Commission for consultations, and the regional bodies will be able to put queries to BGE, which will have a mandate to remedy any deficiencies that are identified as directly as possible. In the context of the re-examination process, it will have an obligation to deal with the re-examination requests from the regional conferences within the time limits that have been set.

7.3.4 Information platform and information offices

As an essential foundation for the participation procedure, the BfE will maintain an information platform on the Internet. To complement this, the BfE will be able to set up information offices on the ground jointly with the individual regional conferences. The services provided are to be conceived in such a way that conflict-laden circumstances too are illuminated from different perspectives and by various authors. Minimum academic standards are to be guaranteed.
The BfE should collaborate with partners such as the Federal Agency for Civic Education for this purpose. This will also allow the topic of the search for a disposal site to be made tangible for young people and children, and taken into Germany's schools.
A balanced, comprehensive information base is to be created by surveying this information in its entirety. The information supplied must be presented and made accessible in such a way that laypeople, committed citizens with specialist knowledge, researching journalists or experts from academia and the business community are able to find appropriate levels of information and presentation.
The regional bodies are to take on an active role in the development of the platform and its ongoing administration. The platform and the optional information offices on the ground are to be tools with which to make the results of the regional bodies' deliberations known to the regional public and receive feedback from communities. The National Societal Commission will also be able to contribute content.
The information platform will have an essential function, in particular for the regional conferences. It will ensure there is communication between the participants in the 'ring model'.[1043] To this end, the online platform will need to have suitable methods at its disposal if the regional conferences are to be able to gather and aggregate suggestions from the public.[1044]
A central element in the information work will be the balanced, comprehensible description of all measures that will lead to the site with the best-possible safety,

[1043] See, on this issue, section B 7.4.3 of the present report.
[1044] Cf. the Bertelsmann Foundation's citizens' forum method methodology, http://www.buerger-forum.info.

from the search criteria to the structure of the disposal system with its different safety concepts. The long-term prospects for the next few thousand years will also have to be presented professionally for the different target groups. Only if the overall process of nuclear waste management is readily understandable and therefore imaginable for all population groups will it be possible for the discussion to take a constructive course.
The value of information provided with a low threshold and specifically tailored to different target groups was also emphasised again and again at the participation events on the Commission's work. It was felt this factor could not be valued highly enough when it came to such a complex topic that was so hard to broach.
In addition to this, the BfE will also be able to provide raw data practically in open formats and as open data in order to give data journalists and other actors the opportunity to carry out plausibility checks.
The information work that is done must not merely reach those who already come to the procedure with an interest in it from the beginning. It will be far more important that, in the interests of activating broad sections of society, the procedure is accompanied by a supraregional information campaign, so that people who have not taken any notice of it until then are also informed about the context for the selection of the disposal site and the opportunities for participation.
Two different approaches are therefore to be conceived both for the information platform and for the information offices: Initially, the services should be designed for interested parties who want to study the topic more intensively for the first time. The physical and societal context must be explained in generally comprehensible ways. To complement this, detailed information is to be reserved for the analyses that are drawn up during the site selection procedure.

7.3.5 Transparency and rights to information

The German federal Freedom of Information Act (IFG) and Environmental Information Act (UIG) provide for everyone to have access to official information held by federal authorities, federal organs and federal institutions, in so far as they perform administrative functions under public law. This information is supplied on application, provided none of the protective criteria set out in the IFG and/or the UIG are infringed.
Further to this access to official information granted on application, the Hamburg Transparency Act provides for a duty to supply and publish such information. This duty obliges the city's authorities to make all official information publicly accessible in an information register. In this respect, the Hamburg Transparency Act sets the same benchmark as the IFG for the examination of whether it is permissible for information to be published.
In consequence, it is fundamentally necessary to examine all official information, without petitioners having to demand access to it by applying to the authorities. This increases the amount of effort involved in conducting examinations of official information.
The public information register makes it possible for the public to engage actively with official materials. For it first becomes worthwhile to research information once the type and scale of the available information are known.

Several preconditions have to be fulfilled before transparency can be exploited in an effective manner: the knowledge that information exists, access to that information, and the capacity to analyse the information and put it in its scientific or political context. Access will be allowed by the information platform while, with the regional conferences, new institutions will be created that are to be capable of responsibly developing people's capacity for analysis and contextualisation.

The Commission therefore recommends that the experience gained with the Hamburg Transparency Act be drawn on to help compile a public information register of the documents held by BGE and the BfE.

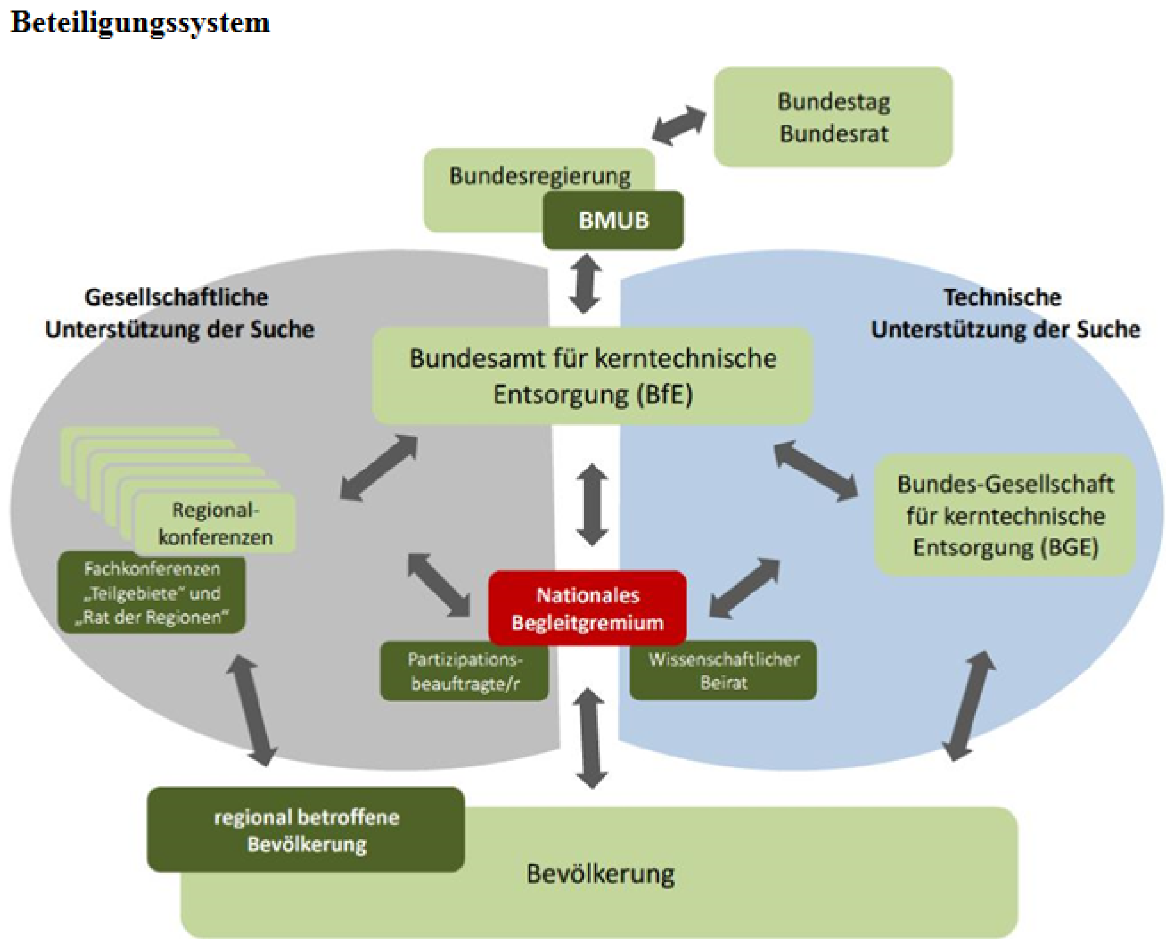
Apart from the protection of personal data, there are further exceptions from the duty to provide information under the Hamburg transparency legislation. These include 'the Senate's direct participation in decision-making, drafts, preparatory notes and memoranda.' Not only that, all drafts of decisions, as well as studies and resolutions concerning their immediate preparation are exempted from publication in so far and as long as the premature disclosure of the information would frustrate the successful implementation of decisions or forthcoming measures. Statistics, collections of data, geodata, regular results from the gathering of evidence, notifications, expert reports, third party comments, assessments of the comments that are received and reports on such comments are not regarded as contributing to direct decision-making. The Commission recommends that 'direct participation in decision-making' be defined very restrictively in order to allow far-reaching transparency.

The remarks in section B 8.6 and the provisions set out in Section 57b of the Atomic Energy Act are also to be borne in mind for this purpose, in particular paragraph 9 with its definition of 'essential documents'.

7.4 Actors and bodies

The Commission recommends that the regional and supraregional public actors and bodies described below be equipped with strong resources and rights, and the public thus placed in a position to oversee the site selection procedure critically and constructively. Graphic 19 outlines the participation system, which is explained in detail in the following sections:

Graphic 19: Structure of community participation



Beteiligungssystem = Participation system
Bundestag = Bundestag
Bundesrat = Bundesrat
Bundesregierung = German Federal Government
Gesellschaftliche Unterstützung der Suche = Societal support for the search
Technische Unterstützung der Suche = Technical support for the search
Bundesamt für kerntechnische Entsorgung (BfE) = Federal Office for the Regulation of Nuclear Waste Management (BfE)
Regionalkonferenzen = Regional conferences
Bundes-Gesellschaft für kerntechnische Entsorgung (BGE) = Agency for the Disposal of Nuclear Waste (BGE)
Fachkonferenzen „Teilgebiete" und „Rat der Regionen" = Subareas and Council of the Regions Conferences
Nationales Begleitgremium = National Societal Commission
Partizipationsbeauftragte/r = Participation officer
Wissenschaftlicher Beirat = Scientific advisory board
Regional betroffene Bevölkerung = Affected regional population
Bevölkerung = Population
BMUB: Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

7.4.1 National Societal Commission

7.4.1.1. Function of the National Societal Commission

The central functions of the National Societal Commission will be the mediating oversight and monitoring of the site selection procedure. In particular, the implementation of public participation in the procedure will have a special status in this respect.
The search for a site with the best-possible safety will only be successful if a societal consensus can be reached. To this end, the institutions involved in the procedure will have to foster trust and gain people's loyalty. The open-ended, scientifically based search for a site can therefore only be successful if it is accompanied early on by comprehensive societal participation. For this purpose, a societal entity that is independent from the authorities, Parliament, and directly involved enterprises and expert institutions, that will stand above the procedure, that will be characterised by its neutrality and expert knowledge, and that will be intended to convey continuity of knowledge and trust will be of particular significance. Such a body is to oversee, explain and monitor the search for a site, and be able to intervene between the actors as a kind of arbitrator.
The Commission's focus will therefore lie not only on the public interest-oriented oversight of the process, but also on building up and maintaining continuity of trust between the actors who contribute to it.
The work of the Federal Office for the Regulation of Nuclear Waste Management will have to be overseen before the site selection procedure begins. Since the BfE will be being built up at this point and will, in particular, be engaged with the public participation that will commence immediately, the National Societal Commission is already to be deployed in this context as a guarantor of participation.
During the site selection procedure, the National Societal Commission is to review the proposals from the BfE and BGE. In addition to this, the Group will also be able to develop proposals on ways in which the site selection procedure should be improved and further developed − in the light of changes in the fundamental science.
The National Societal Commission will also be assigned a relevant role in the implementation of a self-interrogating system.[1045] It will be able to critically observe the safety culture and culture of self-reflection in the participating institutions and throughout the selection procedure, and collaborate on the establishment of a culture that welcomes criticism.
The National Societal Commission will engage in dialogue with the public and all the actors in the site selection procedure, and will intervene in a mediating role when conflicts arise.
The results of its deliberations will be published and communicated to the legislature. As a rule, the Commission will decide by consensus. Dissenting opinions will have to be documented when its recommendations and comments are published.

[1045] Cf., on this issue, section B 6.4.

7.4.1.2 Composition of the National Societal Commission

The National Societal Commission will consist of ordinary citizens and recognised eminent figures in public life.
The citizens to be appointed will have to be in a position to conduct very high-quality analyses of the issues and, furthermore, assess them as unbiasedly as possible. In order to guarantee this, they will be determined using the tried-and-tested principle of the planning cell: A random sample will be taken of all the citizens entitled to vote in elections throughout Germany. This mailing list of invitees will be used to assemble a gender-balanced, age-diverse group. The group will compile well founded knowledge and discuss the societal issues thrown up by the final disposal of radioactive waste in a series of workshops. Subsequently, the participants will publish their recommendations and elect their representatives on the National Societal Commission. This method will ensure that the members of the population who participate are well qualified and do not act as representatives of particular interests.[1046] In order to make it possible for the representatives elected to provide feedback on their work in the Societal Commission again and again, the group should also remain in contact after the workshop series is over. It will not be a formally established body, but an informal network of contacts, which the representatives on the National Societal Commission will be able to fall back on as necessary in order to secure backing for their positions.
The National Societal Commission is to be composed as follows:

- Twelve members are to be recognised eminent figures in public life. They are to be determined jointly by the Bundestag and the Bundesrat.
- Four citizens will be elected using the procedure described above and appointed by the Federal Minister for the Environment, Nature Conservation, Building and Nuclear Safety. Furthermore, the same procedure will be used to nominate two representatives of the younger generation, who will also be appointed.

The members may not belong to a legislative body of the German Federation or one of the German Länder and/or the Federal Government or a Land government. Furthermore, they must not have business interests connected with the selection of the disposal site or the final disposal of radioactive waste in its broadest sense. All the groups of members are to have a balanced gender ratio.
The members of the National Societal Commission will jointly appoint two of their members (female and male) as their spokeswoman and spokesman.
The members of the National Societal Commission will be appointed for three years each and may be reappointed twice.
The National Societal Commission will be characterised by its independence and neutrality. In consequence, no members are to be appointed as representatives of regions. Nonetheless, the National Societal Commission will cultivate continuous, intensive dialogue with the regional bodies and formats.
The appointment of ordinary people will send out a clear signal about the National Societal Commission's special role. From a theory-of-justice perspective, these members, especially, will be able to communicate credibly and plausibly to third parties how fairness is ensured during the site selection

[1046] The progress report from the series of workshops with young adults and participation practitioners in the Annex should also be drawn on for the fine-grained conceptualisation of this method.

procedure. Numerous examples of praxis from Germany and abroad demonstrate that, thanks to the unconditional, high-quality collaboration engaged in by private citizens, the principle of the ‘planning cell’ strengthens representative democracy and has a mediating function in debates with critical stakeholders.[1047]

7.4.1.3 Rights and duties of the National Societal Commission

From the very beginning, the National Societal Commission will oversee the site selection procedure continuously. It will have the duty to present the results of its deliberations in a report on each phase.
Its members will be given the right to consult all files and documents held by the BfE and BGE. Should they consult documents that are not to be disclosed under the Environmental Information Act (UIG), the members are to be bound to secrecy as necessary. The National Societal Commission will be able to demand that representatives from the BfE and BGE attend and contribute to its meetings.
The Societal Commission will have the duty to gather information regularly, comprehensively and consistently about the progress of the deliberations in all the regions. For this purpose, the Group will have the right to appoint ambassadors, who will be able to take part actively in the meetings of the regional bodies. It will be possible for this right to be restricted for non-public meetings.
The National Societal Commission will help to ensure any changes and innovations that are required can be identified. If it comes to the conclusion that parts of the procedure or decisions are to be reassessed, it will be able to recommend appropriate changes to the legislature. On the basis of its recommendations, the legislature will be able to adopt modifications to the procedure that may even return it to earlier stages.
The National Societal Commission will be able to appoint a scientific advisory board and take advice from experts who will reflect on issues, design processes and supply expert scientific opinions.
The National Societal Commission will be the ombuds office for the public and the point of contact for all participants in the site selection procedure, as well as for parties affected by interim storage facility sites. It will appoint a participation officer to perform this function. The participation officer will contribute to the resolution and arbitration of conflicts for the National Societal Commission, and will therefore be responsible for conflict management, as is described in section B 2.4, ‘Principles for handling conflicts during the participative search procedure’.
The National Societal Commission will hold the rights to take up issues on its own authority and make complaints, and will therefore be able to put questions to the BfE and BGE at any time, and demand that they be answered. At the same time, in order to prevent overlaps and delays, it will synchronise the scheduling of its activities with the regional conferences’ procedural processes and the re-examination processes that are carried out.
During each phase, the National Societal Commission will communicate the results of its deliberations to the German Federal Government and the legislature. In addition to this, the National Societal Commission is also to be given the right

[1047] Cf. Kamlage, Warode (2016): ‘Kurzexpertise „Zur Rolle von Laienbürgern in komplexen, dialogorientierten Beteiligungsprozessen“’, K-Drs./AG1-73.

to communicate with the public by issuing reports (analogous to the annual reports published by the Data Protection Commissioner).

7.4.1.4 Resourcing of the National Societal Commission

The National Societal Commission will be supported in the performance of its functions by a secretariat. This is to be established by the Federal Ministry for the Environment and assigned to the Ministry for budgetary purposes. Analogously to the German Advisory Council on the Environment, the staff of the secretariat are to be employed by the German Environment Agency. In its technical work, the secretariat will be subject only to the instructions of the National Societal Commission. Administrative supervision will lie with the German Environment Agency. In its performance of administrative supervision, the German Environment Agency will have to respect the independence of the National Societal Commission. The budget is to be assigned to the Federal Environment Ministry's departmental budget. The Commission is to be able to dispose freely of its budget with the exception of its personnel costs.
The members of the National Societal Commission will have their expenses reimbursed and/or be compensated for loss of earnings under arrangements modelled on those for the German Ethics Council.

7.4.1.5 Scientific support

The National Societal Commission will be able to have recourse to scientific support. E.g., when questions arise in the short term, it will be possible for it to draw on scientific expertise by holding hearings or commissioning expert reports. As far as its longer-term functions are concerned, the National Societal Commission will be able to appoint a scientific advisory board and specify the mandate for its deliberations according to need. These deliberations may, e.g., involve monitoring developments in the natural sciences/technology or the social sciences that are of relevance for the selection procedure, and the comparison to the latest advances in science and technology. The advisory board will also be able to act as a point of contact for the National Societal Commission in relation to all issues that require particular academic competence.
If it is established, the members of the academic advisory council will be appointed by the National Societal Commission. The option of appointing an advisory board and the short-term commissioning of academic advice must be allowed for when its resourcing is planned.

7.4.1.6 Appointment of a participation officer

The participation officer will analyse tensions that arise during the site selection procedure and work to remove possible obstacles to the procedure early on. He or she will be available to the actors in public authorities and the regions as a point of contact, and will advise them on successful participation. He or she will have the job of responding to the concrete concerns expressed by the public, dealing with them in a non-partisan manner and, under a favourable scenario, bringing about jointly supported solutions with the actors. In the spirit of de-escalatory

conflict management, the participation officer will be able to propose mediation and arbitration measures. The participation officer will advise and report to the National Societal Commission. All the actors in the site selection procedure will be able to consult the participation officer as necessary.
The role is only to be held by someone employed full time, will require a formal appearance and is to be performed independently of the substantive work done by the Societal Commission. The National Societal Commission will appoint the participation officer, who will make use of the National Societal Commission's secretariat for his or her work. The participation officer will be accountable to the National Societal Commission, and it will be possible for him or her to be dismissed by the Group.

7.4.1.7 Early establishment of the National Societal Commission

Section 8 of the original version of the Site Selection Act states that the National Societal Commission is only to be established when the search for a disposal site commences. From the point of view of the Commission, however, it will be necessary for the National Societal Commission to be established at an earlier stage, shortly after the conclusion of the Commission's work.
There is a risk of the thread being lost during the period between the delivery of the Commission's draft report and the entry into force of the evaluated Site Selection Act. Various parties have expressed fears that the dialogue with the public begun in the first few steps will break down during this period, the idea of consensus and the trust that has been built up will be lost again, and the Commission's work will not be reflected in an adequate fashion in the subsequent search procedure. There is therefore a need for this gap to be bridged.
Consequently, the Commission has resolved unanimously that the proposal concerning the National Societal Commission's early establishment, which goes back to an initiative of all the five rapporteurs of the parliamentary groups in the Bundestag, should be implemented as rapidly as possible.
Apart from the functions discussed above, such as its oversight and bridge functions, the National Societal Commission is to ensure during the preliminary phase that it will be capable of working effectively from the beginning of the site selection procedure. This will mean, among other things, the formation of networks with the German actors in the search for a disposal site and comparable international bodies, and the preservation of the knowledge gained from the work done by the Commission. Alongside this, it will already be possible for the work of the Federal Office for the Regulation of Nuclear Waste Management to be overseen.
It is envisaged that the National Societal Commission will consist of a smaller number of nine members for the phase between the delivery of the Commission's report and the beginning of the site selection procedure.

- Six members are to be recognised eminent figures in public life. They will be determined jointly by the Bundestag and the Bundesrat.

- Two ordinary citizens will be selected using the procedure described above and appointed by the Federal Minister for the Environment, Nature Conservation, Building and Nuclear Safety. Apart from this, the same procedure will be used to nominate a representative of the younger generation, who will also be appointed.

In the interests of continuity of knowledge and trust, the members who will already have been active during the National Societal Commission's preliminary phase are also to continue to work with it after the Site Selection Act has been evaluated. The Group is therefore to be expanded with the new members provided for in the evaluated Site Selection Act.
The cross-party draft bill[1048] put forward by the Christian Democratic Union/Christian Social Union (CDU/CSU), the Social Democratic Party of Germany (SPD), The Left Party and Alliance 90/The Greens was tabled in Parliament on 9 June 2016. The act should finally be passed by the Bundesrat on 8 July 2016.

7.4.2 Subareas Conference

Once the Commission the Storage of High-Level Radioactive Waste has concluded its work and the search procedure has begun, it will still not be possible for affected regions and their citizens to participate because appropriate regions will not yet have been located. Nonetheless, it will be expedient to offer participation formats during this phase in order to oversee the process by which structures are formed for the participative search procedure, as well as the drafting of BGE's interim report during Phase 1.
The aim is to defuse the paradox of participation (potentially extensive opportunities to have input at the beginning of a process usually meet with little or no real willingness to participate).
To deal with this problem, it would seem obvious to continue using the formats developed and successfully put into practice during the work done by the Commission the Storage of High-Level Radioactive Waste,[1049] and introduce a Subareas Conference.
The Subareas Conference will open up opportunities to shorten the amount of time devoted to merely providing information and initiate well informed deliberations promptly before primarily regional interests become significant.

7.4.2.1 Function of the Subareas Conference

The Subareas Conference will discuss BGE's interim report after Step 2 of Phase 1.[1050] It will look at the application of the exclusion criteria, minimum geological criteria and geoscientific consideration criteria that have led to the identification of subareas by BGE during Phase 1, and will present a report on this process.[1051]
The aim will be the early examination of the selection steps discussed above before the selection of sites is narrowed down to the siting regions that are to be explored from the surface. This will make it possible to open up perspectives on all the potential sites that will promote the building-up of a stock of experience and knowledge, and will therefore subsequently make it easier for the regional

[1048] Draft Act tabled by the parliamentary groups of the Christian Democratic Union/Christian Social Union (CDU/CSU), the Social Democratic Party of German (SPD), The Left Party and Alliance 90/The Greens: Draft Act Amending the Site Selection Act, Bundestag Printed Paper 18/8704.
[1049] Cf. section B 7.7 of the present report, 'Participation in the Commission's work'.
[1050] Cf. section B 8.8 of the present report.
[1051] Cf. section B 7.4.2.3 below, 'Rights and duties of the Subareas Conference'.

conferences and the Council of the Regions to start their work, as well as facilitating the design of the public participation process.
To complement the Subareas Conference, further participation formats may be offered by BfE, in particular during Phase 1, partly in order to develop a culture of participation in the search procedure. Online consultations, and specific formats for young people and expert circles have already been trialled by the Commission the Storage of High-Level Radioactive Materials and also evaluated from this perspective.[1052]

7.4.2.2 Composition of the Subareas Conference

The Subareas Conference is to be convened three times within six months. It will be composed primarily of representatives from the subareas that have been identified in the interim report that is to be discussed.
The participants will be openly invited by the Federal Office for the Regulation of Nuclear Waste Management (BfE). When this is done, the representatives of local authorities, societal organisations and the communities in the subareas are particularly to be targeted. The participation of experts from outside the subareas in question is also desirable in order to permit an in-depth technical discussion. Furthermore, it would be advantageous if individuals were represented who had been involved in the events and participation formats during the preliminary phase.[1053] Attempts are to be made to ensure a balanced gender ratio and spread of ages among the participants and expert advisers.
Participants who accept the invitation should commit to attend all three dates, in order that the results of the deliberations can be adopted in a conclusive opinion. The Conference's events will be public and will be made publicly accessible by means of livestreams and video documentations. Representatives of the media will be able to make use of comprehensive information services and opportunities for interviews.

7.4.2.3 Rights and duties of the Subareas Conference

The participants in the Subareas Conference will have the right to comprehensive explanations of the substantive issues covered in the interim report and the methods used when it was drawn up, which are to be provided by BGE's representatives. In contrast to the regional conferences, the Subareas Conference will not have the right to demand re-examinations. A formal re-examination of the selection of the subareas will only be possible at a later date in connection with the identification of the siting regions to be explored from the surface.
Within four weeks after its final event, the Subareas Conference will communicate the results of its deliberations to BGE and BfE in its function as the organisation that delivers the public participation. On the basis of the proposals from the Subareas Conference, BGE will incorporate the interim report, modified as necessary, into its report on the selection of the sites to be explored from the surface, which will be communicated to BfE.

[1052] Cf. section B 7.7, 'Participation in the Commission's work'.
[1053] See section B 7.5.1.

7.4.2.4 Financing of the Subareas Conference

As the organisation responsible for delivering the public participation, BfE will guarantee the financing of the Subareas Conference.
Ultimately, account is to be taken of the fact that participation may require monetary expenditure on the part of ordinary citizens, which sometimes represents a significant obstacle to their involvement. Financial compensation schemes, at least the payment of travel and accommodation expenses, may therefore increase people's willingness to participate.

7.4.3 Regional conferences

In each region that is proposed during Phase 1 as a siting region to be explored from the surface, a regional conference will oversee the steps of the procedure intensively over the long term. Each regional conference will consist of a plenary and a representative panel.
The Federal Office for the Regulation of Nuclear Waste Management will set up the regional conferences, and provide organisational and financial resources for as long as they continue to be active. The regional conferences are to be placed in a position to organise their work autonomously with a high degree of independence from the BfE.

7.4.3.1 Functions of the regional conferences

The main functions of the regional conferences will be to intensively oversee the whole selection process, and review the main proposals and decisions in order to ascertain whether they are correct and readily understandable. Furthermore, they will have the function of involving all interested citizens with low-threshold formats.
Should it not be possible to remedy deficiencies that have been identified in dialogue with BfE and BGE, it will be the function and right of the regional conferences to formulate re-examination requests.[1054]
The regional conferences will discuss the socio-economic potential analyses of the regions initiated by BGE.[1055] During Phase 3, the regional conferences will collaborate on the drafting of the siting agreement.[1056] Furthermore, it will be incumbent upon the individual conferences to inform the public in their own regions about the progress made towards the selection of the disposal site and continuously consult the public. Collaboration on the information platform will be an important instrument for this purpose,[1057] just as will be the autonomous forms of public participation designed by the regional conferences.
For as long as they are active, the regional conferences will offer participation formats for all citizens who wish to get involved in the process. In accordance with the principle of the 'permanent offer of action', opportunities for involvement will have to be offered to citizens who are motivated to participate

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[1054] See section B 7.4.3.
[1055] Cf. section B 6.5.10.
[1056] Cf. section B 7.2.2.
[1057] See section B 7.3.4.

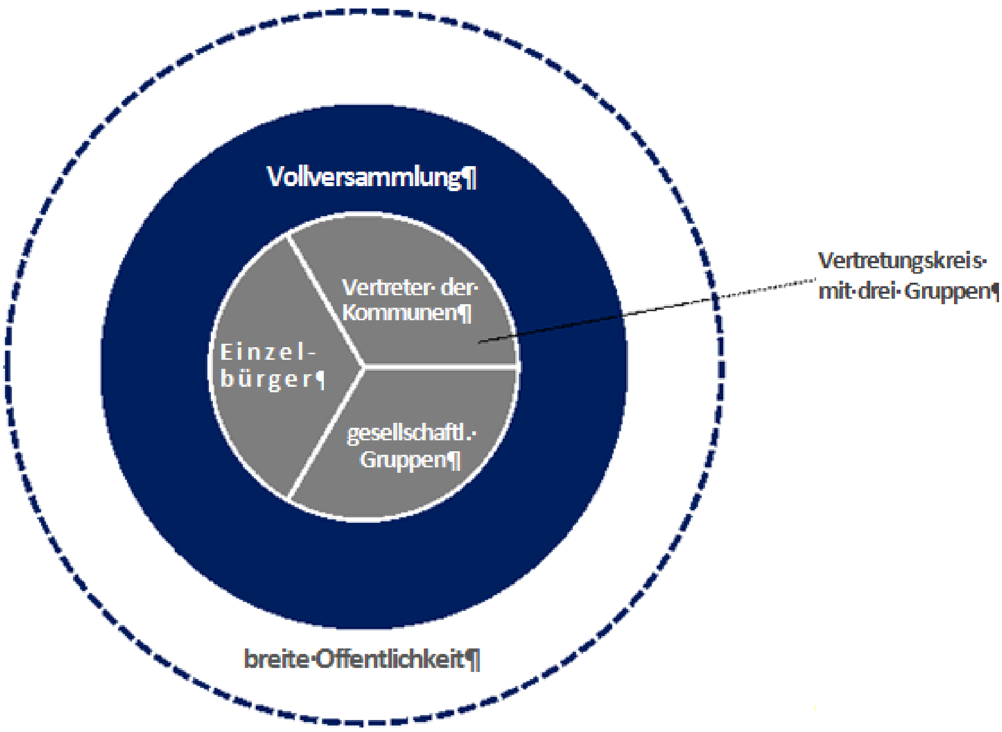
not in every single case, but at least by one or more elements of the whole ‘participation portfolio’ at all points in the procedure.
The regional conferences will delegate representatives to the Council of the Regions Conference in order to compare and coordinate regional and supraregional points of view.[1058]
The regional conferences will be involved in the hearings to be organised by BfE.[1059] In this context, against the background of their intensive preliminary work, they will be able to help ensure that information deficits are rapidly clarified at the events and the discussion focuses on essential topics. The regional conferences will deal with conflicts that arise using the de-escalation procedure discussed in section B 2.4, ‘Principles for handling conflicts during the participative search procedure’.
During each phase of the site selection procedure, the regional conferences will draw up a report in which they document the results of their deliberations and, where necessary, assess the results of any re-examination activities.

[1058] See section B 7.4.4.
[1059] See section B 7.4.5.

7.4.3.2 Composition of the regional conferences

With regard to the composition of the regional conferences, it will be necessary to establish a model that both offers the greatest possible openness to all interested parties and guarantees the continuity of the work that is done.[1060] As illustrated in Graphic 20, the plenary, the representative panel and the wider public will constitute a 'ring model'.

Graphic 20: Ring model for the regional conferences



Vollversammlung = Plenary
Vertreter der Kommunen = Local authority representatives
Einzelbürger = Individual citizens
Gesellschaftl. Gruppen = Societal groups
Vertretungskreis mit drei Gruppen = Representative panel with three groups
Breite Öffentlichkeit = Wider public

Outer ring – the public: The wider public forms the outer ring. The aim is to inform the regional population appropriately about the work done by the regional conferences, and put them in a position to ask questions and make suggestions. The representative panel will organise the wider public's participation in various ways, for instance by collaborating on the information platform[1061] and using the regional conference's own participation formats.

[1060] A suggestion made by the Workshop of the Regions with the aim of resolving the paradox between the involvement of all parties and the actors' capacity to work effectively (cf. 'Sammlung und Auswertung der Ergebnisse der Öffentlichkeitsbeteiligung durch die Kommission', K-Drs. 259, entry RE2472).
[1061] See section B 7.3.4.

Middle ring – plenary: Citizens who are entitled to vote in local elections within a regional authority will be invited to the plenary through general, public media, e.g. the Internet, radio and newspapers. Where necessary, it will also be possible for a notice to be sent to all the households in the region in order to additionally ensure the diversity of the participants in the plenary.
The participants in the plenary will form the middle ring. The plenary will have the following functions:

- It will elect and/or confirm the members of the representative panel, depicted as the inner ring.
- It will be the discussion forum for the members of the representative panel.
- It will be able to submit motions to the representative panel and make proposals to it.

All the key decisions that are reserved for the representative panel will be taken after the plenary has been heard.
The first plenary session will have to be held as an open meeting. As a rule, the subsequent plenary sessions are to be conducted as open meetings. Should it not be possible for the plenary to be convened as a single meeting on account of the regional situation (e.g. the size and/or population of the catchment area, the large number of interested citizens, a location close to the German border with a high proportion of foreign citizens among the parties affected), alternative procedures for democratic participation in the decision-making process (e.g. several sub-meetings) may be chosen.
As soon as the representative panel has been elected, it will take charge of issuing invitations and making organisational arrangements. Until this point in time, the events will have been organised and the participants invited by BfE with the involvement of the National Societal Commission and the participation officer.
To simplify the organisational arrangements, those who wish to participate in the conferences' events may be asked to register in advance.
Inner ring - representative panel: The representative panel will form the inner ring of the model and perform the operative functions of the regional conference. It will prepare events and resolutions for the regional conference's plenary. Each of the following segments will provide one third of the representatives on the panel:

- representatives of local authorities at the municipal and county levels,
- representatives of societal groups, such as business, environmental and other organisations, whose fields of activity are immediately connected with the selection of the disposal site,
- individual citizens.

The number of people on the representative panel should be calculated so that, on the one hand, it is able to represent the three groups mentioned across the whole region but, on the other hand, is not too large to be capable of working effectively. 30 members is the maximum size.
The members of the representative panel will be elected by the plenary. An election procedure is to be applied that will allow three equally large groups to be elected to the representative panel. The BfE will ask the participating county councils and county borough councils for a list of representatives for the 'local authorities' segment. The BfE will collaborate with the local authority

representatives to specify a procedure for the nomination of candidates for the ‘societal groups’ and ‘individual citizens’ segments. Both the representatives of the societal groups and the individual citizens will be elected by the plenary of the regional conference. The BfE will call upon all participants to pay equal attention to women and men when putting forward candidates.
The election procedure will be successfully concluded as soon as all the members of the representative panel have been confirmed together by the plenary.
Young adults are also to be represented in the ‘societal groups’ and ‘individual citizens’ segments. To qualify them, an event format for young adults should be offered continuously by each regional conference, as well as formats for all other groups.
The members of the representative panel will be elected for three years each, and it will be possible for them to be re-elected twice.
Members who are elected to the representative panel will commit to attend its meetings and take part regularly in its work. In return, they will be reimbursed their expenses and paid compensation for loss of earnings (see section B 7.4.3.6 below).
The representative panel will formulate re-examination requests after listening to the arguments put forward in the plenary.

7.4.3.3 Rules of procedure of the regional conferences

The arrangements for cooperation between the public, the plenary and the representative panel will be specified in rules of procedure. The Federal Office for the Regulation of Nuclear Waste Management will supply model rules of procedure to all the regional conferences that, if necessary, will make allowances for the various sizes of the conferences in different regions. The plenary will adopt the rules of procedure, and will not be bound by the model rules of procedure when it does so. The model rules of procedure should foresee decisions of the representative panel to be taken usually by a simple majority vote.

7.4.3.4 Definition of the conferences’ regional boundaries

When the regional conferences are established, the question of the definition of their precise geographical boundaries will be faced.
Section 10 of the Site Selection Act states that participation is to take place ‘in the area around the project’. The Commission assumes that the definition of the boundaries of the regions in question will have to be based equally on geological and socio-economic points of view. The regional conferences are to represent the perspectives of all people who feel they would be affected by the construction and operation of a disposal facility at the possible site. People will be affected outside the area above the rock formation. Nor will state borders constitute barriers to participation.
Where it is found that people beyond Germany’s borders would be affected, it is to be ensured that they are represented appropriately in the relevant regional conference and all other bodies. In this respect, the same criteria as in Germany will be used to establish whether regions on foreign territory would be affected.

Appropriate quotas are to be set in order to ensure adequate representation of the affected parties identified in this way.
In the light of the experience of German participation in the search for a disposal site in Switzerland, we recommend that, if foreign citizens would be affected, a treaty be concluded with the neighbouring states in question that would regulate their involvement.
From a long-term perspective, it is to be taken into account that, although the regional conference will be able to assume a central role in the elaboration of the siting agreement,[1062] only statutorily defined local and regional authorities will be able to become parties to the treaty.
As a pragmatic basic rule, it is recommended that the local authorities whose territory is located above the possible underground facility jointly form a region together with all the directly adjoining local authorities. This basic rule is to be adapted depending on the specific geographical situation.

7.4.3.5 Rights and duties of the regional conferences

The main right of each regional conference will be to formulate a re-examination request if it comes across a deficiency that, in its estimation, is not consonant with the procedural provisions laid down in the Site Selection Act, and it is also unable to remedy this deficiency in cooperation with BfE and BGE.[1063]
The regional conferences will have the right to consult documents as described in section B 7.3.5. They will be able to demand that representatives from the project delivery organisation (BGE) and the Federal Office for the Regulation of Nuclear Waste Management attend and contribute to their meetings.
Each regional conference will have the duty to present reports on the results of its deliberations to the Federal Office for the Regulation of Nuclear Waste Management. The points when each regional conference’s preliminary and final reports should be presented are discussed in greater detail in section B 7.5.

Re-examination
The regional conferences will have the right to demand re-examinations from the Federal Office for the Regulation of Nuclear Waste Management, which are to be dealt with by the Federal Office itself or BGE as the project delivery organisation.
The instrument of re-examination will be used to pursue the aims of raising the quality of the site selection procedure by giving the affected parties strong opportunities to exert influence, resolving conflicts in good time and reducing the risk of the process being discontinued or permanently delayed.
The re-examination request is to relate to a forthcoming decision in the site selection procedure and describe the defects that have been found or alleged as concretely as possible. In its previous deliberations, the conference must have given BfE and/or BGE an opportunity to remedy the error that is reprimanded.
Re-examination may be requested once by each regional conference prior to every decision taken by the Bundestag under the Site Selection Act. The BfE and the regional conferences will agree on an appropriate time limit. Should no

[1062] Cf., on this issue, section B 7.2.2.
[1063] On the definition of ‘re-examination’, see the text box below.

agreement be reached, the National Societal Commission will decide on an appropriate time limit within a month after hearing the parties involved.
The Federal Office for the Regulation of Nuclear Waste Management will deal with the re-examination request and, where necessary, consult BGE. This will potentially involve clarifying information and transparency deficits, giving comprehensible answers to scientific enquiries, gathering data that may be missing and proactively looking into new questions that are thrown up. However, re-examinations are not to clarify circumstances that are first due to be studied during a later phase in the planned course of the procedure. A re-examination will be concluded when BfE presents a revised proposal together with the answers produced by the re-examination process.
The results of the re-examination will be presented to the legislature together with the comments of the bodies that triggered it.

7.4.3.6 Organisation and financing of the regional conferences

The financing of the regional conferences will be guaranteed by the organisation responsible for delivering the public participation. The following key requirements are to be borne in mind when their funding is calculated: A dedicated secretariat to deal with the regional conference’s organisational matters, independent technical support (e.g. in the form of external expert reports), external facilitation, arrangements to compensate for any loss of earnings suffered by the members of the representative panel, provision for the conduct of regional media activities and public participation, and involvement in the information platform.
The regional conferences and BfE may cooperate in a spirit of partnership when it comes to the conception and conduct of the public participation. In this respect, the regional conferences’ representative panels should generally assume a strategic role, while BfE will have an operative role.
The regional conference’s secretariat should perform service functions both internally and externally. Internally, it will support the work of the representative panel and plenary, externally it will support information activities, sometimes making use of community offices as necessary.
A regional conference will suspend its work if the region is provisionally deferred during Phase 2 or 3 of the selection procedure. In the course of the procedure, the number of active regional conferences will therefore decrease. On account of decisions to return to earlier stages when applying the criteria[1064], it will be possible under certain circumstances to shift the focus back onto provisionally deferred regions again. These regions will reactivate their regional conferences and/or build them up again.
In particular, the rights and financing of the regional conferences will have to be regulated in the Site Selection Act.[1065]

Arguments for and against a survey
In its final report, the AkEnd provided for a survey of what is termed ‘willingness to participate’, which would grant the regional population an opportunity to voice its opinion, allowing it to express opposition to the further exploration of its own

[1064] See section B 5.
[1065] Cf. section B 8.8.

region. According to the AkEnd recommendation, a siting region would be deferred in the selection procedure if the majority of its population were not willing to participate.
The Commission has discussed and considered this form of involvement in decision-making at length, but finally argued against it because conflicting aims are being pursued here: On the one hand, there is the aim of conducting a criteria-based and therefore, in principle, reproducible process to select a site with the best-possible safety. On the other hand, there is the aim of granting a region's population the right to decide about the development of its region and prevent burdens from being imposed on its communities.
In the opinion of the Commission, the criteria-based procedure must not run the risk of being politically overruled by a one-off vote. It appears far more important to involve the regional population throughout the process, use criticism to improve the search for a disposal site, and so earn tolerance and trust.
In the course of the deliberations within the Commission, there was also discussion of the possibility of a referendum – which would, however, be held jointly in all the affected regions. In such a referendum, the population would not vote on the role of their own region, but on whether the site selection procedure had been perceived as fair and equitable up until that point. A positive vote would provide backing for, and legitimate, the procedure. A negative vote ought to mean the procedure would be reviewed and improved, but not blocked.
This variant of involvement in decision-making too was finally rejected because so many imponderables were seen with regard to its operative implementation. However, the Commission views the concept of a high-quality written survey, which could be deployed as necessary during all phases of the site selection procedure, as a possible tool for the regional conferences. Such a survey would be founded on empirical methods and used in all eligible regions to throw light on whether, and to what extent, the regional populations were critical of the procedure and felt it needed to be improved, and what approaches to the solution of problems could be deployed to respond to these sentiments.
It goes without saying that this form of participation too would impose exacting requirements on the procedure. Firstly, the conception of the survey, its conduct and the evaluation of the questionnaires would have to be planned carefully and carried out in accordance with social-scientific standards; secondly, participation in such a survey would demand a high level of competence and access to comprehensive information on the part of the respondents.

7.4.4 Council of the Regions Conference

At the Council of the Regions Conference, representatives from the regional conferences will discuss with one another their experiences of the processes that have been taking place in their various home regions and develop a supraregional perspective on the search for a disposal site. This will allow the potential for possible problems, but also areas for optimisation, to be recognised and dealt with more efficiently. The representatives of the regions are to work together on the processes that are taking place and, as the procedure continues, the proposed decisions concerning the identification of the disposal site with the best-possible safety as well. In this respect, the aim will be, in particular, to help accommodate the regions' conflicting and contrary interests.

The Council of the Regions Conference will take up its work following the formation of the regional conferences and will continue to meet through Phases 2 and 3. While the regional conferences will have a regional focus, the significance of the Council of the Regions Conference will lie, in particular, in its 'supraregional character'. The Council of the Regions Conference will allow primarily regional interests to be contextualised and a supraregional understanding to be reached. Apart from the siting regions to be explored, the representatives from the sites of interim storage facilities are also to contribute their perspectives at the Conference because this will make it possible to take note of, and accommodate, different interests. Furthermore, it will increase the transparency and comprehensibility of the site selection procedure.

7.4.4.1 Functions of the Council of the Regions Conference

The results arrived at by BGE and BfE will be verified at the Council of the Regions Conference and the regional conferences' processes compared with one another. The dialogue between the delegates will allow different topics from the regions to be analysed to ascertain their relevance for the various other regions. The Conference will review how comprehensibly the exclusion criteria, minimum requirements and consideration criteria used to identify the sites/siting regions for exploration have been applied. This will be intended to support the acceptance of all the sites, as well as making it easier to build up experience and competences. Issues that represent similar challenges for the regional conferences and on which they have similar perspectives will be discussed at the Council of the Regions Conference in relation to all the potential sites, and on an equal footing with BfE and BGE. This will mean possibly differing interests can be dealt with early on. The interests of the sites of interim storage facilities will also be taken into account and will strengthen yet further the orientation towards the public interest.

In addition to this, the Council of the Regions Conference is to develop an overarching strategy for the promotion of regional development in the siting regions. This strategy is initially to be drafted for all the possible sites during Phase 2 and then formulated in concrete terms specifically for the individual sites at the local level during further procedural steps – with the socio-economic potential analysis being factored in as well.

The collaborative examination of these questions with the necessary distance from possible individual interests is intended to help find and assess appropriate instruments, e.g. general projects to promote intergenerational solidarity and improve infrastructure.

7.4.4.2 Composition of the Council of the Regions Conference

The representative panels of the regional conferences will determine from among their ranks the representatives to be sent to the Council of the Regions Conference in order to be able to guarantee there are transfers of knowledge between the various bodies.

Each regional conference will delegate the same number of representatives. In addition to this, representatives are to be delegated by the municipalities where the sites of existing intermediate storage facilities are located. The number of all

the representatives from the interim storage facility sites is to match the number of delegates who represent one regional conference. To ensure the Council of the Regions Conference remains capable of working effectively, the maximum number of participants is not to exceed approx. 30 persons. The regional conferences and municipalities with interim storage facilities will ensure that their delegates include individuals from the three segments (local authority representatives, societal groups and individual citizens). The delegations are to have balanced gender ratios. It is to be ensured that young adults are represented. The delegates will be elected for three years each.
The Council of the Regions Conference will take up its work following the formation of the regional conferences. The number of meetings held and their frequency will depend on the progress made in the search for a disposal site, but they should take place at least three times a year.

7.4.4.3 Rights and duties of the Council of the Regions Conference

At the Council of the Regions Conference, representatives of BGE and BfE will give comprehensive explanations of the proposals for the sites/siting regions to be explored from the surface, sites to be explored underground and the decision concerning the disposal site. An overview will also be given of the current status of the processes in the regions affected, as well as the next steps that are planned. The representatives of each individual regional conference will ensure their region has a sufficient presence at the Council of the Regions Conference and that the perspectives elaborated at the supraregional level are transported back to their own regional conferences. The Council of the Regions Conference will communicate the results of its deliberations in reports to BfE within the time limits valid for the regional conferences. In contrast to the regional conferences, the Council of the Regions Conference will not have the right to demand re-examinations.

7.4.4.4 Financing of the Council of the Regions Conference

As the organisation responsible for delivering the public participation, BfE will organise and finance the Council of the Regions Conference. The delegates will be reimbursed their travel and accommodation expenses.

7.4.5 Comments procedure and hearings

At the end of each phase, following the discussion of the proposal put forward at that point by the regional bodies, and its potential re-examination and revision, the conclusive proposal will be presented to the general public and public agencies (associations, other authorities, etc.) for discussion. With this step, public participation will be secured with procedural elements that are strongly defined in legal terms (cf. the basic forms of public participation discussed in section B 7.3.1).

7.4.5.1 Functions of the comments procedure

Pursuant to Section 9(3) of the Site Selection Act, the public is to be given the opportunity to comment on the substantive issues that are discussed in section B 7.2.1. These substantive issues will be set out in extensive, technically demanding analyses and proposals, which will demand the devotion of a great deal of time and considerable expertise if they are to be completely comprehended.

The work of the regional bodies and the submission of comments by the general public will therefore require BfE to present the information to be provided appropriately, and publish it on the information platform and in other suitable media in forms that enable different target groups to readily understand it (cf. section B 7.3.4).

As a matter of principle, comments will be submitted publicly online. The authors will therefore be able to share what they have written with other members of the public to provide starting points for an informed public debate. In addition to this, the option of signing other people's comments is to be offered so that concerns can be bundled and the technical answers that are provided can be focussed on particular submissions.

At the request of the authors, comments may also be submitted non-publicly. This may be expedient in exceptional cases if a comment discusses circumstances whose publication is not permitted or desired. The BfE will communicate the comments to BGE as the project delivery organisation. Within BGE, the first step will be to evaluate them quantitatively and qualitatively so that substantive priorities become apparent.

The second step will be to look at each comment and consider it individually. BGE will draw up an evaluation report that summarises all its conclusions. On the basis of this evaluation, the Federal Office for the Regulation of Nuclear Waste Management will publish its own conclusions, which it will plan to take account of in the ensuing procedural steps.

7.4.5.2 Functions of the hearings

The evaluation and the conclusions will form the basis for the subsequent hearing, for which BfE will issue invitations. Should several regions be affected, an event is to be held as a hearing in each region. The subject of the hearing will be BGE's proposal and, where relevant, any (interim) reports from the regional conferences and the Council of the Regions that are available, the results of the re-examination process, the evaluation of comments received during the comments procedure and the participation of public agencies.

Under the current version of the Site Selection Act, it is to be set out with the help of documentation on the meetings, 'whether and on what scale there is acceptance.'[1066] As the Commission understands the matter, acceptance cannot be measured meaningfully in this format. Furthermore, acceptance is not a criterion for the search for a site with the best-possible safety. Rather, the hearing should be used to improve the information base for all parties and explain considered decisions in detail in a readily understandable fashion.

[1066] Cf. Section 10(4) of the Site Selection Act.

7.4.5.3 Composition

Opportunities to comment and attend the hearings will be open to all interested citizens. These events are to be conducted in the area around the project. They must be announced in good time through suitable channels.[1067] In addition to this, representatives of the project delivery organisation, regional bodies, affected local and regional authorities, and public agencies will have to attend.

7.4.5.4 Rights and duties

The public will have the right to the readily understandable presentation of the information on which it is to comment. It will have the right to a plausible evaluation of the comments that have been received and the results to which they lead, which is to be taken into account in the ensuing procedural steps.

1067 Cf. Section 10(2) of the Site Selection Act.

7.4.5.5 Financing

The comments procedure and hearings will be organised, conducted and financed by the Federal Office for the Regulation of Nuclear Waste Management as the organisation responsible for delivering the public participation.

Graphic 21: Integration of the comments procedure, including hearings and the right to request re-examinations, illustrated by the example of Phase 2

<table>
<tr><th>Process step</th><th>Time limit required[1]</th><td rowspan="13">Continuous oversight by the National Societal Commission</td></tr>
<tr><td>Publication of BGE’s report on the proposal for the sites to be explored underground, exploration programmes and examination criteria; examination commenced by the BfE[2]</td><td></td></tr>
<tr><td>The BfE communicates the report to the regional conferences and the National Societal Commission</td><td></td></tr>
<tr><td>The regional conferences examine the proposal</td><td>X</td></tr>
<tr><td>The regional conferences make use of their right to request re-examinations as necessary</td><td>X</td></tr>
<tr><td>The BfE and BGE deal with the re-examination request, if necessary</td><td></td></tr>
<tr><td>The BfE presents the proposal, revised as necessary in accordance with the re-examination, to the regional conferences, the National Societal Commission and the public</td><td></td></tr>
<tr><td>The proposal goes into the comments procedure</td><td rowspan="2">X</td></tr>
<tr><td>The BfE holds a hearing on the objections submitted by the public and presents its evaluation</td></tr>
<tr><td>The regional conferences submit comments on the proposal and the results of the hearing to the BfE</td><td>X</td></tr>
<tr><td>The BfE communicates the proposal to the BMUB (the documents attached to the selection proposal include, in particular, the results of the National Societal Commission’s deliberations and the results of the public participation)</td><td></td></tr>
<tr><td>The German Federal Government informs the Bundestag and Bundesrat</td><td></td></tr>
</table>

BfE: Federal Office for the Regulation of Nuclear Waste Management; BMUB: Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

[1] *The BfE and the regional conferences will agree on an appropriate time limit. Should no agreement be reached, the National Societal Commission will decide on an appropriate time limit within a month after the parties have been heard.*

[2] *The examination by BfE will be conducted in parallel until the regional conferences submit their comments on the proposal.*

7.5 Public participation process

The Commission recommends that the public participation be organised in parallel to the decision-making processes in the site selection procedure, as they are described in detail in section B 6.3.1. All key decisions taken by the authorities and the legislature are to be overseen, reviewed and improved by the public.
Graphic 22 gives an overview of the chronological sequence in which the bodies will be involved during the three phases. It is to be borne in mind that the number of regional conferences will decline continuously (from approx. six to just one) in the course of the intensifying search for a disposal site. Apart from the national level, the supraregional level (Council of the Regions Conference and/or the Subareas Conference during Phase 1), in particular, is therefore important if the diversity of perspectives is to be covered.

Graphic 22: Bodies involved in the various phases of the site selection procedure

	Phase 1		Phase 2		Phase 3	
	Subareas	Proposal for siting regions to be explored from surface	Exploration phase	Proposal for sites to be explored underground	Exploration phase	Site proposal and siting agreement
National	NBG	NBG	NBG	NBG	NBG	NBG
Supra-regional	Subareas Conference	RdR	RdR	RdR	RdR	-
Regional	-	Large number of regional conferences	Large number of regional conferences	Several regional conferences	Several regional conferences	One regional conference

NBG: National Societal Commission; RdR: Council of the Regions Conference

Each phase of the site selection procedure will be concluded by a federal act. The adoption of this legislation will see all the results of the public participation available up until that point in time drawn together, and unresolved differences decided by a consideration process. Once a legislative decision has been taken, the procedure may only be reassessed if fundamental legal objections or scientifically founded reappraisals are brought forward. Each federal act will set the parameters for the subsequent phase. As the basis for decision-making, the German Federal Government and the legislature will receive the following documents during each phase:

- BfE’s report with its proposals for the sites and/or siting regions, including BGE’s report. Where necessary, these proposals are to be revised in the course of the public participation process, e.g. as a result of the work done to deal with re-examination requests.
- The results of the public participation. These will encompass both the results from the fundamental participation formats (cf. section B 7.3.1) and the

results from the regional bodies, including the documents on the re-examinations processes, where relevant.

- The results of the National Societal Commission's deliberations, in which the natural-scientific and social-scientific challenges will be illuminated, fields of conflict analysed and options for the further development of the procedure recommended.

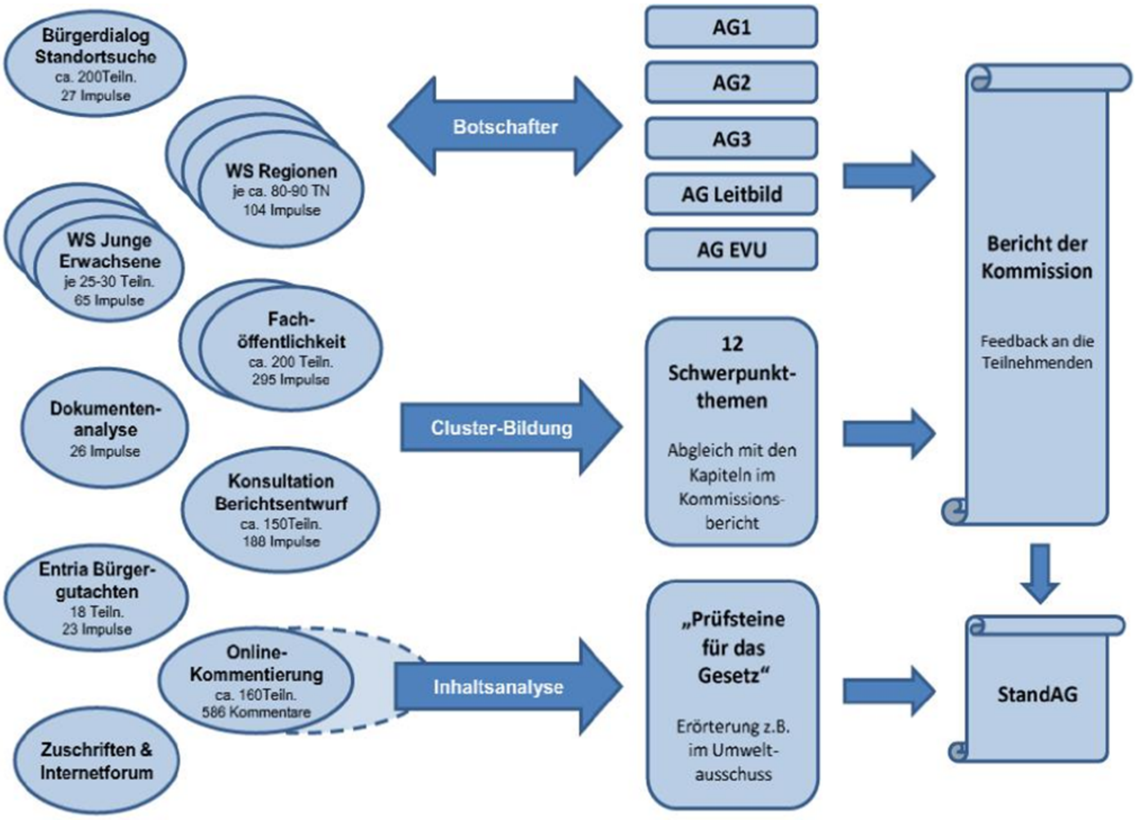
7.5.1 Preliminary phase and start of Phase 1

The Commission recommends that the Federal Office for the Regulation of Nuclear Waste Management begins preparing the public participation early on. Events in the Länder, media work in social and professional media, and the creation of the information platform are the primary activities that will prepare the wider public for the search for a disposal site. This participation work should also be continued during the period up until the identification of the subareas during Phase 1. Apart from BfE, the National Societal Commission should also start overseeing the public discussion, and opinion-formation within the Bundestag and Bundesrat at the earliest possible point in time.

7.5.2 Phase 1: Narrowing down the regions

As the project delivery organisation, BGE will have the task of identifying the regions to be explored from the surface by means of the stepwise application of the previously defined criteria. Information about the site selection procedure must be provided and discussed objectively to ensure that the proposal to be drawn up is received by a public that has previously been educated about the issues and is already willing to participate during this period – without exaggerating the extent to which it will be directly affected. The aim must be to follow on seamlessly from the information work and informal participation during the preliminary phase, and ensure there is transparency about the increasingly concrete discussions that will lead to the definition of the sites to be explored from the surface at the end of Phase 1.

Graphic 23: Simplified public participation process during Phase 1 under Sections 13 to 15 of the Site Selection Act



Teilgebiete = Subareas
BGE erarbeitet Vorschlag = BGE draws up proposal
Fachkonferenz Teilgebiete = Subareas Conference
Standortregionen, Erkundungsprogramm = Siting regions, exploration programme
Regionalkonferenzen erörtern Vorschlag = Regional conferences discuss proposal
Fachkonferenz „Rat der Regionen“ = Council of the Regions Conference
Regionalkonf. erteilen ggf. Nachprüfaufträge = Regional conferences issue re-examination requests, where necessary
Nat. Begleitgremium legt Zwischenbericht vor = National Societal Commission presents interim report
Nachprüfung = Re-examination
BGE überarbeitet Vorschlag = BGE revises proposal
Abwägung = Consideration
BfE holt Stellungnahmen ein, Erörterungstermine = BfE obtains comments, hearings
Alle Gremien* finalisieren Berichte = All bodies* finalise reports
BfE übermittelt alle Ergebnisse an Bundesregierung = BfE communicates all results to Federal Government
Bundesgesetz = Federal act
Bundestag und Bundesrat beschließen übertägig zu erkundenden Standortregionen und Erkundungsprogramm = Bundestag and Bundesrat vote on siting regions to be explored from surface and exploration programme
Nationales Begleitgremium = National Societal Commission

Informationsplattform = Information platform
* The following bodies will finalise their reports at this point in time: regional conferences, Council of the Regions Conference, National Societal Commission

7.5.2.1 Detailed process for Phase 1 of the selection procedure

As the project delivery organisation, BGE will draw up a proposal for the subareas and regions to be explored from the surface (cf. section B 6.3.1.1). It will do this in three steps by applying exclusion criteria, minimum requirements and geoscientific consideration criteria.
After Step 2, BfE will receive an interim report from BGE, in which the subareas will initially be designated. On the basis of this information, BfE will issue invitations to the Subareas Conference, which will discuss the interim report (cf. section B 7.4.2). BGE will possibly make modifications on the basis of the results of these deliberations, but will continue to work on Step 3 uninterrupted once the interim report has been delivered.
Following the conclusion of Step 3, BGE will communicate its proposal for the siting regions to be explored from the surface and the exploration programmes to BfE. On this basis, BfE will establish regional conferences in all the regions that are designated (cf. section B 7.4.3). As soon as the regional conferences have taken up their work, BfE will issue invitations to the Council of the Regions Conference as a vehicle with which to promote collaborative, supraregional work (cf. section B 7.4.4).
Within the constraints of the formal requirements that have been laid down and the time limits that have been set (cf. section B 7.4.3), the regional conferences will be able to issue re-examination requests to BfE, which will either deal with these requests itself or pass them on to BGE.
As a matter of principle, the National Societal Commission will not be bound by formal requirements and time limits, but will have a meaningful anchor point at this point in time, when it will present an interim report that discusses perceived deficiencies in the procedure and additionally enhances the quality of the re-examination process.
The proposal for the siting regions and exploration programmes will be revised by BGE, depending on the progress of the re-examination. BfE will obtain comments from the public and public agencies on the proposal that will now have been put forward, conduct the hearings and, where necessary, make last amendments to the proposal (cf. section B 7.4.5).
In parallel, while these comments are being obtained, all the regional conferences, the Council of the Regions Conference and the National Societal Commission will finalise their reports. When doing so, they will draw on both the results of the re-examinations, and the results of the comments procedure and the hearings. On the one hand, the reports are to assess whether the re-examination requests have been dealt with appropriately and comprehensibly in methodological terms and, on the other hand, describe the points at which there are differences and how these contradictions should be dealt with in the forthcoming procedural steps. The reports should be completed within a short time limit after the conclusion of the hearing.
Subsequently, BfE will communicate all the results to the German Federal Government, i.e., as discussed above, BGE’s ultimate proposal, the results of the

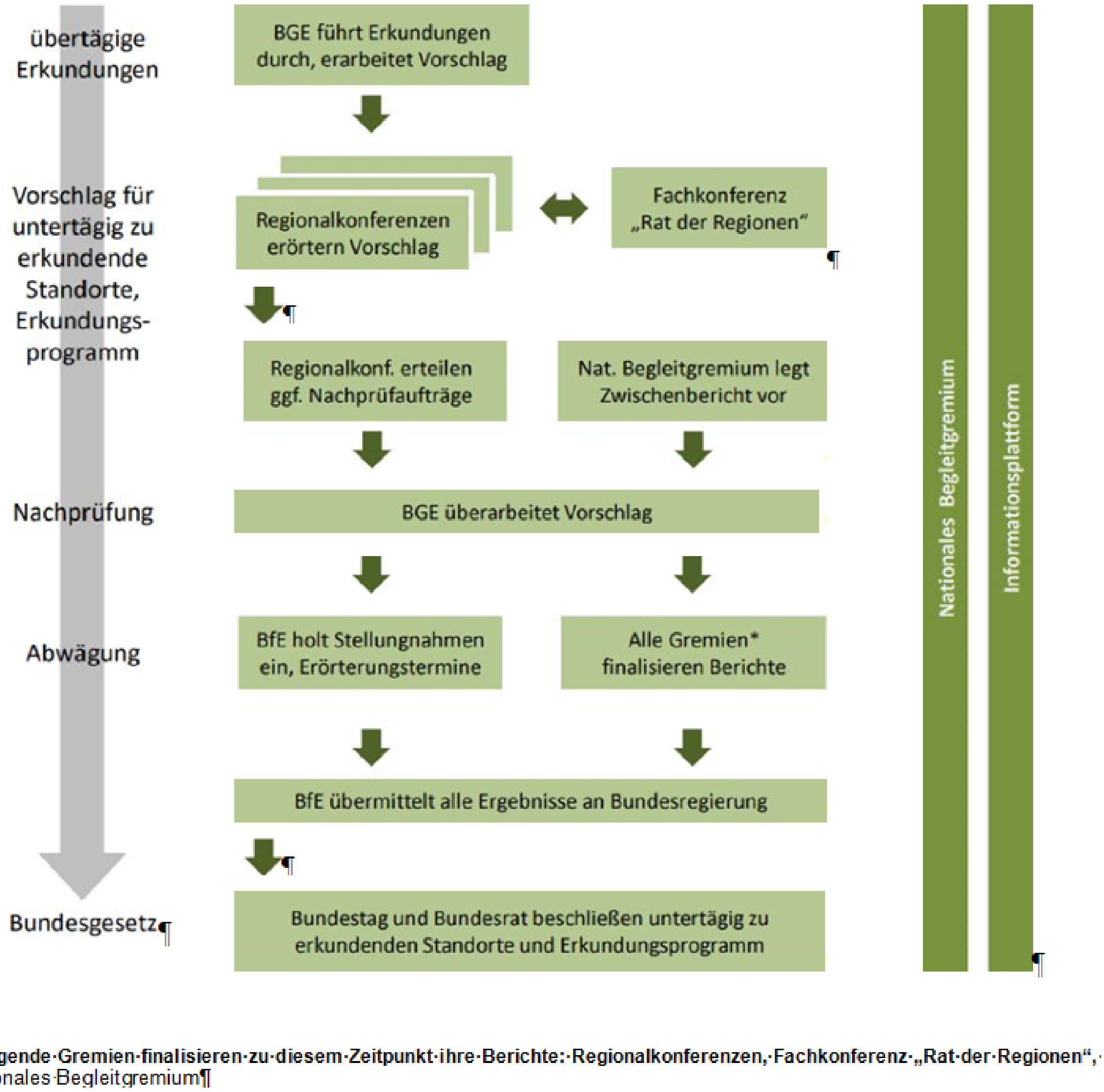
public participation and the results of the National Societal Commission's deliberations. In response, the German Federal Government will initiate the legislative procedure.
Like all the ensuing phases, this whole phase will be overseen continuously by the National Societal Commission and supported by the information platform. All the institutions will collaborate on the content for the information platform.

7.5.3 Phase 2: Surface exploration

During Phase 2, the surface exploration will be conducted in the regions that have been identified. BGE will use the results to draw up a proposal for the sites to be explored underground, as well as the exploration programmes and examination criteria (cf. section B 6.3.1.2). The public participation during this phase will be influenced by the fact that the number of regional conferences will decline noticeably and the extent to which people feel affected will rise to the same extent.
When the surface exploration begins, the project will no longer merely exist on the drawing board, but will become tangible in the real world. This is the moment at which the classic paradox of participation will be reversed: The scope for decision-making will become markedly more limited, while people's perceptions of the extent to which they will be affected will strengthen dramatically.[1068]
It is therefore more important than ever during this phase to broaden the reach of the communication activities. The regional conferences will require sufficient resources to inform the wider public, answer their questions and involve them actively in the participation formats. Simultaneously, BfE should also use its public relations activities to clearly explain its neutral role as a regulatory authority and the organisation responsible for delivering the public participation. As far as its information work is concerned, the project delivery organisation should also be optimally positioned to respond to questions with well founded answers that are comprehensible for all target groups.

[1068] Cf. Walter, Franz (ed.) (2013): Die neue Macht der Bürger: Was motiviert die Protestbewegungen?

Graphic 24: Simplified public participation process during Phase 2 under Sections 16 to 18 of the Site Selection Act



Übertägige Erkundungen = Surface exploration work
BGE führt Erkundungen durch, erarbeitet Vorschlag = BGE conducts exploration work, draws up proposal
Vorschlag für untertägig zu erkundende Standorte, Erkundungsprogramm = Proposal for sites to be explored underground, exploration programme
Regionalkonferenzen erörtern Vorschlag = Regional conferences discuss proposal
Fachkonferenz „Rat der Regionen“ = Council of the Regions Conference
Regionalkonf. erteilen ggf. Nachprüfaufträge = Regional conferences issue re-examination requests, where necessary
Nat. Begleitgremium legt Zwischenbericht vor = National Societal Commission presents interim report
Nachprüfung = Re-examination
BGE überarbeitet Vorschlag = BGE revises proposal
Nationales Begleitgremium = National Societal Commission

Informationsplattform = Information platform
Abwägung = Consideration
BfE holt Stellungnahmen ein, Erörterungstermine = BfE obtains comments, hearings
Alle Gremien* finalisieren Berichte = All bodies* finalise reports
BfE übermittelt alle Ergebnisse an Bundesregierung = BfE communicates all results to Federal Government
Bundesgesetz = Federal act
Bundestag und Bundesrat beschließen untertägig zu erkundenden Standorte und Erkundungsprogramm = Bundestag and Bundesrat vote on sites to be explored underground and exploration programme
BfE: Federal Office for the Regulation of Nuclear Waste Management
* The following bodies will finalise their reports at this point in time: regional conferences, Council of the Regions Conference, National Societal Commission

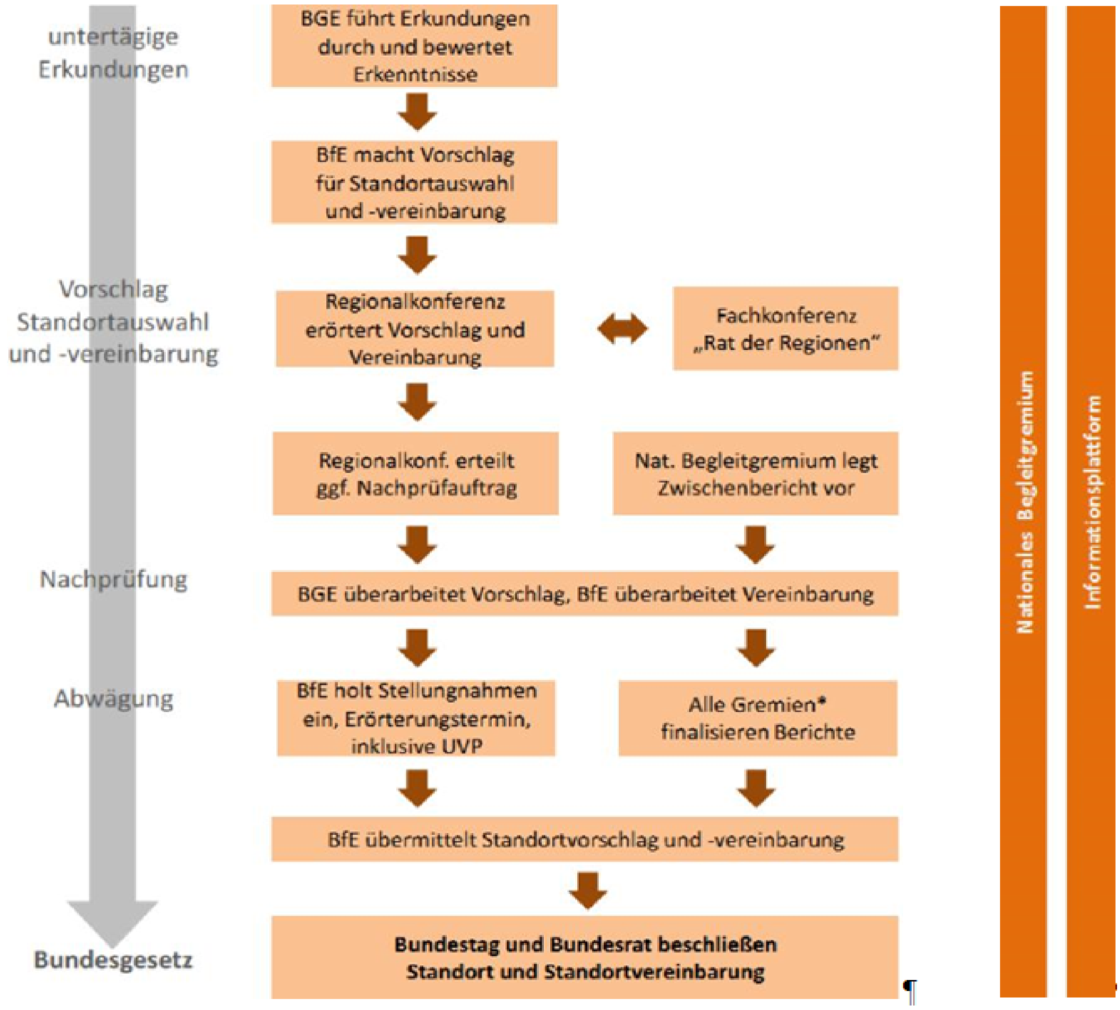
7.5.3.1 Detailed public participation process during Phase 2

At the beginning of Phase 2, the project delivery organisation, BGE, will conduct the surface exploration programmes and draw up a proposal for the regions to be explored underground, as well as the exploration programmes and examination criteria. To accompany this, BGE and the Federal Office for the Regulation of Nuclear Waste Management will inform the public about the progress of the work through the information platform and the regional conferences.
Once its analyses have been concluded, BGE will communicate a proposal to BfE. The regions affected by the proposal will continue their work in the regional conferences and the Council of the Regions Conference. On request, those regions that have been provisionally deferred by the proposal will receive observer status at the Council of the Regions Conference. Should they be included in the shortlist once more in the further course of the procedure, they will resume their regular work again.
The regional conferences will examine the proposal that has been put forward in dialogue with BfE and BGE. Should major questions about the proposal remain open, the regional bodies will be able to issue re-examination requests as during Phase 1. These requests are to be dealt with by BfE and BGE.
The National Societal Commission too will be called upon again at this point in time to present another interim report in order to additionally enhance the quality of the re-examination process.
Once the re-examination requests have been answered and, where necessary, the proposal has been amended, BfE will conduct a comments procedure with hearings again. As during Phase 1, all the bodies will finalise their reports in parallel so that BfE is able to communicate all the results to the German Federal Government shortly after the hearings.
This will be followed by the legislative procedure that will define the sites to be explored underground.

7.5.4 Phase 3: Underground exploration and long-term agreements

The underground exploration activities will be conducted during Phase 3 (cf. section B 6.3.1.3). The public participation during this phase will be influenced by the fact that the remaining siting regions will be able to assume there is a very high probability of the disposal facility being constructed in their region. The focus should therefore increasingly be placed on the management of long-term regional development, among other things by means of the elaboration of a siting agreement (cf. section B 7.2.2).

Graphic 25: Public participation process during Phase 3 under Section 18(3) and (4) and Section 20 of the Site Selection Act



* Folgende Gremien finalisieren zu diesem Zeitpunkt ihre Berichte: Regionalkonferenz, Fachkonferenz „Rat der Regionen", Nationales Begleitgremium

Untertägige Erkundungen = Underground exploration work
BGE führt Erkundungen durch und bewertet Erkenntnisse = BGE conducts exploration work and assesses findings
BfE macht Vorschlag für Standortauswahl und -vereinbarung = BfE makes proposal for site selection and siting agreement
Vorschlag Standortauswahl und -vereinbarung = Proposal for site selection and siting agreement
Regionalkonferenz erörtert Vorschlag und Vereinbarung = Regional conference discusses proposal and agreement

Fachkonferenz „Rat der Regionen“ = Council of the Regions Conference
Regionalkonf. erteilt ggf. Nachprüfantrag = Regional conference issues re-examination request, where necessary
Nat. Begleitgremium legt Zwischenbericht vor = National Societal Commission presents interim report
Nachprüfung = Re-examination
BGE überarbeitet Vorschlag, BfE überarbeitet Vereinbarung = BGE revises proposal, BfE revises agreement
Nationales Begleitgremium = National Societal Commission
Informationsplattform = Information platform

Abwägung = Consideration
BfE holt Stellungnahmen ein, Erörterungstermin, inklusive UVP = BfE obtains comments, hearing, including EIA
Alle Gremien* finalisieren Berichte = All bodies* finalise reports
BfE übermittelt Standortvorschlag und -vereinbarung = BfE communicates site proposal and siting agreement
Bundesgesetz = Federal act
Bundestag und Bundesrat beschließen Standort und Standortvereinbarung = Bundestag and Bundesrat vote on site and siting agreement
BfE: Federal Office for the Regulation of Nuclear Waste Management; EIA: environmental impact assessment
* The following bodies will finalise their reports at this point in time: regional conferences, Council of the Regions Conference, National Societal Commission

7.5.4.1 Detailed public participation process during Phase 3

The fundamental process for Phase 3 will be similar to that of the preceding phases. As the project delivery organisation, BGE will conduct the exploration work that is due and assess the findings.
The BfE will develop a proposal for a site on this basis. The BfE will develop a draft siting agreement for the regions (cf. section B 7.1.2).
The regional conference of the affected region will discuss the results of the underground exploration and, where necessary, develop re-examination requests. In parallel to this, but separately in terms of the matters to discuss, the regional conference will deal with the question of how regional development can be promoted in case the decision is taken to choose a site in the region. On the basis of this discussion, the regional conference will enter into negotiations about the terms and conditions of a possible siting agreement with BfE.
The collaboration on the siting agreement must not have any influence on the scientifically based work of the actual site selection procedure. If an understanding is reached early on about the terms and conditions of a possible agreement, this will have no impact of any kind on the selection of the site or the possible options for legal redress against the selection of that site.
Apart from issues connected with the selection of the site, the National Societal Commission’s interim report should also analyse the ideas put forward about a possible siting agreement during Phase 3.
Once any re-examination that has to be undertaken has been dealt with, BfE will again conduct a comments procedure with a hearing. During this phase, the

hearing will also have the function of the environmental impact assessment (EIA) (cf. Sections 7-9b of the Act on the Assessment of Environmental Impacts).
Once the bodies have completed their reports within the relevant time limit, BfE will finalise the site proposal and communicate it, including all accompanying documents, to the German Federal Government, along with the jointly drawn up draft siting agreement. The legislature will subsequently vote on the site and the siting agreement.

7.5.5 Licensing phase

Following the completion of the site selection procedure, the licensing procedure will begin. This will not be governed by the Site Selection Act, but by the Atomic Energy Act. The public's participation in the procedure and the configuration of the project will continue to be of outstanding significance.

7.5.6 Options to gain legal redress

As explained in section B 7.3.1, the actors in the expanded participation formats will require a large degree of freedom for designing the process, while the fundamental participation formats are to be characterised by high levels of legal security. Consequently, the Commission recommends that, as a matter of principle, no right is to be granted to bring legal action before the courts against procedural acts taken by the authorities and the configuration of the Subareas Conference, the regional conferences, the Council of the Regions Conference or the information platform. However, it should be possible for the courts to review whether the building blocks of the procedure discussed above have been established in accordance with the specifications that were laid down and whether the regional conferences have been able to exercise the right to request re-examinations vested in them.

7.6 Waste capacity

Section B 6.6 describes in detail what physical and geological conditions will have to be fulfilled in order for different types of radioactive waste (high-level, medium-level and low-level) to be disposed of responsibly in close spatial proximity.
The public participation channels discussed in section B 7 are conceived assuming that the volumes of waste to be emplaced will be defined qualitatively and quantitatively from the very beginning. The Commission expressly wishes to draw attention to the fact that the procedure described above will be at risk of failure if its aims are defined imprecisely. The reason for this is, above all, that the representatives of the different regions would rightly question whether their region would have been included in the shortlist if a different volume or area capacity was required – on account of the low and medium-level radioactive waste not foreseen for the Konrad Mine.
One possible way of finding a solution would be to initially conduct Phases 1 and 2 of the site selection procedure exclusively following the criteria for high-level radioactive waste, and only to explore the option of combined storage during Phase 3. More detail will be found in the discussion in section B 6.6.

7.7 Participation in the Commission's work

The Commission has set itself the goal of gathering public feedback during its work and considering said feedback when developing its recommendations. To this end, various segments of the public were invited to attend a variety of events held between June 2015 and May 2016, thus enabling them to participate in the development of the recommendations for action, to voice their opinion on the Commission's work, to criticise its work, and to provide alternatives as well as suggestions for improvement. This therefore means that expert knowledge and assessments from the public were considered and taken into account when preparing this report.

On 20 June 2015, the Commission presented a participation concept containing specific implementation recommendations as to how the public may be involved in the Commission's work and its final report. This concept was continued during the Commission's work, and added to and updated as part of a learning process. Members of the Commission attended the various participation formats in person as ambassadors and to ensure that the central findings of the events were taken up in the Commission's work. Concise results of the public participation formats were documented in the report in the form of quotations and explanations. These results are available in full in the annex to the present report, which includes a participation table showing the results of all the formats provided for by this participation concept and described below. The results were recorded in a uniform manner so that they can be assessed. The annex also includes documentation and reports on findings that were produced after the various participation formats, which included workshops and specialist conferences.

7.7.1 Concept and formats

Working group 1, 'Societal dialogue, public participation and transparency', was tasked with developing proposals enabling public participation both in the search for a disposal site itself and in the Commission's work.

The participation concept[1069] approved by the Commission therefore initially described the objectives of this public participation, the principles of good participation, and the key content and topics surrounding such participation in the Commission's work. These aspects were then translated into specific formats conducted alongside the Commission's work. The results of these formats were then to be incorporated into the Commission's recommendations, i.e. into the present final report. Any changes due to new findings that came about during the Commission's work were added to the concept as part of an ongoing 'learning process'.

The objectives and guidelines of participation in the Commission's work do not differ significantly from those of the actual disposal site search described at the start of this section. On the one hand, there was a need to achieve participation of a higher quality, and to attract as many people as possible who are willing to get involved.

On the other hand, there was the condition to present every aspect of participation in a transparent and understandable manner, while also clearly indicating the

[1069] Cf. Concept for public participation in the Commission's report, K-Drs. 108 (new).

influence participation has on the report. External moderators ensured the requisite neutrality and were obliged to implement the principles of good participation throughout the process.

The content and topics of participation are derived directly from the Site Selection Act which specifically stipulates the mandate to participate in the Commission' work. Working group one has advocated that the recommendations of Section 4 (2) of the Site Selection Act be adopted as the subject of participation in the Commission's work. Again, the overarching question was: 'Who is to participate in which topics, and how?' The target groups to be reached included, among others, the general public, young people and young adults, representatives of the regional public, experts and critical members of the public. It was important to come up with suitable formats at an appropriate time for each of these different segments of the public in order to generate as much interest as possible and to achieve good results for use in the present report.

Table 42: Overview of community participation in the Commission's work

Participation format	Event	Status
Community Dialogue on the Search for a Disposal Site	Plenary session with working groups	Conducted
Information campaign	Information provided to the general public regarding core content of the draft	Postponed
Workshops with the regions	Three one-day workshops	Conducted
Workspace and specialist conference with experts	Online workspace and specialist conference	Conducted
Young adults and participation practitioners	Three two-day workshops	Conducted
Offers to meet with critical groups	Document analysis	Conducted
Letters and online offerings	Online commenting on the draft	Conducted
Draft Commission report	World Café with networked documentation and plenary sessions	Conducted

Alongside the primary events listed in Table 42, several other items such as the ENTRIA citizens' report did not form part of the Commission's concept, but they were indeed stated in the Commission's recommendations and should be taken into account. In the end, the Commission also agreed to several optional events that should also be carried out if the need arises.

Each of the conducted formats was attended by at least two members of the Commission who were present as ambassadors. They were tasked with reporting the main findings of the participation formats to the respective working group within the Commission, but also with conveying the current state of discussion

within the Commission or working group to the respective target audience. Every format was structured, moderated and carried out by external service providers, while independent institutes evaluated the findings by applying social science standards.[1070].At the end of this process, many of the recommendations from the individual formats were applied in the present report, while the collected results were documented in the participation table included in the annex to this report. At some events the neutral moderators prepared additional documentation and minutes of the meetings in order to record the key messages.
Below is a brief description of the individual formats and their course of events. It is only possible to provide a brief description and analysis here, but a more detailed description of each format is provided both in the participation concept and in the evaluation report.

7.7.1.1 Community Dialogue on the Search for a Disposal Site

The Community Dialogue on the Search for a Disposal Site[1040] took place on 20 June 2015, with the participation concept forming the main item on the agenda. Around 200 participants discussed key topics surrounding the search for a disposal site in the form of focus groups and plenary sessions based on the World Café method. The Community Dialogue was a mixture of an information event and a participation event.[1041] The discussions held at the event included important questions regarding the search for a disposal site as well as the participation concept itself. This provided the framework for the Commission's further work. Unfortunately, despite efforts made in advance, it was not possible to get in touch with critical groups and motivate them into attending the event. This means that it was not possible to address the 'general public' as planned. This meant that at a very early stage, participation was limited to a small proportion of the population that either had knowledge of the subject or had taken a long-standing interest in the topic. Nevertheless, a lot of important topics were addressed and a pleasant atmosphere of discussion was established throughout the course of the event.
The findings of this event are provided in the participation table in the annex to the present report and marked with the abbreviation BD, while the scientific evaluation of this format is provided in the final report on the evaluation of the participation formats (K-Drs. / AG 1-67).

7.7.1.2 Information campaign

The information campaign[1071] was added to the concept at the request of the participants of the Community Dialogue on the Search for a Disposal Site, but subsequently postponed until the end of the Commission's work.
An information campaign was to be added to the participation concept with the aim of comprehensively informing the general public about the Commission's work and providing the public with an opportunity for comment. Despite the storage of radioactive waste generally being a well-known and controversial topic, only members of the public who are directly affected by the storage will be

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[1070] All of these results are available in the participation procedure evaluation report by the Commission on the Storage of High-Level Radioactive Waste, K-Drs. 230, K-Drs. 230, p. 11.
[1071]Cf. Concept for public participation in the Commission's report, K-Drs. 108 (new), p. 31 ff.

likely to participate. A national information campaign should generate awareness while, above all, providing an opportunity to comment on the core content of the draft report. Unfortunately, the Commission was delayed somewhat in preparing its report, meaning that some of the key content could only be discussed much later than originally planned.

7.7.1.3 Workshops with regional representatives

A total of three workshops were held with regional representatives[1072] between October 2015 and January 2016. Representatives of regional administrations and interested citizens travelled from all over Germany to attend and, above all, to discuss regional topics. The main topics of discussion involved regional public participation during the disposal site search as well as the theoretical planning criteria and potential consequences of a disposal facility for the given region. Here, all of the regions that were or could be affected by the construction of a disposal facility were given the opportunity to send representatives to a series of events.[1073] All of the counties in Germany were invited to send representatives. Around 40-60 people were expected to participate, but this figure was easily exceeded as around 80-90 people attended all three workshops.
Unfortunately, it was not possible to achieve a healthy balance between representatives from politics, administration and citizen groups/initiatives as the former were clearly in the minority. Nevertheless, all three events saw fruitful discussions, and the aim of putting together specific recommendations as to how the regional and national population could be included in the search for a disposal site was also reached. All three workshops involved working groups and plenary sessions in which specific recommendations for action were put together and then implemented in both the working groups and the final report. Some of the regional bodies described in section B 7.3 were invoked during the series of workshops and adopted by the Commission, albeit in a somewhat modified and enhanced form.
The results of these workshops have been summarised in a document and are also provided as a table with the abbreviation RE 1-3 in the annex to this report. All three workshops were also evaluated and included in the participation procedure evaluation report.

7.7.1.4 Workspace and specialist conference with experts

The two-day conference[1074] and accompanying online commenting by experts looked into the exclusion criteria, minimum requirements and consideration criteria for the site selection procedure that were put together with experts from the fields of final storage, geosciences, mining and planning sciences. An online consultation was held before and after the conference to provide the opportunity to comment on the draft. This consultation focused on scientific documents already made available as Commission printed papers.[1075]

[1072] Cf. Concept for public participation in the Commission's report, K-Drs. 108 (new), p. 34 f.
[1073] Cf. Concept for public participation in the Commission's report, K-Drs. 108 (new), p. 23.
[1074] Cf. Cf. Concept for public participation in the Commission's report, K-Drs. 108 (new), p. 36 f.
[1075] Including, among others, K-Drs. 157 and K-Drs. / AG 3-69A.

The aim of the conference was to enable a result-oriented discussion at an expert level in order to directly influence the work carried out by working group three, 'societal and techno-scientific decision-making criteria and criteria for correcting errors', before their draft report was submitted for use in the Commission's draft report. During the two-day conference, around 200 participants were split up into working groups who were supported and guided by both experts and neutral moderators. The working groups then reconvened to present and discuss their findings in a plenary session. Almost 200 comments were submitted during the online commenting session. These comments and the central results of the conference were recorded in the participation table with the abbreviation FOE. The responsible service provider also produced a document containing results.

7.7.1.5 Series of workshops with young adults and participation practitioners

A series of workshops[1076] was held which primarily considered the question of how to go about ensuring good public participation in the search for a disposal site. The participants – young adults aged between 18 and 27 – looked at future generations' expectations of a fair and transparent process. The workshops were supported by seasoned participation practitioners who worked with the young people to discuss and devise proposals. A total of three workshops, each attended by 25-30 young people, were held between October 2015 and March 2016, and involved progressive discussions on various questions pertaining to successful public participation. The workshops alternated between barcamps/working groups and plenary sessions/expert input. Innovative methods were also used at each workshop to convey the content in a way that was appropriate to the target audience and with the aim of fostering networking among the participants. While the first workshop provided an overview of the Commission's work and the key aspects of public participation, the second workshop was designed to allow the participants to put together specific recommendations for action. The third workshop was in fact optional, but the participants specifically requested that it take place. During this third workshop, the participants voiced their criticism of the draft submitted at that time by working group one. The participants were concerned that the draft did not sufficiently cover the central topics of the young people's workshop. A letter to the chairperson of working group one expressed their desire to present their concerns to the working group members in person. On 1 April 2016, this request was granted as representatives of young adults and participation practitioners were invited to attend one of the working group meetings where they presented their core demands to the members and subsequently discussed the issues at hand.

One of the innovations implemented at this series of workshops was the appointment of two young people's ambassadors whose job was to convey the central results of the individual workshops to working group one and, inversely, to report back to the workshop participants regarding the outcome of the discussions and the current state of the working group's work.

As the participants consisted of both young adults and participation practitioners, it was important to pay particular attention to the needs of the young adults. Contrary to original plans, they did not form the clear majority, but at no time was there any feeling that their views and opinions were underrepresented. On

1076 Cf. Concept for public participation in the Commission's report, K-Drs. 108 (new), p. 38 f.

the contrary: participant satisfaction levels were above-average for all three workshops.[1077]The results of this series of workshops have been summarised in the documentation and presented as a table of results with the abbreviation JE 1-3 in the annex to the present report. Due to time constraints, only the first two workshops have been evaluated.

7.7.1.6 Offers to meet with critical groups

A central requirement[1078] of the Commission's mandate was to work through the errors made in the past in terms of handling and storing radioactive waste so as to enable a new start regarding the handling high-level radioactive waste and the search for a disposal site. A number of environmental associations and anti-nuclear initiatives were initially very critical of the Commission. Differing points of view came to the fore, particularly following the Bundestag's motion for a resolution of 10 April 2014. While the German League for Nature, Animal and Environment Protection (DNR) and several other environmental associations were open to working with the Commission, many groups from the anti-nuclear movement continued to reject any such cooperation and provided a detailed explanation as to why that was the case.[1079] Despite this rejection, the Commission pledged to take account of the views of this section of the population by analysing the documents and statements provided by the so-called 'critical groups' within the anti-nuclear movement. This term is used to describe groups of the population who have proven highly critical in the past, both when it comes to the use of nuclear energy in general and in terms of the procedure to search for a disposal site. During the analysis, the websites of citizens' initiatives, NGOs and other civil-society groups were browsed for statements referring to the Commission's work, and blog posts[1080] were reviewed. These groups adopted a generally critical stance in terms of the credibility of a new start, and they also voiced concerns that time pressure and the appointed members of the Commission would prevent past problems from being solved. The results of the document analysis are set out in the table of results with the abbreviation DOK.

7.7.2 Scientific evaluation

The institutes *Dialogik gemeinnützige GmbH* and the *European Institute for Public Participation* have both taken on the task of scientifically evaluating the participation process and providing impetus to the ongoing participation procedure. The aim of this in-process evaluation was to identify the strengths and weaknesses of the participation procedure, both theoretically and empirically. It also serves as a basis for providing recommendations on how to design future participation procedures. The empirical analysis is based on qualitative observations derived from criteria, and on quantitative surveys conducted among

1077 Cf. participation procedure evaluation report by the Commission on the Storage of High-Level Radioactive Waste, K-Drs. 230, pp. 33–44.
1078 Cf. Concept for public participation in the Commission's report, K-Drs. 108 (new), p. 40 ff
1079 Cf. the documentation statements provided in K-Drs. 46 and K-Drs. 88a.
1080 Cf. Participation procedure evaluation report by the Commission on the Storage of High-Level Radioactive Waste,
K-Drs. 230, p. 7.

participants at selected events. The following events were included in the evaluation:

- Community Dialogue event held on 20 June 2015 in Berlin
- Workshop organised by the Commission on the Storage of High-Level Radioactive Waste with representatives of the regions in preparation of the site selection - part I held on 12 October 2015
- Workshop organised by the Commission on the Storage of High-Level Radioactive Waste with representatives of the regions in preparation of the site selection - part II held on 20 November 2015[1081]
- Workshop organised by the Commission on the Storage of High-Level Radioactive Waste with representatives of the regions in preparation of the site selection - part III held on 15 January 2016
- Workshop organised by the Commission on the Storage of High-Level Radioactive Waste with young adults and participation practitioners - part I held on 10 and 11 October 2015
- Workshop organised by the Commission on the Storage of High-Level Radioactive Waste with young adults and participation practitioners - part II held on 28 and 29 November 2015
- Specialist event organised by the Commission on the Storage of High-Level Radioactive Waste - held on 29 and 30 January 2016

From the commissioned institutes' point of view, what conclusions can be drawn from the seven evaluated events in terms of the participation process initiated by the Commission and conceived as a 'learning process'?[1082]

Every participant considered community participation to be useful, necessary and in line with the problem. Most of the events saw around twice as many registrations as originally planned, and these encouragingly high numbers of participants are proof of the large level of interest shown in the disposal procedure along with the will to find out more about and play a part in shaping the search process. The various event concepts reflected this public need.

Although the feedback from the events was generally very good, the aspect of *fair and balanced selection of participants* was in fact met with a certain degree of criticism. One question was whether it is actually possible to speak of a 'community' participation process if the main audience of the events are experts and representatives of (regional) authorities and administrations. Middle-aged men (40+) were also over-represented. This meant that the event participants were barely representative of the population as a whole.

There are a number of reasons for this insufficient public representation. A lack of financial resources and free time on the part of the participants were compounded by the issue of *active recruiting policy (feedback and transparency in the invitation process)*. There appears to be doubts regarding the extent to which the Commission met its 'obligation to take proactive measures' to arouse the general public's interest in the disposal site search and generate awareness for the problems it heralds. Particular effort should be made to focus PR activities on the younger generation as it is this generation that will be particularly affected by the topic. However, frequent efforts are required to generate interest among this

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[1081] Quantitative surveys were carried out at this event, but there was not qualitative observation.

[1082] The entire methodology, all of the collected data, and an evaluation of the individual events and of the process as a whole are available in the participation procedure evaluation report by the Commission on the Storage of High-Level Radioactive Waste, K-Drs. 230

target audience, as was the case when recruiting participants for the young people's workshop.

Overall, the *process and moderation quality* was relatively high. It is important to generate a pleasant atmosphere at events, even though this may appear trivial at first glance. Participants are only willing to get involved in discussions at events if they feel at ease and can identify with the content. In this respect, all of the events fared well, with high-quality discussions conducted at each of them. However, it is important to allocate enough time for discussions, which is why it is recommended to keep the 'blocks of information' at events as concise as possible in order to allow enough time for discussions. Care must also be taken to ensure that the events are conducted professionally from start to finish. The quality of moderation varied a great deal between the different events. Well-trained, seasoned moderation teams with sound expertise are vital to ensuring successful community participation.

Future participation processes need to invest more time in and focus more on *safeguarding expectations and fostering a feedback culture*. The swift succession of the individual workshops failed to allow enough time to look at the results comprehensively and reflectively, particularly with a view to an in-process feedback culture. One such example involves the recommendations of the Community Dialogue in June, which were only partially implemented as there was not enough time available to initiate the corresponding coordination processes before the start of the next events.

Time also needs to be set aside for internal coordination and administrative processes so that the planned sequence of events and commitments thus achieved can be implemented in a timely manner. The ability to link *to political decision-making processes* for the following steps of the process requires urgent clarification to ensure commitment to the process as a whole. One such example is the expert conference where a concern was raised that the Commission's report may end up going the same way as the report by the Committee on a Selection Procedure for Repository Sites (AkEnd), i.e. that it may 'end up being put in a drawer and forgotten about'. This would lead to immense disappointment and frustration among the participants involved in the process to date as they would consider it a snub to the time and effort they have put in so far. This would be a calamitous signal for the ongoing search procedure, and it is up to the political decision-makers in the Bundestag and Bundesrat in particular to act accordingly.

Despite the recommendation provided in the wake of the Community Dialogue, the Commission has not spent enough time *working through the past*. It was not possible to approach critical groups or generate any deal of willingness for dialogue among them. However, acceptance for the ongoing procedure will largely depend upon the extent to which it is possible to involve the public in areas that are already affected as well as civil-society initiatives and associations. In order to defuse criticism such as 'ex post legitimisation' or 'staged events' in the future, the main interest groups from all corners need to be involved at an early stage, i.e. when planning events.

This leads to a specific overview of the factors that are highly relevant in terms of evaluating subsequent participation procedures to ensure a fair and successful process when searching for a disposal site to store radioactive waste.

In order to represent the population as realistically as possible, more attention should be paid to ensure a *fair and balanced selection* of participants at future participation formats. In this regard, it is vital to ensure that target groups are addressed and recruited appropriately. This in turn requires an active recruiting policy and an increase in PR activities. It is particularly important to focus on the wider public, civil-society groups (especially critical groups from among the anti-nuclear movement) and young people, all of whom have been underrepresented at the events held to date. An increase in female participation would also be welcomed.

In order to motivate more people into getting involved in the procedure, an *information campaign* should be launched as soon as possible throughout Germany with the aim of providing the public at large with comprehensive information. The campaign should also generate awareness for the problem and encourage people to participate. To this end, a lot of different concepts (such as short information films broadcast on TV, integrating the subject in curricula) could be used.

Social media should also be used more in order to reach out to younger generations. Innovative concepts (such as future workshops or open space conferences) can help to foster new and productive perspectives. These are also suited to taking greater account of the viewpoints of future generations than has been the case to date.

Transparency is also important as the Commission's work and website have received a lot of criticism in this regard. It would therefore be useful, alongside the information campaign, to create a central *information platform* that provides all of the relevant information in a well laid-out and easy to understand manner (e.g. in the form of teaching materials for schools).

Another key finding of the evaluation was that a *'learning process' needs enough time to review and process* the results as this is the only way to draw conclusions that can be used in subsequent steps of the process. In the future, care must be taken during planning to include reflection phases between the individual events so as to enable everyone involved to analyse the findings of the respective event.

Irrespective of this, *continuity* of the participation process must be ensured, particularly with a view to the phase after the Commission completes its work, as this is the only way to prevent a 'black hole' from occurring further on down the line, which was a concern voiced on several occasions at events held to date.

The phase after the Commission completes its work should also be used for a genuine *new start* as it has not previously been possible to motivate groups from within the anti-nuclear movement that are critical of the Site Selection Act into participating in the procedure. Measures should be taken to work through the past, alleviate mistrust and establish a constructive communication culture as this is the only way to get all of the relevant people involved, which is vital to ensuring the success of the overall 'disposal site search' process.

In this context, it is also extremely important to avoid *setting a unilateral agenda* in the future. The agenda for the disposal site selection procedure should be planned together by all of the target groups from politics, administration, science, civil society and the economy rather than being stipulated in advance by politics. This also includes refraining from unilaterally stipulating the mandate, objective and formats of the envisaged regional organisations (such as the Council of the Regions Conference and regional conferences). To this end, there needs to be sufficient design scope available to ensure that participation appears worthwhile (in particular to people who have been critical of the process to date).

Nevertheless, *a start has been made* – but successful dialogue needs time and careful planning coupled with respectful communication that gives all of the participants the feeling that their opinions and concerns are being taken seriously and that they are actually able to make a contribution to the disposal site selection procedure. The high number of registrations for the events showed that there are a lot of interested citizens who would like and are able to participate in this challenging process. If this group can be motivated by way of an appealing address strategy and integrated into the next steps of the search procedure by way of a carefully planned approach, it should be possible to build upon the successful start that has been made and pave the way towards high-quality participation in the long term.

Evaluation notes

The Commission did not share some of the key points of the evaluation results because the evaluation had not been completed by February 2016. This means that the results gleaned from individual events and the Commission's work could not be used in the evaluation to their full extent. One such example is where the Commission covered the topic 'working through the past' in detail in its report, e.g. in sections A 2.1 and B 4.1 of the present report. The public participation design contains a definition of the key points for the information policy[1083] and balanced recruiting of participants by way of, among other things, weighted random selection. [1084] The improvement to the feedback culture and the ability to link to political decision-making processes was also addressed by extending public participation and submitting their evaluation to the political process in an orderly manner.[1085]

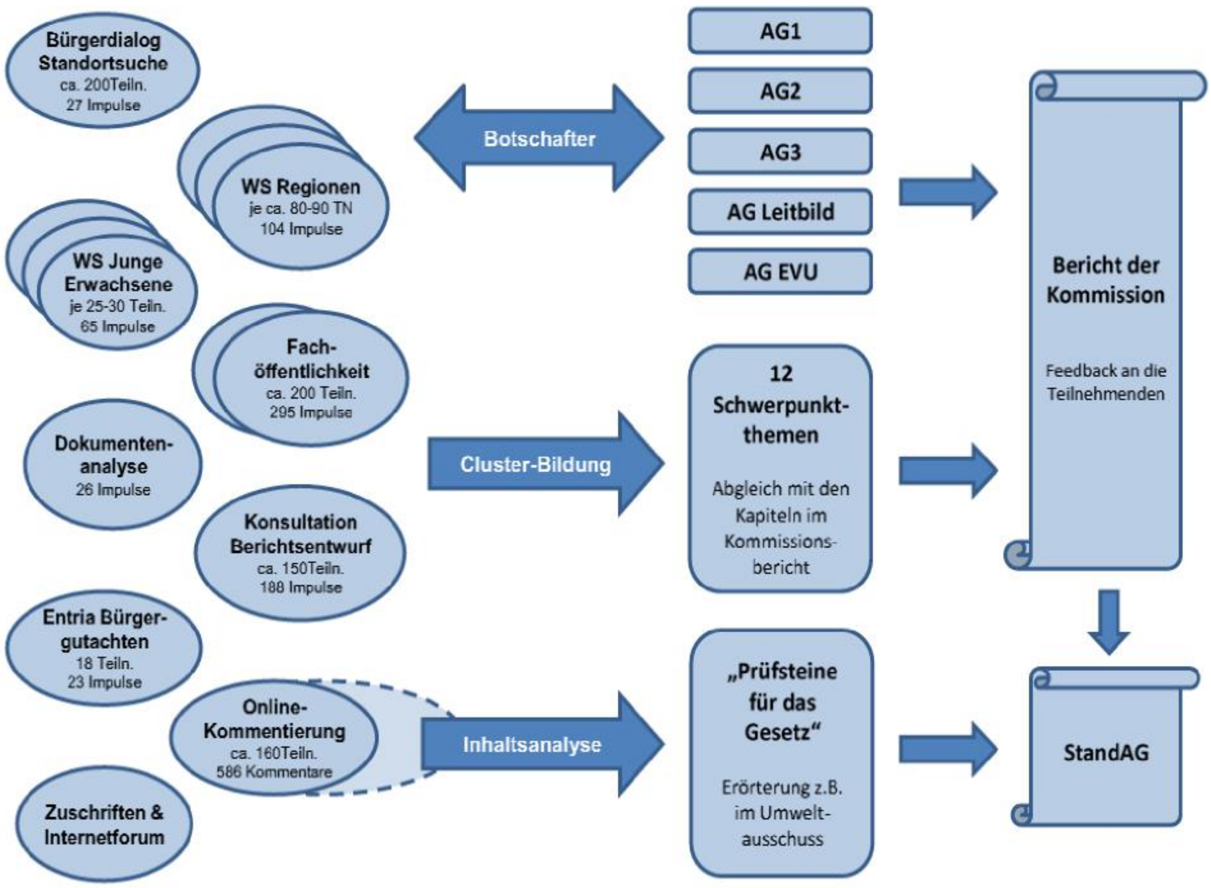
7.8 Main topics of public participation

In keeping with the breadth of topics to be covered, each format led to different results from which recommendations for action were derived along with open questions to be put to the Commission. These open questions were communicated to the working groups for discussion via the respective ambassadors and the accompanying documentation of the results. The main topics covered in detail at the various events were identified by means of clustering and are set out in sections 7.8.1 ff. The full Commission report will be made available for public commenting, and the outcome of that step will be passed on to the political process.

The following graphic provides an overview of the evaluation pathways.

[1083] Cf. sections B 7.3.4 and 7.3.5 of the report.
[1084] Cf. section 7.4.1 of the report.
[1085] Cf. section B 7.7.1 item 7 of the report.

Graphic 26: Evaluation of public participation



Bürgerdialog Standortsuche ca. 200 Teilnehmer 27 Impulse	Community Dialogue on the Search for a Repository Site Approx. 200 participants 27 ideas
WS Regionen je ca. 80-90 TN 104 Impulse	Workshops with the regions Approx. 80-90 participants in each case 104 ideas
WS Junge Erwachsene je ca. 25-30 TN 104 Impulse	Workshops with young adults Approx. 25-30 participants in each case 104 ideas
Fachöffentlichkeit ca. 200 Teiln. 295 Impulse	Experts Approx. 200 participants 295 ideas
Dokumentenanalyse 26 Impulse	Document analysis 26 ideas
Konsultation Berichtsentwurf ca. 150 Teiln. 188 Impulse	Consultation on the draft report Approx. 150 participants 188 ideas
Entria Bürgergutachten 18 Teiln. 23 Impulse	ENTRIA citizens’ report 18 participants 23 ideas
Online-Kommentierung ca. 160 Teiln. 586 Kommentare	Online commenting Approx. 160 participants 586 comments

Zuschriften & Internetforum	Letters and online offerings
Botschafter	Ambassadors
Cluster-Bildung	Clustering
Inhaltsanalyse	Content analysis
AG1	Working group 1
AG2	Working group 2
AG3	Working group 3
AG Leitbild	Working group vision
AG EVU	Working group energy companies
12 Schwerpunktthemen Abgleich mit den Kapiteln im Kommissionsbericht	12 main topics Alignment with sections of the Commission's report
„Prüfsteine für das Gesetz" Erörterung z.B. im Umweltausschuss	"Touchstones for the law" Discussion, e.g. in the environmental committee
Bericht der Kommission Feedback an die Teilnehmenden	Commission report Feedback sent to participants
StandAG	Site Selection Act

7.8.1 On handling the evaluation results

The Commission's goal was to document all of the results from the various participation formats in a comprehensive and uniform manner so as to arrive at a detailed overview of the formats. To this end, a table of results was produced in which the moderators noted all of the demands, messages, questions and comments from the formats as neutrally as possible. This table forms part of the participation report provided in the annex to the Commission's report and contains the main statements along with their respective level of agreement and acceptance. Each statement also has its own ID to which reference may be made in the text, as well as a reference to the passage(s) in the text where the topic was covered.

This allows participants to directly see where the report covers a certain outcome of the format. The overarching ability to evaluate this data provides a wealth of data that is also valuable to future decisions. The documentation is likely to already include the answers to many of the questions that may come up in the future. This means that questions can be put to the public – past and present – and answered throughout the entire disposal site selection procedure. This approach means that the participation formats are far more beneficial than the results of their latest evaluation.
A key condition for ensuring the success of the participation process was that the core results of the formats should be used in the participation report and included in the Commission's recommendations, i.e. in the present report. This should also help to indicate the Commission's position on the respective topics and convey the consideration process in a clear and understandable manner.
This step was associated with major challenges for several reasons. Firstly, a vast number of statements were received; secondly, the results were extremely diverse, some of which came from discussions in small groups, while others emerged from voting or were provided as individual statements. Some of the participation formats saw participants taking several weeks to discuss certain topics at great length, while other topics were dealt with within a matter of hours.

Both the format structure and the composition of participants were extremely varied, consisting of experts from various specialist fields, interested laypeople, young adults, representatives of communal local authorities and members of groups that are critical of nuclear energy. In addition, the content covered and the approach used varied considerably between formats. The results of the respective formats were not uniform and developed throughout the course of a format. At times, they were formulated as a consensus, while on other occasions they were noted as individual opinions that faced controversial discussion within the group of participants.
Here, it was important to come up with selection criteria that take account of this variety and quantity while also being able to perform an evaluation in a clear and understandable manner. In the end, the Commission agreed to take both quantitative and qualitative aspects into account. Topics that were repeatedly discussed at several formats were identified and summarised as so-called focus topics based on the documentation of the results of the formats, i.e. the service provider documentation, the table of results, and the evaluation report by scientific institutes. This section also included topics that formed the subject of particular controversy or where a clear consensus or dissent was observed. The individual aspects that make up such a focus topic are substantiated with original quotations from the respective formats and thus show the many interpretations and options of handling the evaluation results. The use of comments and original quotations from the documentation of results also help to boost authenticity. Below is an overview of the individual focus topics, including text passages from the formats, as well as an evaluation by the Commission. When considering the topics, reference is made to the corresponding passages in the Commission's report in which a detailed discussion of the given topics took place.
Due to the aforementioned difficulties in selecting key participation results, the text passages provided below are by no means exhaustive. The following 'References to the conclusions of the Commission' only constitute a brief summary. The actual conclusions are provided, to the extent deemed expedient by the Commission, in the Commission's report containing the results of community participation. However, the Commission's report does not explicitly state the participation format from which a certain situation was taken.

7.8.2 Working through errors made in the past

The Commission considers discussing the past and acknowledging errors to be vital to ensuring the success of the search for a disposal site and is covered in section B 3.7 'Ten principles'.
Suggestions from the formats:
Document analysis: A genuine new start did not occur as past events were not worked through and the conditions for a 'new start' were set unilaterally rather than being developed mutually. This in turn gave rise to the need for a 'new start for the new start' (DOK358). Harsh criticism was exercised due to the fact that the procedure still considers Gorleben a potential option for disposal;
It is also one of the main reasons for rejecting a cooperation with the Commission and for not accepting the Site Selection Act (DOK297). Difficulties in establishing (and fostering) trust and a constructive cooperation can be attributed

to a lack of discussion regarding errors made in the past and the failure to assume responsibility (DOK935).

- *Workshop with the regions*: In order to build trust, the history of nuclear energy needs to be worked through while adopting an open and honest approach to dealing with past difficulties and problems. An open and honest approach to content and people is also a key prerequisite for ensuring that the disposal site selection procedure is a success in the future. The participants set great store on those involved being prepared to make concessions and acknowledge errors (RE3836). One specific proposal was to use existing information centres at interim storage facilities to hold discussions between facility operators, NGOs and critical actors. These regional dialogues can also be used to discuss the past and to work together on the future site selection procedure (RE3718).
- *ENTRIA citizens' report*: All of the facts and decisions taken in the past are to be reviewed. The search for a disposal site must represent a new start (BG1373). Errors from the past must be worked through and critical viewpoints taken seriously (BG1410).
- *Online consultation:* From today's perspective, it is all too easy to condemn the notion of discussing and coming to terms with the past. This approach is therefore unnecessary (2.1.007). There should not be any discussions on nuclear energy as they would make it difficult to arrive at a broad consensus (2.1.007). Critical voices within the anti-nuclear movement should receive recognition and appreciation for their many years of commitment as this is a prerequisite for satisfying the needs of society (2.1.008).

References to the conclusions of the Commission:

- Section B 3.8, principle no. 9: The Commission has considered and assessed earlier experiments and projects relating to the permanent storage of radioactive waste. It has attempted to learn from the conflicts surrounding nuclear energy, disposal facilities or disposal facility projects, and to avoid repeating previous errors. It wishes to express its great respect for the diverse forms of commitment shown over long periods of time by numerous citizens, many scientists, and the environmental and anti-nuclear movements who campaigned for the phasing-out of nuclear power in Germany. It also recognises the hard work done by the employees of nuclear power plants to guarantee the safe operation of the installations and minimise risks. The Commission also wishes to place on record its gratitude for the societal and company-level efforts that are being made to manage the phasing-out of nuclear power in a socially benign manner.
- Section B 2.1 ff.: When talking about the best-possible storage of radioactive waste, the best way to foster renewed trust throughout society is to learn from the errors made in the past. The Commission is aware of this and uses the Site Selection Act as a basis for assuming that a complete new start was required to achieve broad acceptance throughout society in terms of the disposal of radioactive waste. This includes a comprehensive review of the past which traces the origins of nuclear energy and looks at this history in a critical and reflective manner.
- Section B 5.1 ff.: The Commission also takes the term new start to mean that radioactive waste management needs to be revisited and revised from the ground up. To this end, alternative disposal options were reviewed in detail along with options other than emplacement in a deep repository in a deep geological formation, which was the preferred option to date.

7.8.3 Should there be a retrievability option?

In section B 5 of the present report, the Commission provides an overview of conceivable disposal options along with reasons to support its recommendation for the disposal pathway 'deep repository with reversibility/retrievability/recoverability.'

Suggestions from the formats:

- *Community Dialogue on the Search for a Disposal Site:* The group currently agrees that the assignment of disposal pathway 5.2 'disposal in a deep repository, in salt, claystone or crystalline rock' to category C should be reviewed as the group thinks it would make more sense for it to be assigned to category B (BD1144). The Commission should specify the retrievability and recoverability criterion in far greater detail in order to be in a better position to assess safety and error tolerance over time (BD1615).
- *Consultation with experts:* On the topic of 'conflict of interest between retrievability, long-term monitoring and operational safety': After emplacement has been completed, the deep repository should no longer be accessible (see amendment, stage 4, p. 1). If the disposal facility is partially accessible, it will lead to a conflict between recovery and retrieval. Only the shaft should remain accessible (FOE5862). The retrievability option should depend on the selected site. Qualitative objectives are to be provided that can, however, be revised for future generations; example concepts are to be viewed as just that, i.e. as examples; surface structures for retrievability are not to be planned for the operating period, but must be possible and included in the concept (interim storage facility, infrastructure…) (access for recovery). The main disposal facility concept requirement in terms of retrievability involves 'sorting' the containers along with knowledge management: If recovery is required, it is imperative to know about the material to be recovered (FOE6522).
- *ENTRIA citizens' report:* Retrievability minimises the level of mistrust among the population. Monitoring the facility can be seen as a control mechanism, thus promoting acceptance within society (BG873). Retrievability receives the necessary openness to react to changes in levels of scientific knowledge (BG935). Retrievability involves a great deal more effort when building the disposal facility in order to ensure that it can be accessed without risk for hundreds of years. This will lead to significant cost increases (BG1048).
- *Online consultation:* The 'best-possible storage' criterion is called into question just as much as the 'one million years' criterion. Both of these criteria are not scientifically substantiated and therefore come across as being implausible (1.4.001). It can also be assumed that corrosion of the containers in the borehole fluid will lead to the containers and encasing forming a single unit within the space of a few years, and that mechanical force will be required to separate them again (5.4.3.5.082).

References to the conclusions of the Commission:

- *Section B 5.2:* Retrievability of waste was a recurring subject during the discussion on the various disposal options available. A potential conflict of interest between

- a disposal facility offering a state of long-term safety without the option to retrieve the waste and

- a disposal facility offering a state of long-term safety where the measures needed for simplified retrieval (to correct errors) could impede long-term safety proved to be particularly controversial.

- *Section B 5.3.5.* Following intense discussions on the subject, the Commission decided to provide for retrievability of waste when stored in deep geological formations. In the past, options to correct errors pertaining to the emplaced waste, i.e. recoverability or recoverability, were not included in order to enable swift sealing with the aim of achieving a state of long-term safety. The Commission holds the view that geological disposal without any provisions for retrieval or recovery of the waste to correct errors is no longer in keeping with current requirements and the need to be able to perform monitoring. For this reason, the Commission recommends no longer pursuing considerations relating to disposal that do not include such error correction options.
- *Section B 5.5.2.* In terms of reversibility of decisions, the retrieval and recovery option should be provided for, but only with a view to permanent safe storage of waste and not as an option to use the waste as reusable materials. When providing for the 'option of retrieval', it is a given that all of the necessary provisions are made to prevent impeding long-term safety. Careful consideration is required if any measures to facilitate waste retrieval are provided for which may impede long-term safety (conflict of interest which can only be resolved by taking the individual technical measures into account). The Commission also emphasises that retrieval of waste is not expected to be necessary in every case, but future generations should have this option available to them in the event of unexpected incidents.

7.8.4 Inclusion of interim storage facility sites

How are the municipalities designated for interim storage to be handled? How can these municipalities be included in the site selection process? What legal challenges are associated with this? Sections B 5.7 and B 2.2.5 of the present report cover interim storage.

Suggestions from the formats:

- *Workshop with the regions:* The working group issued the Commission with a recommendation to rethink the interim storage concept based on expectations that the disposal facility search procedure is likely to take a long time. One objective could be to reduce the number of interim storage facilities (RE22776). The recommendation to discuss the safety requirements at interim storage facilities was again approved, and discussions could take place in emulation of the disposal site selection procedure (RE22960). In addition, community offices like the ones envisaged for disposal sites should be set up at the interim storage facility sites with the aim of providing the community with information (Section 9(3) of the Site Selection Act - StandAG) (RE23294). Municipalities with interim storage facilities and municipalities with nuclear power plants should be given a place as a full member of the National Societal Commission and the Council of the Regions (RE23658). Also: RE22856, RE22610, RE22574, RE3718.

- *Consultation on the disposal facility report:* Question: What role do the Länder play when reorganising and participating in interim storage? Assertion: Bundling
- regulatory tasks within a single national authority makes sense as it is a national duty. It does not make sense to create two authorities (the Federal Office for Radiation Protection (BfS) and the Federal Office for the Regulation of Nuclear Waste Management (BfE)). The duties should also be accorded to a single authority (its name is irrelevant) because it would represent economical use of taxes. Dissenting opinion: The regulatory tasks, particularly those relating to interim storage, should remain with the Länder (KON 17712). Local authorities with existing interim storage facilities need to start being prepared for an extension of the interim storage facilities. The dialogue with municipalities and the Land supervisory authority needs to be conducted now (KON7273). The process pertaining to the disposal site selection procedure means that the interim storage facilities are likely to remain in operation for much longer than has been planned to date (KON 7382). Con: The discussion surrounding interim storage facilities needs to be conducted separately and therefore removed from the Site Selection Act (StandAG) (KON7546). Pro: 'interim storage facility commission'. A commission similar to the Commission on the Storage of High-Level Radioactive Waste should be set up for interim storage facilities. This commission should then manage the process from an early stage and, in particular, involve local authorities with interim storage facilities (KON7480). Also: KON7624, KON7765, KON7874, KON7984, KON8074 and more).
- *Online consultation:* There is a risk that extending the interim storage facility licences would be a purely administrative deed without any public participation. Existing interim storage facilities represent a major safety risk because they do not offer enough protection against terrorist attacks. The gap between expiry of the interim storage facility licences and provision of repositories is of secondary importance as the safety of the interim storage facilities needs to be improved upon in any case. The discussion on repositories and the discussion on interim storage facilities cannot be separated if credibility and acceptance are to be achieved (5.7.002).

References to the conclusions of the Commission:
- *Section B 2.2.5.* Both the Commission and many of the participants are aware of the challenge that the disposal site offering the best-possible safety will not have been determined by the time the first storage licences expire. The conflicts of interest arising from this must be addressed.
- *Sections B 5.7, B 7.4.1 and B 7.4.4:* The site selection and interim storage facility concept are closely linked with one another.The period of time between expiry of the current interim storage facility licences and emplacement of the first containers in the disposal facility may be anything from five years through to several decades. The period of time for which interim storage is required until disposal should be kept to a minimum, yet the primacy of safety in the disposal site selection procedure must not be compromised. Regular reviews regarding feasibility of the current interim storage facility concept are required to counter this conflict of interest. In the interests of fostering societal support during the disposal site selection procedure, the representatives of the interim storage facility municipalities should collaborate in the Council of the Regions Conference and play a part in solving the conflicts of interest. The participation

officer and National Societal Commission are also available as a point of contact for those affected by the interim storage facility sites and can be addressed at any time.

7.8.5 Ability to amend criteria and the procedure itself

How, on the one hand, can it be ensured that the procedure is defined robustly in advance while, on the other hand, ensuring that any need for amendment due to new scientific findings or a shift in values can be accommodated? The Commission considered these questions in section B 6.3 of the present report, 'Overview of the recommended disposal pathway'.

Suggestions from the formats:

- *Workshop with young adults:* Intergenerational justice: The procedure should also be open to amendment by future generations on account of changes in values and circumstances (JE21196). This requires high hurdles (JE21233) and a discussion of the criteria: The criteria must be discussed at length with each involved group before the report is submitted and during the preliminary phase (JE21882). The criteria must be checked in regional conferences at the start of each phase to ensure they are still valid and up to date (JE31145). Amendment of (and the option to amend) the process itself as well as the criteria if better and safer technical innovations are available (JE31233).
- *ENTRIA citizens' report:* The Commission on the Storage of High-Level Radioactive Waste has the right and the duty to return to earlier stages of the procedure if the Commission's consultation processes show that the chosen path is no longer tenable on a social level, or if previously stipulated criteria for the site selection procedure can no longer be met (BG2015).
- *Experts:* The ability to amend criteria must be considered. A decision in favour of a site is the status quo. It is not the site selection procedure criteria themselves which need to be amended, but amendments that require consideration in light of new findings after a decision has been taken (FOE9640). FOE: Planning criteria are snap-shots. How are changes in the future to be dealt with? How can it be made clearer in the selection procedure that more focus is needed in terms of theoretical planning? (FOE9590). Regular reviews of assumptions (information); decisions to return to earlier stages must be justified objectively. Safe disposal facility within an appropriate period of time Top priority: Safe disposal facility (FOE7242).

References to the conclusions of the Commission:

- *Section B 6.3.6.1.* A key challenge when selecting a disposal site is to define the criteria to be stipulated in advance while also being able to adapt flexibly to any changes in the given circumstances. The Commission has discussed this dilemma at great length. Criteria to limit the search to certain areas need to be defined now in order to prevent those affected at a later stage from amending them. At the same time and in the spirit of a future-oriented approach, these criteria must allow for the early detection of unexpected developments and the correction of errors. This is why the Commission is in favour of permanent monitoring of the site selection process, its evaluation and possible optimisation. This includes an evaluation of the institutional situation, reflection of the self-imposed objectives, and inclusion and reflection of the steps and formats planned for in the participation procedure. This, in turn, requires regular ascertainment of the state of knowledge coupled with reviews to ensure that the disposal site selection procedure is still in keeping with the latest advances in science and technology. In light of this, phase one in particular will require access to the applicable geoscientific data.

- *Sections B 7.4.1 and B 7.4.3:* The National Societal Commission assumes a major role in this context. As part of a learning process, the National Societal Commission is required to identify the need for change and innovation. If it concludes that parts of the procedure or decisions need to be reassessed, or that amendments are required, it has the duty to recommend appropriate changes to the legislature. This requires the National Societal Commission to determine the current state of the search in detail and on a regular basis, and, where necessary, to call upon expert assistance during reflection, when designing processes and when preparing scientific reports. Providing reassessment as a tool means that the regional conferences are granted the right to approach the BGE and BfE in the event of any questions or purported defects, and to call upon the BGE and BfE to review the work they have performed. This reassessment option may be exercised once per selection phase. Before a reassessment can be commissioned, consultations must be held to give the BfE and the project delivery organisation the opportunity to remedy the reported error. Re-examination is an optional part of the procedure which should only be invoked as and when required. It is not a replacement for permanent process monitoring;[1086] it is a means of additionally reducing the risk of being forced to discontinue or permanently delay the process by granting the affected regions with major scopes of influence.

- **7.8.6 Setting priorities for the site with the best-possible safety**

Which criteria have priority and why? Which foundations for decision-making are to be used for the search? How are theoretical planning consideration criteria to be handled? The Commission's report covers these questions in section B 6.5 'Decision-making criteria for the selection procedure'.

Suggestions from the formats:

- *Experts:* Proposal: Put in place a national rating matrix for all relevant goods, roughly comparable with the planned Federal Compensation Ordinance for the assessment of interventions in nature and the landscape. To simplify this, create a criteria catalogue to determine from the outset which criteria will not play a part in the subsequent steps of the procedure [...]. What effect will the theoretical planning consideration criteria have on the public? Conclusion: An objective matrix for surface criteria at the given time is required; geological criteria are to be used to identify potentially suitable areas which will then be investigated further in order to arrive at a specific site rating. The methodical approach for the theoretical planning consideration criteria should be similar to that used for the geological consideration criteria (FOE10333). Theoretical planning consideration criteria should provide an opportunity to narrow down the number of geologically suitable areas, while the matrix will limit this selection further -

1086 See section B 6.3.6.1

working group three has not looked into the theoretical planning criteria in enough detail yet - request: do not define too many exclusion criteria [...] (FOE10191). Also: FOE8764, FOE8997, FOE10213, FOE8570, FOE9073, FOE9590 and more.

- *Consultation on the disposal facility report:* Agreement with the core message (setting priorities for the site with the best-possible safety): ... in view of the fact that safety must be discussed and defined in an ongoing process. The term safety needs to be clarified from a technical, cultural and systemic point of view. The conditions required for ongoing discussion of safety aspects are knowledge transfer, qualification of future generations, and cultural awareness of the need for safety. Safety also means facing up to uncertainties (KON18414). We are responsibile for one million years. We are responsible for thousands of generations to follow. Rejection of the core message: We think that the core message does not state that the best-possible site is to be determined using geological and scientific criteria applied by way of a comparative procedure. 2. Part A sounds good, but the term 'best-possible safety' − a prerequisite for determining the best-possible site − has not been defined sufficiently. –> To date, geological criteria (such as a safe overburden) have only been stated in the consideration criteria. The criteria specified are 'diluted'. Assertion: they have been diluted so that Gorleben is not excluded –> this will lead to us only having 'best-possible' sites (KON18630).
- *Workshop with the regions:* A consensus was reached that an extension to and differentiation of the planning criteria are required, in particular with a view to the temporal aspect of the procedure and the various steps in the process. The following aspects should be included during considerations: At what point in the process are planning criteria to be applied, and what level of detail is required (i.e. 'can any layers be shed')? At what stage are individual planning criteria of importance? During construction, operation and/or final storage? Which planning criteria need to be defined in order to ensure public services and safety? Are they also minimum requirements, i.e. criteria of an exclusionary nature, or not? (RE33368, RE33479, RE33550, RE33668).

References to the conclusions of the Commission:

- *Section B 6.2:* The Commission's task is to determine criteria with the aim of finding the disposal site with the best-possible safety. This phrase also establishes that there may be several sites where safe disposal is feasible. For this reason, all that remains is to apply safety aspects in a multistage procedure so as to find the best-possible disposal site from among the list of potential sites. This method, combined with the application of exclusion criteria and minimum requirements, will initially enable a distinction to be made between potential and unsuitable sites. After that, the remaining sites will be compared with one another. This will take place during comparative safety studies and corresponding considerations.
- *Section B 6.5.9.* The Commission has thus specified that long-term safety will have primacy over other considerations. However, during the course of the procedure, theoretical planning criteria will also be used to limit geologically equal subareas and/or siting regions. Due to the primacy of safety, however, the Commission holds the view that theoretical planning criteria must not be weighed up against geoscientific criteria.

7.8.7 Legitimise the procedure by veto or referenda?

Should a referendum be held at one or more stages in the procedure in order to build up a picture of public opinion? Section B 7.2 of the present report investigates this question.

Suggestions from the formats:

- *ENTRIA citizens' report:* The coordinated procedure proposal must be subject to a referendum that provides the opportunity to reject the proposal. The search procedure and the institutions involved in the procedure must be legitimised by way of a referendum. This will help to counter existing mistrust, generate public attention for the procedure, and, eventually, ensure acceptance for the search procedure (BG1642).
- *Workshop with young adults:* Survey among the regional population: How exactly would this work? Who would carry it out? Who would write the questions? Alternative to yes-no questions! Quora? Alternative: National referendum at the outset regarding the process and criteria (JE21033). Dissent regarding the national referendum: A national referendum on the criteria and process – including preceding intensive participation – to be held at the beginning. (JE22183) or the national referendum at the end of the final selection of the disposal site (JE22252).
- *Community Dialogue on the Search for a Disposal Site:* The group did not agree as to whether referenda and a regional right of veto could contribute to the search for the site with the best-possible safety. Right of veto: On the one hand, a right of veto could boost acceptance within society; on the other hand, it poses the risk of impeding progress of the site search procedure. Is a right of veto still required in the event of societal consensus? Referendum: A referendum should be held regarding the disposal site search procedure, not the decision on the site. A referendum poses the challenge of encouraging large segments of the population to vote. Germany does not have a strong culture of direct participation (BD931).
- *Workshop with the regions:* At a very early stage it became clear that all of the participants were against granting municipalities or regions (the definition of regions remained open) a comprehensive right to veto a decision on a site for storing high-level radioactive waste. Outcome: The participants agreed that the decision on a site should always be based on the primacy of safety. A veto must not be allowed to prevent a site from being stipulated (RE11074).
- *Online consultation:* Right of veto as a precondition for a broad societal solution. If there is no right of veto, those affected will not tolerate a disposal facility in their area (2.4.001). A right of veto is not required for good participation. However, the Commission's draft is not convincing. There is no genuine participation involving directly affected citizens; instead, participation extends only to local politicians attending informal events without any purpose or influence (2.4.001).

References to the conclusions of the Commission:

- *Section B 7.2.3.* The Commission looked at the option of a (regional) vote in detail, in particular due to the report by the Committee on a Selection Procedure for Repository Sites (AkEnd), and decided that it would not be a good idea as such a vote would give the region in question the opportunity to reject further exploration and therefore be deferred in the selection procedure. The

Commission believes that the main argument against such a vote is the specified need to apply a scientific, criteria-based and transparent procedure with the aim of finding the site with the best-possible safety. A right of veto conferred upon those directly affected would ignore the interests of the general public and may impede the disposal mandate society at large. A national referendum to legitimise the procedure was also discussed on several occasions, but it was eventually rejected due to the operative imponderables. Instead of this, the regional bodies involved should be granted reassessment rights which would enable them to describe the defects in the work of the BGE and BfE that have been found or alleged in as much detail as possible. This would then allow errors to be identified and rectified at an early stage and in dialogue with the project delivery organisation or the Federal Office without putting the overall procedure at risk. The regional conferences may demand one reassessment per phase, to be processed by a set deadline.

- *Section B 7.4.3.* The Commission believes that including the interests of the regional population in the site decision from the outset is one of the main requirements in ensuring that the disposal site search procedure is a success. Early and permanent inclusion should allow the respective region to provide qualified and solution-oriented criticism, to pursue its own interests, and to prevent burdens. To this end, the Commission recommends using regional conferences as strong regional bodies in order to qualify citizens and foster both tolerance and trust in the process.

7.8.8 Compensation for potential disposal sites

How can people in potential disposal regions be prepared in good time? What potential for development in the individual regions needs to be considered? What incentives need to be offered and what incentives should not be offered (accusations of bribery)? The Commission report covers these questions in sections B 7.2 and, above all, B 7.2.2 'Long-term agreement on the strengthening of regional potential'.

Suggestions from the formats:

- *Workshop with young adults:* The consequences of a disposal facility must be discussed in the regions at an early stage (JE21932). The opportunities and benefits (structural, economic, financial and in terms of ideals) should be presented.
- *Document analysis:* The debate on compensation was criticised because it is always associated with accusations of bribery (money in return for acceptance) (DOK2062).
- *Workshop with the regions:* Regional development programmes foster willingness to participate. Potential measures should be linked to existing regional needs. Build-up of expertise must be determined; SWOT analyses should be performed and compared with regional planning to date (RE1433). The Commission's mandate is to discuss a means of compensation, in whatever form that may take, not just for a disposal site, but also for the interim storage facilities (RE23814).
- *Community Dialogue on the Search for a Disposal Site:* There needs to be settlement measures that compensate for the disadvantages with which the

disposal regions will be presented. However, such compensation must be provided in a fully transparent manner (BD828).

References to the conclusions of the Commission:

- *Section B 7.2.2.* The issue of potential for development in the regions was discussed at length in various formats. The unanimous conclusion was that the consequences for potential disposal sites should be communicated at an early stage and, above all, in a transparent manner. No agreement has been reached thus far as to how such an agreement to safeguard long-term regional potential could be set out in detail, and whether this would be possible without automatically garnering accusations of bribery. The Commission and the Committee on a Selection Procedure for Repository Sites (AkEnd) have already dealt with the issue of compensation at length. The Commission concurs with the statement that any such compensation must be made in the interest of the affected region. In order to counter accusations of bribery in return for acceptance, the Commission calls for a long-term, multigenerational agreement tailored to the needs of the individual region. However, such a solution must not merely be a short-term compensatory payment, and should not simply consist of purely financial incentives. Instead, a strategy must be developed with the affected region in order to safeguard the events surrounding the construction of the disposal facility in the long term, and to include the concerns of the population as well as expertise and forecasts regarding future developments. Here, a number of aspects need to be taken into account, such as expressing appreciation for the assumption of responsibility and comprehensive support of regional development.

7.8.9 National Societal Commission as a guarantee of independence

What requirements does the National Societal Commission need to meet in order to fulfil such a role? The present report investigates this question in section B 7.4 ‘Actors and bodies’ and, in particular, in section B 7.4.1 ‘National Societal Commission’.

Suggestions from the formats:

- *Workshop with the regions:* It is considered imperative for the National Societal Commission to have more than four experts as proposed to date in the report. Disciplines also deemed necessary include chemistry, geophysics, biology, sociology, climate research, future development and, later, operational safety. The experts should be as independent as possible, with any conflicts of interest excluded by disclosing their career history (RE24090, RE23965). Both municipalities with interim storage facilities as well as municipalities with nuclear power plants should be given a place as a full member of the National Societal Commission and the Council of the Regions (RE23658).
- *ENTRIA citizens’ report:* The Commission should represent as broad a spectrum of the population as possible. To this end, particular interests and overrepresentation should be avoided (BG1864). The Commission on the Storage of High-Level Radioactive Waste has the following duties: Final preparation and stipulation of criteria for the disposal site search; collection/management and distribution of all knowledge available in this context along with all findings on a national and international level; where necessary, establishment of expert groups, etc.; communication regarding the disposal site search and intensive community

participation; formulation of a final basis for decision-making to be submitted to the Bundestag and Bundesrat (BG2187).

- *Workshop with young adults:* Adopt a citizen-oriented approach instead of an expert-oriented approach. We consider citizens to be more independent in their evaluations, less driven by interests in the matter at hand, and better suited to representing the population (2nd report for the Commission. Key messages from the three workshops with young adults and participation practitioners, p.5). The National Societal Commission should meet the following criteria: it should consist of citizens and representatives of groups within society; citizens should be selected at random; the societal groups should be appointed by the Bundestag and Bundesrat, who, in turn, will delegate people to the Commission; none of the National Societal Commission members should hold office in the Bundestag, the Bundesrat or a German Land parliament; the Commission should be moderated by external persons; ability to work: along with the speakers, the Commission should not comprise more than 20 members (JE32317).

References to the conclusions of the Commission:

- *Section B 7.4.1.* Both the Commission and attendees of the participation formats hold the view that the National Societal Commission is a central actor in the site selection procedure whose task is to monitor the disposal site selection procedure and oversee it in a mediatory capacity. The National Societal Commission will be the ombuds office for the public as well as the point of contact for all participants in the site selection procedure, and for parties affected by interim storage facility sites. The composition and tasks of this Commission have been discussed in detail. The Commission agrees with the view adopted at the events whereby the National Societal Commission should be as independent as possible and free of any particular interests. To this end, the National Societal Commission should consist of recognised eminent figures in public life and ordinary citizens, the latter of whom will be provided with training using proven methods to ensure they are sufficiently qualified for the tasks involved. The Commission does not consider it expedient to appoint experts from specialist disciplines. Instead, it proposes giving the National Societal Commission the option to receive scientific advice at any time and to convene a scientific advisory council. Should it come across any procedural errors or consider it necessary to make any changes, the National Societal Commission is obliged to present its recommended changes to the legislature for approval. It should also appoint a participation officer to assist in the resolution and arbitration of conflicts.

7.8.10 Earliness and transparency as a prerequisite for subsequent tolerance

The population must be informed and involved at various levels right from the beginning of the site selection procedure. Intermediate steps and controversies must not be treated as taboo topics in order to build trust and foster subsequent acceptance. Section B 7.5 ‘Public participation process’, section B 7.3 ‘Structure of public participation’ and, in particular therein, sections B 7.3.4 and B 7.3.5 discuss this issue.

Suggestions from the formats:

- *Workshop with the regions:* Particularly when it comes to building trust, the working group agreed that it is extremely important to supply transparent information from an early stage and in an ongoing manner. All of the information must be made readily available from the outset and updated constantly. Following establishment of the regional conferences, an overarching platform shall serve as a source of information and provide insights into the work of the respective regional conference. This platform, which requires further specification, shall then serve as a public medium for interested parties and as a means for the individual regional conferences to exchange with one another (RE21126). Phase one of the disposal site selection procedure will of course start with a 'blank map' of Germany, but this this will be swiftly followed by and filled with initial regional situations and impacts. The disposal site procedure must be sufficiently legitimised from the beginning; otherwise any subsequent specifications and decisions regarding a site are highly unlikely to garner acceptance once the participants have been convinced (RE32075). The participants acknowledged the need for early involvement of the regional public beyond the scope of legislation pertaining to public participation. The basic message is that there should not be any gaps in the participation process (RE31915).

- *Community Dialogue on the Search for a Disposal Site:* Currently, the group sees the following existing consensus among society and within the Commission: there is a national responsibility to store nuclear waste in Germany; the public must be involved in the site search from an early stage (e.g. by organising regular events such as the community dialogue); the criteria for selecting a long-term site must be developed on the basis of scientific knowledge; differing opinions during debates must be respected and handled by way of a constructive approach (BD377).
- *Workshop with young adults:* As well as specific participation opportunities, there also needs to be quality criteria which the Commission would like to achieve by way of participation, e.g. early participation, participation target groups, transparency regarding methods and content, information that laypeople can understand, etc. (JE1229). Early participation: specifically attempt to inform and involve a large number of people right from the beginning of the process (anti-participation paradox) (JE22020). The process of (non-)participation starts with submission of the Commission's report. At this time we believe that participation must take place in the form of information (communication platform and information campaign) and by way of consultations regarding the criteria (JE3628). Also: (JE3559, JE3721, JE3852 and JE3923).
- *Online consultation:* Absolute consensus is simply not possible, and this fact should be openly acknowledged. For this reason, transparency has to be the top priority for participation and acceptance (2.4.005). There needs to be a sole participative search procedure with a convincing participation system which, by way of clear structures and roles, ensures participation without overburdening formats. Several options are feasible, but they should not be stipulated at this time. The names of the individual formats are not important; what is important, however, is that participation is organised thoroughly from the beginning (2.4.011).

References to the conclusions of the Commission:

- *Section B 7.3.5.* In almost all of the participation formats, the Commission was called upon to present all of the steps leading to the selection of certain regions or

areas in a transparent manner. The conclusion drawn by the participants was that the loss of trust resulting from the history of nuclear energy in Germany can only be offset if existing information is managed in an open and honest manner, and if measures are put in place to avoid any taboos from arising. The Commission supports this opinion unreservedly, and therefore recommends that the experience gained from the Hamburg Transparency Act be drawn on to help compile a public information register of the documents held by BGE and the BfE. It is not enough to simply provide information. What is in fact required is to supply knowledge about the existence of information, access to that information, and the capacity to analyse the information and present it in its scientific or political context. As also stipulated by the Hamburg Transparency Act, personal data and draft documents whose premature publication would thwart the success of the decisions and forthcoming measures are exempted from publication.
Sections B 7.3.4, B 7.4.1 and B 7.5.1: An additional aspect the participants demanded in this context is public involvement at an early stage. The Commission also shares the view that this should be seamlessly linked to the information work and should commence prior to publication of the first proposal by the BGE, i.e. without any direct regional impact.[1087] In contrast to original plans, the Commission recommends that the BGE publishes the selected subareas at a very early stage. In order to discuss this interim report, the BfE will hold a Subareas Conference, and the results of those deliberations will be subsequently submitted to the BGE. The Subareas Conference represents an extension of the successfully conducted participation formats, and helps to reduce the phase that only involves information. On top of that, it also ensures that the topics involved are dealt with competently at an early stage before regional interests become relevant. This early phase will be constantly monitored by the National Societal Commission and supported by the information platform.

7.8.11 How can the procedure be safeguarded institutionally?

The Commission discussed the supervisory bodies, the establishment of new institutions, and institutional separation. Section B 8.2 of the present report contains a recommendation regarding the structure of the authorities.

Suggestions from the formats:

- *Workshop with the regions:* The supervisory and licencing authorities and construction companies must consist of various independent authorities/institutions, construction companies and operators as a basic requirement for fostering trust and acceptance among the public. The independence of every authority, institution and company involved must be guaranteed (RE31234). However, most of the participants argued that the project delivery organisation has an important part to play as a ‘knowledge bearer’, but it is not suitable in terms of realising participation as it is neither neutral nor independent (RE32257). Most of the participants were in favour of establishing a new institution which should enable early participation as well as critical

[1087] See section B 7.4.1.

dialogue among societal groups regarding the site selection procedure (RE32333).

- *Document analysis:* Create a trust commission, a supervisory committee/ombudsman as well as a fund to finance disposal; in addition, work collectively when designing processes, and appoint a representative for the interests of future generations (DOK 2746).
- *Workshop with young adults:* Appoint a participation officer tasked with performing reviews and provided with his/her own secretariat. The participation officer should act as an ombuds office and hold powers/expertise comparable to those of the Federal Data Protection Commissioner. Conflict management will be an important task to be performed by this person/office (JE32440). It requires coordination of the various information processes as well as the formal and informal participation processes beyond the scope of the BfE (JE21421).
- *Community Dialogue on the Search for a Disposal Site:* It was not possible to agree on where the supervisory function should be established. Aspects covered by the discussion included the following: the operating company should not be established within the same ministry as the licensing authority to ensure that the monitoring function can be performed effectively; the operating company should not be established within the Ministry of Finance as this would lead to a conflict of interests in the German Federation since it is the largest state waste holder (BD2868).
- *Online consultation:* The structure of the authorities put forward in the report appears to be poorly suited to managing the forthcoming tasks. Firstly, the services of the BGR and EWN have not been taken into account; secondly, doubt has been cast regarding the ability of the BfS to perform its duties. The past shows that the BfS has made errors, particularly regarding the Brunsbüttel interim storage facility. There is demand for more independent process monitoring (8.2.10). The principal of separation has not been complied with as BGE in its capacity as project delivery organisation and the BfE in its capacity as regulatory authority are both to be established within the BMUB. One of the two institutions must therefore be established within a different ministry (8.2.021).

References to the conclusions of the Commission:

- *Section B 2.1:* During its deliberations, the Commission was aware that the various conflicts in the past have led to a loss of trust in the search for a disposal site. In order to alleviate this loss of trust, at least in part, the Commission agrees with parts of the proposals from the participation formats which included the establishment of a neutral supervisory body in addition to the official structure.
- *Section B 7.3:* The Commission rejects the proposal to create a foundation-like institution intended to act as a counterpart to the BfE as the organisation responsible for delivering the public participation. Rather, a standard process delivered solely by the BfE will provide for clear structures and responsibilities, while also avoiding conflicts. Only a framework defined in this way will provide all of the design options required to carry out legally mandated and any additional informal participation formats. Such formats, which also include the regional conferences, hold a comprehensive set of rights and scopes of influence, meaning that they are in a position to review the steps performed by the BfE and BGE. In order to safeguard the procedure and lend support in handling conflicts, the Commission also recommends appointing a participation officer position

tasked with analysing and, wherever possible, resolving any tension within the process. Given the fact that it is independent, the National Societal Commission also assumes the role of a neutral supervisory body.

- *Section B 8.2:* The Commission is critical of stipulating the BfE as the regulatory authority and the BfS as the project delivery organisation and operator of disposal projects because there are several potential overlaps. For this reason, it recommends the operator duties be taken away from the BfS and bundled in a new, federally owned enterprise – Bundes-Gesellschaft für Kerntechnische Entsorgung (BGE) – together with the functions performed by the operating companies, DBE and Asse GmbH.

7.8.12 The principle of the 'blank map' of Germany

What can be done to ensure that only independent scientific criteria will be selected? Does Gorleben need to be excluded when starting out with a 'blank map' of Germany due to the erroneous political decisions taken in the past? Sections B 8.4 'Temporary moratorium' and B 4.1.4 'Gorleben exploratory mine' consider these questions.

Suggestions from the formats:

- *Document analysis:* Concerns were raised that criteria will be tailored to Gorleben (the keyword here is 'overburden') (DOK1477)
- *Experts:* Bundle consideration criteria and safety studies (method); handling scientifically unreliable 'nominal' criteria with respect to the AkEnd with the sole aim of excluding the Gorleben site. Is this scientifically tenable in the long term? Depth (FOE3678). 'It is imperative to avoid arousing suspicion that criteria were selected for reasons other than scientific ones' (GRS). In my opinion, there would be no question of the scientific need for an overburden (in particular its function in salt as a host rock) as a minimum criterion to be met (but at least as a consideration criterion with high weighting) if Gorleben – which fails to meet this criterion – were not a potential site in the procedure. This shows that anyone who rejects the application of this criterion does so for reasons other than scientific ones. An overburden almost perfectly meets two of the principles common to nuclear technology that reflect the latest advances in science and technology: the multi-barrier principle and diversity. In my opinion, waiving compliance with these principles constitutes a breach of the requirement to provide 'best-possible protection against hazards and prevention of risks' which the Federal Constitution Court imposed in its judgment on the Kalkar case. Waiving the requirement to implement such a barrier poses a threat to the site's legal compliance and therefore wilfully jeopardises the requisite success in the search for a disposal site (FOE21377). The topics relating to Gorleben are only contested by professed Gorleben opponents within politics and citizens' initiatives, and this lends the event an imbalance that shows there is clearly no intention to hold an open-ended and objective discussion on these special topics. There is a clear political objective that 'Gorleben must die' (cf. article titled '*Gorleben muss sterben*' published in the Frankfurter Allgemeine Zeitung on 21 July 2014). Can a scientifically based discussion about a disposal facility for

radioactive waste and the Gorleben site still be conducted in line with the criteria of scientific integrity? (FOE29271).

- *Consultation on the disposal facility report:* Core message: We recommend the search for a site with the best-possible safety be started again without specifying certain sites in advance and without excluding certain sites. Siting regions or planning areas identified as being potentially suitable must be legally secured against change without delay, which could in turn impede the construction of a disposal facility. This is agreed on because ‘it is imperative to treat all potential sites equally and in terms of a ‘blank map’ of Germany’ (KON15513). We agree because ‘Gorleben and other potential sites must be treated equally. However: What does ‘at an early stage’ mean? What point in time and which phase would be right for securing sites? If sites are to be secured before selecting subareas, this would mean that very large areas need to be placed under a temporary moratorium. This would have a major impact on the regional economy, thus hampering investment in those areas. If sites are not secured until the subareas have been selected, the temporary moratorium in Gorleben will have clearly expired by then. Should Gorleben be secured as a site beforehand, this would lead to the site again breaching the principle of equal treatment. Or the site could possibly be lost without Gorleben being evaluated against the criteria set out in the agreed procedure (KON16285).
- *Online consultation:* The Gorleben salt dome has already been sufficiently explored and found to be unsuitable for disposal. The nuclear industry continues to advocate Gorleben because millions of euros have already been invested there (8.4.004). It is in the German state’s interest for Gorleben to remain part of the procedure as this would mean that energy companies are unable to effectively file recourse claims. Gorleben may also only be admitted to the procedure as a dummy site because it forms part of a deal with the energy companies (8.4.004).

References to the conclusions of the Commission:

- *Section B 8.4:* The principle of a ‘blank map’ of Germany states that the site must be found by way of a scientifically based and transparent procedure which guarantees the best-possible safety for a period of one million years. On the one hand, this means that no part of Germany can be excluded from the proposed criteria. On the other hand, it also means that all of the potential siting regions must be protected as soon as possible in order to protect them against change. Such changes could, for example, come about due to overplanning or making something unusable, thus excluding the potential site as a disposal facility. The worst-possible scenario would be where the Gorleben site, the only one to be subject to a moratorium to date, is the only potential site available. The Commission agrees with this concern and therefore calls for immediate legislation enabling early action to be taken to secure siting regions or planning areas with the aim of countering the unilateral temporary moratorium in Gorleben and resolving any unequal treatment.

7.8.13 Council of the Regions Conference and participation officer

Along with various other ideas and pieces of advice gleaned from the public participation formats, the Commission immediately incorporated two suggestions into its recommendations: The first is the convening of the Council of the Regions Conference suggested at the workshops with regional representatives, while the second involves appointing a participation officer, which was proposed at the workshop with young adults and participation practitioners. Further information about this is available in sections B 7.4.4 ‘Council of the Regions Conference’ and B 7.4.1 ‘National Societal Commission’, in particular B 7.4.1.5 ‘Appointment of a participation officer’.

Suggestions from the formats:

- *Workshop with the regions:* The idea of a Council of the Regions was put forward at the start of the series of workshops involving regional representatives. This proposal was developed and specified further during subsequent meetings. The tension between the ‘bundling of regional situations and impacts on the one hand, and alignment with public interests and solidarity throughout society at large on the other hand’ was central to the development of the Council (K-Drs. 190b, p. 11 ff). The Commission adopted this recommendation and used it as a basis for the concept of a Council of the Regions Conference (cf. 7.4.4). The supraregional aspect and its associated opportunity to exchange experiences, to develop common viewpoints, and to bundle expertise were key to the development of such a conference. The time at which the Council of the Regions should convene was also discussed during the series of workshops. While participants expressed their desire for it to convene at a very early stage, the Commission arrived at the conclusion that the Council of the Regions Conference should be held when the regional conferences start their work. The Subareas Conference should be offered beforehand so as to counter the so-called paradox of participation (extensive opportunities to have input at the beginning of a process usually meet with little willingness to participate). As a result, the two conferences proposed by the Commission cover the central aspects of the Council of the Regions.
- *Workshop with young adults:* The role of a participation officer comes from the third workshop with young adults and participation practitioners. The key messages from the series of workshops conveyed to the Commission included the appointment of a participation officer tasked with performing reviews and provided with his/her own secretariat. As well as the National Societal Commission, which is tasked with public interest-oriented oversight of the process, thereby fulfilling a major requirement for its success, the participants also demanded an additional operative entity charged with assisting in arbitration and deescalation processes. The central task of this ombuds office is to perform conflict management within the selection process. Due to the number of actors and their various needs, it was considered necessary to provide a central office that responds to the ‘concrete concerns expressed by the public, dealing with them in a non-partisan manner’ (K-Drs. 194, p. 6). The Commission supports this issue, which is why almost the exact same wording has been adopted in section B 7.4.1. The participation officer should be established within the National Societal Commission and able to operate with a secretariat. The participation officer is tasked with identifying any tension within the procedure at any early stage, and with helping to resolve such tension. Everyone involved in the disposal site procedure will be able to consult the participation officer as and when necessary.

References to the conclusions of the Commission:

- *Section B 7.4:* The suggestions were largely adopted.

7.9 Recommendations to amend the Site Selection Act

The concept described above to select a site in dialogue with the regions requires changes and amendments to the Site Selection Act. The main changes and amendments are set out below:

- In section 2 ‘Participation of authorities and the public’, the participation system described above in section B 7.3 is to be implemented with the following elements:

- the National Societal Commission, its participation officer and the option of a scientific advisory council,
- the Subareas Conference and, following on from that, the Council of the Regions Conference, and
- Regional conferences with re-examination rights

- Furthermore, further developments of the imperative of transparency are to be incorporated into the Act as they are manifested in the proposals concerning the information platform and information offices (7.3.4), as well as transparency and rights to information (7.3.5).
- In Section 10(4), the requirement that the degree of acceptance for proposed procedural steps be recorded in the minutes of community meetings that has been provided for to date is to be deleted.
- In section 3 ‘site selection procedure’, the procedural steps that have been provided for hitherto by Sections 15 and 18 of the Site Selection Act are to be integrated into the preliminary procedural proposals (reports) provided for by Sections 14 and 17. Apart from this, Section 13 is to be supplemented to the effect that the subareas identified are published by the BGE in an interim report.
- In sections 2 and 3, the process for public participation is to be organised as described in section 7.5 of the present report.

Further development of the Site Selection Act should include further stipulation as to whether and to what extent the elements and procedural steps of public participation should be made available for (isolated) examination by the courts (7.5.6).

8 EVALUATION OF THE SITE SELECTION ACT

8.1 Analysis and evaluation of the law

In Section 4 (1), the Site Selection Act defines the task of the Commission as drawing up a report wherein it addresses ‘in detail all issues of relevance to the decision-making process. The Commission conducts a review of this law and provides recommendations for action to the Bundestag and Bundesrat’. One of the Commission’s main tasks was therefore to verify, amend or revise the rules and requirements for the site selection procedure on the basis of its recommendations.

This critical review serves to prepare recommendations for a site selection procedure that will lead to broad public consensus so that the outcome of the search for a disposal site for high-level radioactive waste will be accepted in the end or at least offer hope of such acceptance. In particular, the Commission was therefore to analyse and evaluate the extent to which the requirements of the Site Selection Act indeed reflect a fair, transparent and comparative procedure free from premature stipulations or ensure this is the case and develop recommendations for improvements. Through its evaluation of the Site Selection Act, the Commission will comply with this review mandate; the unique aspect of this task is that the evaluation takes place at a time when the Site Selection Act is, for the most part, not yet in force.

A working group within the Commission has been tasked with the 'Evaluation'; it met for the first time on 6 October 2014 and began work.[1088] The Commission was quick to hold a public hearing titled 'Evaluation of the Site Selection Act' on 3 November 2014 where 16 external experts were heard.[1089] The intentionally broad range of podium members led a wide range of topics being discussed:[1090]

- Procedural questions relating to the site selection process: In this case, the majority of the experts heard primarily brought up the topic of the envisaged legal planning and environmental impact assessments. The parties held the unanimous view that the design is of key importance to the site selection procedure.
- Legal redress and possibilities for the affected parties to appeal the decisions in the site selection procedure: The experts who were heard came to different conclusions regarding the question as to whether the Site Selection Act provided for adequate legal redress.
- Questions relating to financing and the statutory procedure for cost contributions in connection with the selection process: There was a lack of consensus regarding the question as to what extent the costs incurred by the search for a site should and could be borne by the utilities.
- The structure and organisation of the authorities involved in the selection procedure: The majority of the experts heard brought up the topic of official structure: At the same time, the overlap or duplication of the recently established Federal Office for the Regulation of Nuclear Waste Management (BfE) and the existing Federal Office for Radiation Protection (BfS) in particular proved to be controversial.
- Aspects of public participation set out in the law: the Site Selection Act provides for public participation as a minimum standard; though this creates flexibility, the specific details must be defined in a concept for public participation if necessary.
- Further handling of Gorleben: It has been noted here that this location is not treated the same as other potential locations as only Gorleben has been placed under a moratorium; other potential sites are currently not under such protection, which must be dealt with accordingly.

[1088] Cf. 1st meeting of the 'Evaluation' working group on October 6, 2014, verbatim record.
[1089] Cf. participants in the 'Evaluation' hearing on 3 November 2014, K-Drs. 46; the 'Absage unserer Teilnahme an der geplanten Anhörung der Atommüllkommission am 3. November 2014' in a joint letter from 'Greenpeace e.V.', 'ausgestrahlt. gemeinsam gegen atomenergie e.V.' and 'Bürgerinitiative Umweltschutz Lüchow-Dannenberg e.V.' can also be viewed in its statement of grounds.
[1090] Cf. in detail the individual short versions submitted in K-Drs. 35 to K-Drs. 44, K-Drs. 47, K-Drs. 52 to K-Drs. 57; K-Drs. 42, the statement of Prof. Dr. Martin Burgi (LMU Munich, Chair of Public Law, Business Administrative Law, Environmental and Social Security Law), which was only submitted in written form. An overview or summary of the experts heard can be found in the evaluation of the hearing 'Evaluation of the Site Selection Act'. Summary of views and results', K-Drs./AG2-4a; a short version has been published with K-Drs./AG2-4b.

- Further topics: A further reaching provision setting out the possibility of expropriation in connection with the site selection procedure, anchoring of the phasing-out of nuclear power in the German Basic Law, an explicit legal ban on the export of radioactive waste materials as well as the reconsideration of the legally prescribed period of one million years.

The working group and Commission began deliberations based on this critical inventory of the Site Selection Act; these and other issues were analysed and evaluated in depth during the further course of discussion. The working group decided first of all to divide the topics for discussion into two categories: on one hand, questions requiring urgent clarification where a prompt decision on the part of the legislator would have to be taken while the Commission is still active and questions to be addressed over the long term where a possible solution could be provided in the final report of the Commission. Based on this categorisation, the following five topics were classified as particularly urgent at the meetings of the working group on 24 November 2014 and 12 January 2015:[1091]

- Structure of authorities
- Legal redress
- Term of the Commission
- Gorleben moratorium
- Ban on the export of radioactive waste

After revising the last point in ‘No export’, the first letters of these topics were abbreviated with BRAVO (translator’s note: BRAVO is an abbreviation consisting of the first letter of the respective German topics); in the following months, this term represented questions requiring an urgent resolution, which in turn shaped the discussions of the working group in the first half of 2015.[1092]

Other topics were also discussed, in some cases, together with the other working groups:

- Rules for public participation
- Making the phase-out of nuclear energy irreversible
- Right of future generations to long-term safety
- Site selection procedure as well as trade and/or service agreements
- Settlement of costs/financing through contributions

The extensive exploration of these topics as well as various corresponding analyses form the basis for the following evaluations, which summarise the discussion and recommendations of the Commission regarding its evaluation of the Site Selection Act.

The Commission on Storage of High-Level Radioactive Waste dealt with the topic of the appropriation of costs as well as financing on the basis of contributions on multiple occasions following the hearing of 3 November 2014. The Commission generally agreed that the polluter-pays-principle would apply and that the waste producers are to carry the costs of safe disposal. However, the actual extent for respective parties was highly disputed. In particular, the representatives of the nuclear power plant operators on the Commission disputed the cost provision in Section 21 et seqq. of the Site Selection Act as well as the need for a new comparative site selection procedure and a resulting obligation to carry the costs. The nuclear power plant operators have filed appeals against an

[1091] Cf. 2nd and 3rd meeting of the ‘Evaluation’ working group, verbatim records.

[1092] With respect to the individual topics and/or issues, expert opinions and statements were regularly obtained during the course of working group two’s discussions; for details, cf. the printed matter of working group two of the Commission.

expansion of the duty of care (as per Section 9a of the Atomic Energy Act) provided in the Site Selection Act, which serves to ensure that upcoming return transports of radioactive waste from reprocessing do not go to Gorleben, but to interim storage facilities close to the respective site. The majority of the Commission's members did not share this view and considered a comparative search procedure to be an inherent component of the costs to be carried by the waste producers.

The Commission initially suspended further discussion of this issue after the German Federal Government ruled on 14 October 2015 to appoint a commission for the evaluation of the financing of the phasing out of nuclear energy. The objective of the Federal Government was to also ensure long-term safety during the remaining operation of the nuclear power plants, their decommissioning, dismantling as well as the interim and final storage of the radioactive waste in a technical and financial respect. The German Federal Government assumed that the polluter-pays-principle would apply in this respect. On behalf of the German Federal Government, the Commission was to determine how the financing of the decommissioning and dismantling of the nuclear power plants as well as the disposal of the radioactive waste will be organised so that the companies are also financially capable, over the long term, of meeting their obligations arising from the use of nuclear energy.

The Commission tasked with evaluating the financing of the phasing-out of nuclear energy has fulfilled its mandate and presented a final report on 27 April 2016 with unanimous approval covering all areas addressed in the appointment resolution. The intention is to amend the legal provisions on the basis of these recommendations. Those involved have expressed their willingness to work towards a solution for the implementation of the recommendations.

Against this background, the Commission on the Storage of High-Level Radioactive Waste Materials, with reference to the report of the Commission on Evaluating the Financing of the Phasing-Out of Nuclear Energy, refrains from providing special recommendations for relevant changes to the Site Selection Act. If the recommendations of the Commission on Evaluating the Financing of the Phasing-Out of Nuclear Energy (KFK) are implemented in this way, the responsibility for financing the storage of high-level radioactive waste materials will lie with the state in the future. Presently, no one knows whether the fund established under public law with funds from the nuclear power plant operators will be sufficient for this task. This will depend on the development of the storage costs and the accrued interest. The state will carry the costs and the interest risk in the future.

The Commission assumes that the state will implement the search procedure as recommended by the Commission despite these financing risks and that it will not, for reasons of cost, refrain from searching for a site offering the best possible safety.

8.2 Organisational structure

8.2.1 Initial situation

As an operator, the Federal Office for Radiation Protection (BfS) is currently responsible for the construction, operation and decommissioning of disposal

facilities as well as for the Asse II mine and makes use of DBE mbH, the majority interest of which has been held privately up to this point, and the federally owned Asse GmbH as an administrative aide to date. Pursuant to the Site Selection Act, the BfS assumes the function of the project delivery organisation in connection with the site selection procedure.
In this function, it is responsible in particular for finding siting regions and sites for exploration, surface and underground exploration of potential sites as well as the corresponding preliminary safety studies; pursuant to the Site Selection Act, it reports to the newly established Federal Office for the Regulation of Nuclear Waste Management (BfE) regarding the results of the in-depth geological exploration programme as well as the findings and evaluations on which the decision of the BfE regarding the site proposal is based. At the same time, the BfS is also the licensing authority for interim storage facilities and transport of the nuclear fuel.
The BfE with its provisional head office in Berlin is responsible for the plan approval of disposal facilities and the licensing of a disposal facility for heat-generating radioactive waste based on the selection procedure in accordance with the Site Selection Act.
In cases where the site in accordance with the Site Selection Act is stipulated by federal law, the jurisdiction provisions of Section 23d sentence 1 of the Atomic Energy Act first apply after this final decision on the site.
The BfE began work on 1 September 2014[1093] and will take on the new tasks in connection with the site selection procedure and subsequent licensing of the disposal facility under nuclear law.[1094]
According to the justification in the Site Selection Act, the BfE will be the main institution for the site selection procedure.[1095] This also includes, in addition to accompanying the procedure from a scientific point of view, the specification of site-related exploration programmes, examination criteria as well as proposals for siting decisions. The BfE will also be responsible for formal public participation in the site selection procedure and in connection with the tasks assigned to it.[1096]
Furthermore, the BfE will also be the competent plan approval authority for the Konrad disposal facility following its commissioning and for the Morsleben disposal facility once an executable plan approval decision for decommissioning is in place; these responsibilities currently lie with the Land of Lower Saxony (NI) for the Konrad disposal facility or the Land of Saxony Anhalt (ST) for the Morsleben disposal facility. With respect to the Asse II mine, the supreme Land

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[1093] Cf. BMUB. Organisational decree for establishing the Federal Office for the Regulation of Nuclear Waste Management dated 5 August 2014. Can be accessed at http://www.bfe.bund.de/fileadmin/user_upload/PDF/organisationserlass_bf.pdf [as of 6 October 2015]. Cf. BMUB. Organisational decree for establishing the Federal Office for the Regulation of Nuclear Waste Management dated 5 August 2014. Can be accessed at http://www.bfe.bund.de/fileadmin/user_upload/PDF/organisationserlass_bf.pdf [as of 6 October 2015].
[1094] Cf. Christian Democratic Union/Christian Social Union (CDU/CSU), Social Democratic Party of Germany (SPD), Free Democratic Party (FDP) and Alliance 90/The Greens (Die Grünen). Draft of an act on the search for and selection of a site for a disposal facility for heat-generating radioactive waste and for the amendment of other laws (Site Selection Act). BT-Drs. 17/13471 dated 14 May 2013, p. 2.
[1095] Cf. CDU/CSU, SPD, FDP and Alliance 90/The Greens. Draft of an act on the search for and selection of a site for a disposal facility for heat-generating radioactive waste and for the amendment of other laws (Standortauswahlgesetz – StandAG). BT-Drs. 17/13471 of 14 May 2013, p. 22.
[1096] Cf. CDU/CSU, SPD, FDP and Alliance 90/The Greens. Draft of an act on the search for and selection of a site for a disposal facility for heat-generating radioactive waste and for the amendment of other laws (Site Selection Act). BT-Drs. 17/13471 of 14 May 2013, p. 22.

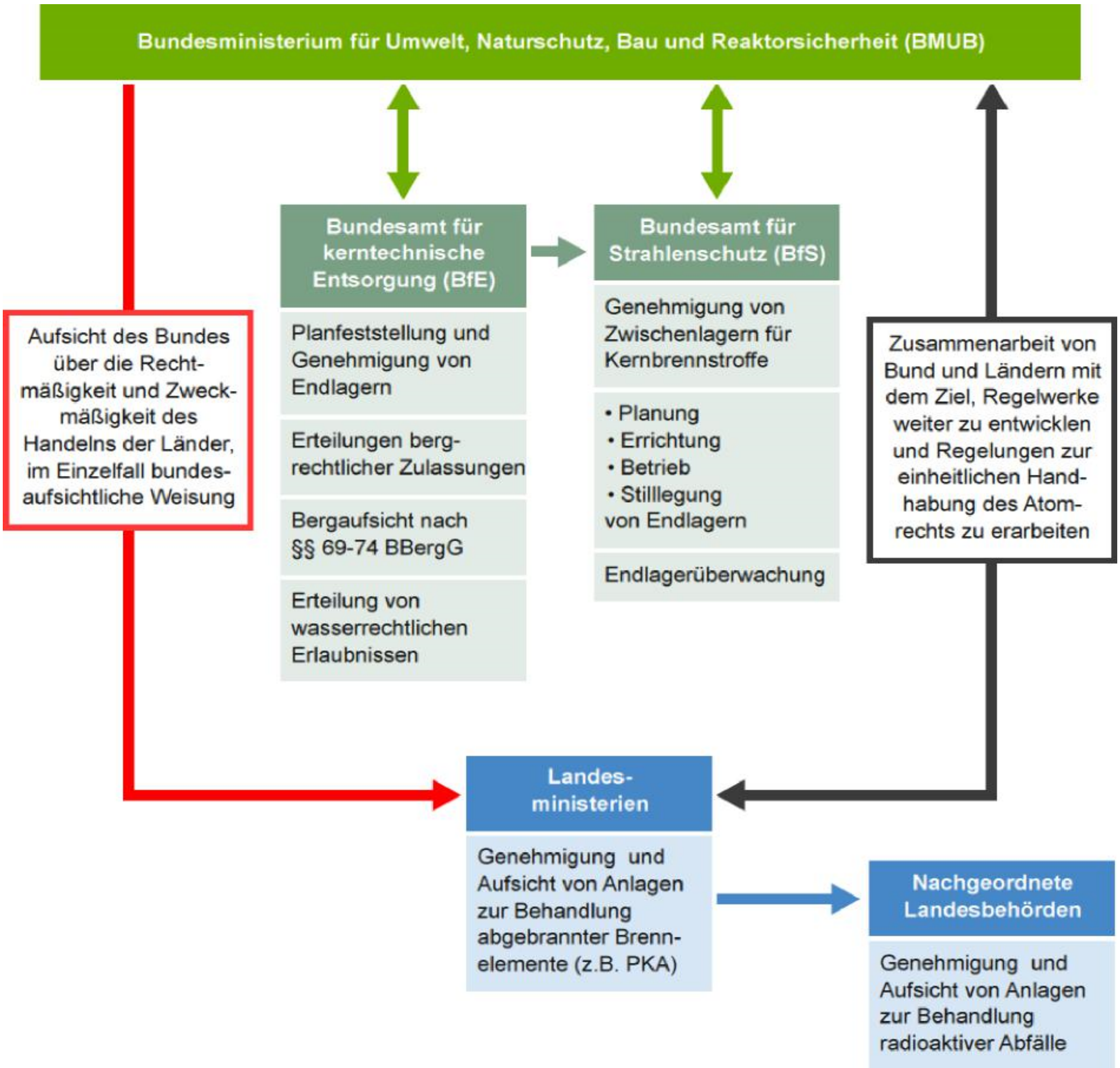
authority of the Land of Lower Saxony continues to be the competent approval authority.
The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) will conduct the legal and technical supervision of the BfS and BfE, which belong to its area of responsibility. Regulatory supervision in accordance with Section 19 of the Atomic Energy Act is not set out for federal government facilities for disposal in accordance with Section 9a (3) sentence 1 of the Atomic Energy Act as well as for the Asse II mine.

The Länder are responsible for permits under mining and water law for surface and underground exploration of HAW disposal facilities.
The following graphic presents the responsibilities of and relationships between the two authorities as well as other responsible bodies.

Graphic 27: Authorities and bodies responsible to date for the final disposal of radioactive waste materials

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB)			
Supervision by the Federation of the legitimacy and appropriateness of the activities of the Länder; in individual cases, supervisory instructions from the Federation	Federal Office for the Regulation of Nuclear Waste Management (BfE) Plan approval and licensing of repositories Granting of permits under mining law Mining authority in accordance with Sections 69-74 BBergG Granting of permits under water law	Federal Office for Radiation Protection (BfS) Licensing of interim storage facilities for nuclear fuel • Planning • Construction • Operation • Decommissioning of disposal facilities Disposal facility supervision	Cooperation of the Federation and Länder with the goal of refining rules and regulations and drawing up provisions for the consistent handling of atomic law
	Land ministries Licensing and supervision of facilities for the treatment of spent fuel elements (e.g. pilot conditioning plant)		Subordinate Land authorities Licensing and supervision of plants for the treatment of radioactive waste

8.2.2 Recommendations of the Commission



The Commission unanimously provides the following recommendations for action[1097]:

- The operator tasks of the BfS, DBE mbH and Asse-GmbH will be bundled in a Federal Company for Nuclear Waste (Bundes-Gesellschaft für kerntechnische Entsorgung, BGE). The new company is federally owned in full.
- This new state-owned company will be established, if possible, with the consent of, in particular, the current owners of DBE. Future privatisation is ruled out.
- To comply with the objective of transparency, the waste producers and, if applicable, other institutions will be involved before decisions are taken by the

[1097] Cf. K-Drs. 91 NEW with the decision of 2 March 2015.

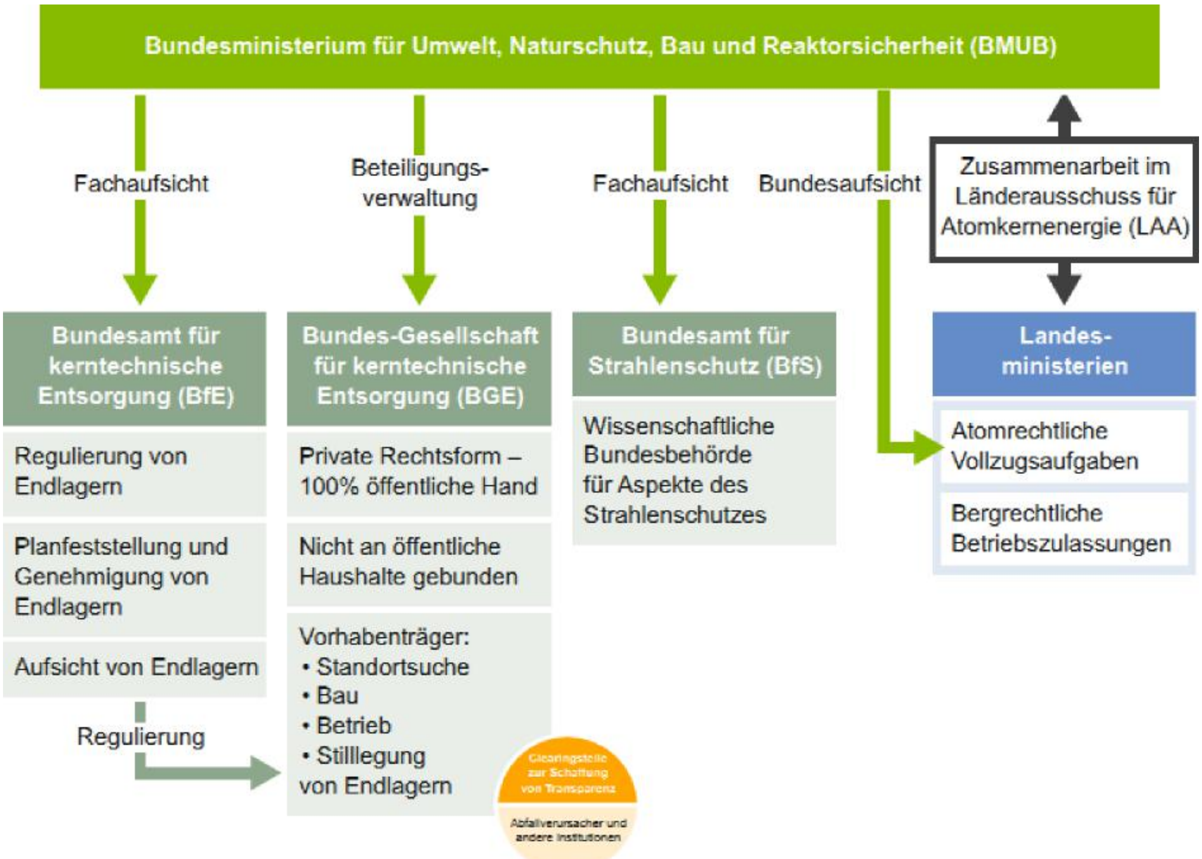
federally owned company . This could, for example, be duly achieved through the use of a clearing centre.[1098]

- All tasks and resources of the BfS as the operator, DBE and Asse GmbH as the administration aide with respect to planning, construction, operation and decommissioning of disposal facilities as well as the BfS as the project delivery organisation in accordance with Site Selection Act will be immediately transferred to the new company.
- The BGE will be run under private law. Its primary task is the search for a site as well as the construction, operation and decommissioning of disposal facilities for radioactive waste materials. It is not directly linked to state budget.
- Public involvement in accordance with the Site Selection Act must be ensured.
- The state regulatory, licensing and supervisory tasks relating to the safe disposal of spent fuel and radioactive waste are – to the extent they are not observed by the Länder – bundled in a single federal office. The Federal Environment Ministry is asked to provide a recommendation for the design of this regulatory authority with respect to its scope, organisation and structure including the corresponding time frame; the authority must be provided with adequate personnel and financial resources. This does not mean that the responsibilities between the Federal Government and the Länder set out in the Site Selection Act have to be amended.
- Independence in accordance with the requirements of the 2011/70/Euratom Directive must be ensured.

The Federal Environment Ministry was asked to involve the Commission in the implementation of the recommendations for action and to promptly provide a timeline as well as relevant recommendations for a revision of the Site Selection Act that addresses the above points.
The following graphic depicts the organisational structure if implemented based on the recommendations of the Commission:

[1098] This recommendation does not take into account the recommendations of the Commission on Evaluating the Financing of the Phasing-Out of Nuclear Energy(KFK), which also provides for changes to the responsibility for the disposal of radioactive waste.

Graphic 28: New organisational structure recommended by the Commission



Organisationsrahmen Behörden der Bundesrepublik Deutschland im Bereich der Entsorgung bestrahlter Brennelemente und radioaktiver Abfälle nach Umsetzung der Empfehlungen der Endlager-Kommission vom 2. März 2015

These recommendations have already been adopted by the Bundestag with the exception of the clearing centre; they were last undergoing the legislative process.

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB)				
Supervisory control	Shareholding management	Supervisory control	Federal supervision	Cooperation on the Länder Committee on Nuclear Power (LAA)
Federal Office for the Regulation of Nuclear Waste Management (BfE)	Bundes-Gesellschaft für kerntechnische Entsorgung (BGE)	Federal Office for Radiation Protection (BfS) Scientific federal authority for aspects of radiation protection		Land ministries
Regulation of disposal	Company under private law - federally owned			Implementation tasks under

facilities				atomic law
Plan approval and licensing of disposal facilities	Not bound to the federal budget			Operating licences under mining law
Supervision of disposal facilities Regulation	Project delivery organisation: • Siting • Construction • Operation • Decommissioning of repositories Clearing centre for creating transparency waste producers and other institutions			

Organisational framework for authorities in the Federal Republic of Germany in connection with the disposal of spent fuel elements and radioactive waste in accordance with the implementation of the recommendations of the Repository Commission of 2 March 2015

8.2.3 Principles of deliberation

On 3 November 2014, the Commission held a hearing of relevant experts based on an extensive
questionnaire.
Based on the results of this hearing[1099] and taking into consideration the discussion paper[1100] submitted by the Federal Environment Ministry, the Commission estimates that the organisational structure currently set out by law requires amendment; particularly the structure of authorities is not suitable for competently and promptly performing the wide range of tasks in the field of disposal including public participation, which must be reorganised in light of this report from the Commission[1101].

The BfS would require significantly more personnel for the task of project delivery organisation and, if the legal situation remains unchanged, also widely engage the services of private third parties in the future, which could give rise to an entanglement of interests. The decisive issue of the interface between the operator (BfS) and the operation managers (Asse GmbH, DBE) would not be resolved.

In the view of the Commission, the design of the BfE as the regulatory authority and the BfS as the project delivery organisation and operator for disposal projects as provided for in the Site Selection Act was to be evaluated. The Commission is particularly critical of the large number of interfaces and resulting problems, system and information discontinuities.

[1099] Cf. K-Drs. /AG2-4a of 30 January 2015.
[1100] Cf. BMUB. Considerations of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety for reshaping the organisational structure with respect to the topic of disposal K-Drs./AG2-2 dated 9 January 2015.
[1101] Cf. 'Evaluation' working group: Framework paper on the topic of 'Official structure'. K-Drs./AG2-9 dated 23 February 2015.

Cost-efficiency and transparency of administrative flows therefore go against such a solution, which would also presumably lead to difficulties in the separation of responsibilities. The Commission therefore recommends that all tasks relating to licenses, monitoring and supervision – to the extent they are not performed by the Länder – are bundled in a single supreme federal authority.
The Commission consequently supports separating the responsibility of operators, in particular from the BfS, and bundling it with the tasks of the operating companies DBE mbH and Asse GmbH in a new, federally owned company; in the process, the same working conditions for all employees must be ensured without infringing upon existing rights of codetermination. Siting, construction, operation and decommissioning of the disposal facilities are to be bundled in this new company, which will be established as the future project delivery organisation. In the view of the Commission, this company must be fully state owned, be unrestricted with respect to its entrepreneurial activities and not be directly bound to the federal budget.
In the view of the Commission, there is no need for two supreme federal authorities to handle disposal tasks, particularly when establishing a new company that assumes the operator function of the BfS and the administrative aide function of the DBE mbH and Asse GmbH, also in consideration of principles of separation. If two supreme federal authorities, the BfS and the BfE, are maintained, the Commission recommends separating the tasks of the BfS and the BfE according to function to ensure that the key task of radiation protection is assured and, at the same time, in order to perform the comprehensive tasks of the BfE (as the regulatory authority) provided for in the site selection procedure. The BfE can engage the BfS in connection with relevant issues relating to radiation protection.

8.3 Legal redress

The topic of the most efficient way to provide adequate legal redress in the site selection procedure in accordance with Site Selection Act as well as in the subsequent licensing procedure in accordance with the Atomic Energy Act was dealt with extensively by the Commission at numerous meetings[1102]. At the same time, the compatibility of the existing legal provisions with the requirements set out in Community Law was reviewed in-depth. Furthermore, the question regarding the extent to which further options for legal redress are to be provided for beyond what is required under Community Law was discussed.
The findings and recommendations obtained in the 'Evaluation' working group two (WG 2) in dialogue with the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) at nearly all meetings[1103] as well as at a joint meeting with working group one served as a basis.
In the first series of topics, the exact requirements of European and international law as well as the resulting, imperative amendments to the Site Selection Act were drawn up and recommendations for amendments were provided. In the process, special emphasis was placed on configuring the Site Selection Act so

[1102] Cf. the 2nd, 4th, 5th, 6th, 10th, 12th, 13th, 15th and 16th meetings of the Commission, verbatim records.
[1103] Cf. the 2nd, 3rd, 4th, 7th, 8th, 9th, 10th, 11th, 12th and 13th meeting of the 'Evaluation' working group, verbatim records.

that the legislator is the decision-making body while taking into account the requirements of European law.
With the second series of topics, it was evaluated as to whether the possibility for legal redress provided for in Section 17 of the Site Selection Act will remain in place after additional possibilities for legal redress, which are provided for under European law, have been introduced.

8.3.1 Initial situation

The Site Selection Act provides for the search and selection of a site for a disposal facility for, in particular, heat-generating high-level radioactive waste. The construction, operation and decommissioning of a disposal facility for high-level radioactive waste are set out in the Atomic Energy Act.
At the same time, the Site Selection Act is configured such that the legislator is the decision-making body and provides for a decision by federal law on four occasions:

- in accordance with Section 4 (5) of the Site Selection Act – on the exclusion criteria developed by the Commission as recommendations, minimum requirements, consideration criteria and other decision-making basis for the site selection procedure;
- in accordance with Section 14 (2) sentence 5 of the Site Selection Act – on siting regions for surface exploration;
- in accordance with Section 17 (2) sentence 5 of the Site Selection Act – on the sites for underground exploration;
- in accordance with Section 20 (2) sentence 1 of the Site Selection Act – on the location.

During the site selection procedure, an environmental impact assessment (EIA) is required in advance of the statutory decision on the site (Section 18 (3) and (4) of the Site Selection Act, Section 19 (1) of the Site Selection Act). Following the decision on the site by federal law, the disposal facility will be decided upon by way of an administrative decision in a licensing procedure in accordance with Section 9b (1a) of the Atomic Energy Act. In this licensing procedure, the decision on the site in accordance with Section 20 (3) of the Site Selection Act is binding for the construction, operation and decommissioning of the facility.
Also in connection with the licensing procedure under the Atomic Energy Act, an EIA will be conducted before a license is issued to construct and operate the disposal facility (Section 9b (2) sentence 3 of the Atomic Energy Act).
In summary, the following possibilities for legal redress exist in the site selection procedure and the subsequent licensing procedure:

- In accordance with Section 17 (4) sentence 3 of the Site Selection Act, legal redress against the decision of the Federal Office for the Regulation of Nuclear Waste Management (BfE) can be sought in accordance with Section 17 (4) sentence 1 of the Site Selection Act. It can therefore be evaluated as to whether the site selection procedure was carried out up to the BfE’s selection recommendation of the sites for underground exploration in accordance with the requirements and criteria of the Site Selection Act and whether the selection recommendation meets these requirements. The Environmental Appeals Act therefore applies with the stipulation that communities, in whose municipal district a location recommended for underground exploration is located, and their residents are considered with the same status as the environmental organisations recognised in accordance with Section 3 Environmental Appeals Act. The Federal Administrative Court will decide, in the first and last instance, on complaints (cf. Section 17 (4) sentence 3 of the Site Selection Act).

- As stipulated by Article 93 of the German Basic Law and Article 100 of the German Basic Law, legal redress can be sought against the Federal Constitutional Court.
- In accordance with Section 40 (1), Section 48 (1) cipher 1 of the Code of Administrative Court Procedure (VwGO), legal redress can be sought against the granting of the license in accordance with Section 9b (1a) of the Atomic Energy Act.
- Finally, legal redress can be sought against various administrative acts, which are necessary in order to execute the site selection procedure and the licensing procedure under the Atomic Energy Act – such as during the search for and selection of the site against court orders to tolerate work in connection with surface or underground exploration. Also based on the provisions of the Federal Mining Act (BBergG), legal redress can be sought against operational plans or assignments of land as well as corresponding compensation. The Atomic Energy Act sets out standards for expropriation in connection with the construction and operation of the disposal facility, its prerequisites and corresponding compensation; compliance with said standards can be judicially evaluated.[1104] All these possibilities for legal redress do not, however, lead to an evaluation of decisions taken on the basis of the Site Selection Act.

8.3.2 Implementation of the requirements of Community Law

8.3.2.1 Recommendations of the Commission

In order to implement the requirements of Community Law, the Commission recommends the following:
- In Section 19 of the Site Selection Act, a possibility for legal redress is implemented based on Section 17 (4) of the Site Selection Act, which permits a comprehensive and, to the extent possible, final evaluation of the site selection procedure including all preliminary inspections and intermediate steps. The BfE publicly announces the site proposal in accordance with Section 19 (1) of the Site Selection Act before passing it on to the Federal Environment Ministry in a form that can be appealed. The level of review before an administrative court is limited to the Federal Administrative Court.
- In Section 20 of the Site Selection Act, it is clarified that the site proposal of the federal government in accordance with Section 20 (1) sentence 2 of the Site Selection Act concerns the site proposal of the BfE in accordance with Section 19 (1) of the Site Selection Act.
- In Section 20 (3) of the Site Selection Act, it is clarified that the suitability of the project must be thoroughly reviewed in the licensing procedure based on the binding site decision in accordance with (2) sentence 1.

[1104] Cf. for further possibilities: Commission on Storage of High-Level Radioactive Waste. Overview of legal redress in connection with the site selection and licensing procedure, K-Drs./AG2-27.

The Commission provides the following recommendations regarding formulation with respect to the concrete implementation of the above proposals:[1105]

- Section 19 (1) of the Site Selection Act (new) – 'The Federal Office for the Regulation of Nuclear Waste Management' proposes, *following a conclusive comparison of multiple sites* based on *the criteria of this law and* the safety studies in accordance with Section 18 (3), the report in accordance with Section 18 (4) and taking into account all private and public interests as well as the results of public participation, *which* site is the site *offering the best possible safety where* a disposal facility is to be constructed (site proposal). *The site proposal must give rise to the expectation* that the required precautions in accordance with the state of the art in science and technology, which are necessary to prevent damages in connection with the construction, are provided for and that no other provisions of public law are precluding. The site proposal must include a conclusive presentation and evaluation of environmental impacts in accordance with Section 11 and 12 of the Environmental Impact Assessment Act and the justification of the territorial impact. Public participation occurs in accordance with Section 9 and 10; official involvement occurs in accordance with Section 11 (2(and (3).
- Section 19 no. 2 of the Site Selection Act (new) – 'The Federal Office for the Regulation of Nuclear Waste Management must provide the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety with the site proposal including all documents required for this. Before forwarding the site proposal,

1. the Federal Office for the Regulation of Nuclear Waste Management gives the affected communal regional authorities and *the affected* property owners the opportunity to comment on the relevant factors for the decision and

2. *determines in a notice whether the site selection procedure to date has been performed in accordance with the requirements and criteria of this law and whether the site proposal complies with these requirements and criteria.*

The notice must be announced publicly with corresponding application of the provisions concerning the public announcement of licences granted of the ordinance provided for in Section 7 (4) sentence 3 of the Atomic Energy Act. The Environmental Appeals Act applies in the case of legal redress against the decision in accordance with sentence 2 point 2 with the stipulation that the applicable communal regional authorities in whose territory the proposed site is located and whose inhabitants as well as affected property owners in the sense of sentence 2 point[1106] *a considered to have the same status as the associations recognised in accordance with Section 3 of the Environmental Appeals Act. A follow-up review of the decision is not required in an advance procedure in accordance with Section 68 of the Code of Administrative Court Procedure. The Federal Administrative Court will rule, in the first and final instance, on any appeals of the decision in accordance with sentence 2 point 2'*

- Section 20 (1) of the Site Selection Act (new) – 'The federal government will *submit the site proposal* to the Bundestag in the form of a bill.'
- Section 20 (2) sentence 1 of the Site Selection Act (new) – 'The *acceptance* of *the site proposal* will be decided on by federal law.'

[1105] In this case, the passages in italics refer to recommendations of the Working group two for amending the applicable law.

[1106] This expansion should also be included in Section 17 (4) of the Site Selection Act.

- Paragraph 20 (3) of the Site Selection Act (new) – 'The decision on the site in accordance with (2) sentence 1 is binding for the subsequent licensing procedure for the construction, operation and decommissioning of the disposal facility in accordance with Section 9b (1a) of the Atomic Energy Act. *The suitability of the project must be thoroughly evaluated during the licensing procedure on the basis of this decision.'*

8.3.2.2 Principles of deliberation

The Commission conducted a hearing of relevant experts based on an extensive list of questions pertaining, among other things, to the topic of legal redress.[1107] In the process, the compatibility of the existing legal provisions with the requirements of European and international law has been identified as an issue requiring clarification. After all, through the enactment of the amending Directive 2014/52/EU[1108] to the Directive 2011/92/EU[1109] (EIA Directive), the legal situation at the level of European law differed from the one established through the enactment of the Site Selection Act: The previous exception from the application of the legal redress stipulations in connection with the approval of projects, for which an EIA is required by law, was removed by the amending Directive 2014/52/EU.
The Commission came to the conclusion that the legal redress currently granted under the Site Selection Act does not satisfy the requirements of the EIA Directive and Article 9 (2) of the Aarhus Convention[1110]. This was based on the corresponding findings of two legal opinions that were commissioned[1111] regarding the question of the compatibility of the Site Selection Act with the requirements of European and international law. After all, the legal redress requirements of the EIA Directive implemented in article 9 (2) of the Aarhus Convention stipulate that, in the case of project licenses where an EIA is required, non-governmental organisations can have the lawfulness of the final decision of the licensing procedure evaluated in terms of substantive and procedural law.[1112] In accordance with the Site Selection Act, it is not possible to evaluate the lawfulness of the final decision of the licensing procedure under substantive and procedural law: The final decision of the licensing procedure is the license for the disposal facility in accordance with Section 9b (1a) Atomic Energy Act. This disposal facility license also includes the statutory decision on the site in

[1107] Cf. Commission on Storage of High-Level Radioactive Waste. Analysis of the hearing 'Evaluation of the Site Selection Act' / collection of
views and results, K-Drs./AG2-4a, p. 24 et seq.
[1108] Directive 2014/52/EU of 16 April 2014 amending the Directive 2011/92/EU on the Environmental Impact Assessment in connection with certain specific public and private projects.
[1109] Directive 2011/92/EU of 13 December 2011 on the Environmental Impact Assessment in connection with specific public and private projects.
[1110] UNECE Convention regarding access to information, public participation in the decision-making process and access to the courts in environmental matters.
[1111] Cf. 3. Decision of the commission, K-Drs. 114 of 3 July 2015, p. 2; this was established on the basis of corresponding findings of two legal opinions that were commissioned regarding the question of the compatibility of the Site Selection Act with European and international requirements, cf. KÜMMERLEIN Rechtsanwälte
& Notare. legal opinion, K-MAT 37b, p. 49; cf. BBH Rechtsanwälte. Legal opinion, K-MAT 37a of 18 June 2015, p. 48.
[1112] The remarks are based to a large extent on: Commission on Storage of High-Level Radioactive Waste, report by the chairman of the working group two'Legal redress in connection with the site selection and licensing procedure', K-Drs. 133b dated 18 January 2016.

accordance with Section 20 (2) sentence 1 (legal planning) including the previous procedural steps - in particular the EIA to be conducted in accordance with Section 18 (4) of the Site Selection Act. The decision on the site on the part of the legislator is, however, legally binding for administrative bodies and courts in accordance with Section 20 (3) of the Site Selection Act and can therefore not be subsequently evaluated in connection with legal redress against the disposal facility license before administrative courts in accordance with the Section 9b Atomic Energy Act.

The existing constitutional legal redress before the Federal Constitutional Court against the decision on the site in the form of legal planning in accordance with Section 20 (2) sentence 1 of the Site Selection Act does not, in many respects, satisfy the requirements prescribed by European law. In constitutional appeals, solely the German Basic Law serves as a yardstick – no general evaluation of formal and material lawfulness occurs. Non-governmental organisations are not authorised to file complaints in environmental matters before the Federal Constitutional Court unlike in the case of recourse to the administrative courts as prescribed by the Environmental Appeals Act.

The Commission therefore tasked WG 2 with drawing up a recommendation for a solution for regulating the site selection procedure, which resolves the identified lack of legal redress. In the process, two different approaches for rectifying the existing lack of legal redress were identified based on the recommended solutions described in the legal opinion: On one hand, retaining the instrument of ‘legal planning’ in Section 20 (2) sentence 1 of the Site Selection Act and on the other, refraining from it entirely.

In the view of the Commission, a solution should ideally be found, which enables a complete review of the final decision on the site as prescribed by European law and occurs in compliance with ‘legal planning’. After all, based on the development of the law, the increased democratic legitimation of the site decision and the ongoing public debate through the involvement of the Bundestag should, to the extent possible, be laid down in the ‘legal planning’.

The following solutions for rectifying the lack of legal redress were therefore discussed in-depth while retaining the instrument of ‘legal planning’:

- The implementation of a judicial review by administrative courts, which could be enabled by means of a review of the legal decision of the Bundestag by an administrative court.
- The ‘weakening’ of the binding effect of the legal decision on the site in order to enable reviewability in connection with legal regress against the approval of the disposal facility before an administrative court in accordance with Section 9b (1a) of the Atomic Energy Act.
- The granting of legal redress before an administrative court in Section 19 or 20 of the Site Selection Act in advance of the ‘decision by law’ of the legislator.
- A combination of these different solutions.

The introduction of a judicial review by the administrative courts oriented in particular towards the review of the ‘legal decision’ in connection with the determination of a site based on the application for standardised control in accordance with Section 47 (1) Code of Administrative Court Procedure was considered a theoretical possibility for remedying the existing lack of legal redress. As this would be completely new from a legal standpoint and introducing it would raise numerous unanswered legal questions, this option has been deemed unsuitable for achieving the objective.

With respect to merely ‘weakening’ the binding effect of the legal decision on the site in order to enable a review in connection with legal redress against the disposal facility license before an administrative court in accordance with Section 9b Atomic Energy Act, the following shortcomings in particular were identified: It would be unclear as to how the binding effect could be reduced with respect to legal doctrine without undermining the decision of the Bundestag. Furthermore, a legal decision would first be issued at the end of a year-long procedure.
Also with respect to introducing solely a possibility for legal redress in Section 19 or 20 of the Site Selection Act in accordance with the provision in Section 17 (4) of the Site Selection Act, there was doubt in the end as to whether this would unequivocally satisfy the requirements of European law:
After all, the provision in Section 20 (2) of the Site Selection Act would remain, according to which the Bundestag takes its own decision and this decision, which is part of the factual decision in the procedure requiring an EIA, would therefore not be subsequently reviewable as before. As a result, a party seeking legal redress could, in challenging the decision to grant a license, be told that such questions have already been ruled on in connection with the legally binding site selection, which would go against reviewability of the licensing decision in terms of substantive and procedural law as required by European law.
The Commission therefore suggests a combination of the different approaches:

- The legislator’s decision on the site should, to the greatest extent possible, be relieved of requirements of European law by means of an evaluation of the procedure conducted up to that point, including the EIA: To achieve this, a possibility for legal redress modelled after Section 17 (4) of the Site Selection Act should be implemented in Section 19 of the Site Selection Act prior to the decision of the Bundestag and the BfE should publicly announce the site proposal in accordance with Section 19 (1) of the Site Selection Act before passing it on to the Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety in a legally appealable form. The level of review before an administrative court is limited to the Federal Administrative Court. This recommendation is based on the legal opinion of the Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety presented in the Commission Printed Paper /AG2-31 that the laws governing the determination of sites for exploration, which were enacted in connection with the site selection procedure, do not rule out the judicial review of the previous procedure.
- Furthermore, the binding effect of the legal decision will be reduced so that a subsequent judicial review of the decision on the site will continue to be possible during the licensing procedure under atomic law.

The introduction of an appealable notice from the BfE in Section 19 (2) of the Site Selection Act was considered to have no alternative overall. In order to ensure the continuity of the judicially reviewable decision of the BfE for the further procedure, it was also ruled to supplement Section 20 (2) sentence 1 of the Site Selection Act by adding that the Bundestag only votes on the (judicially reviewable) site proposal of the BfE. Otherwise, the judicial review of the EIA conducted for the site selection, which is required under European law, would not be at hand. Though an alternative review for the legislator is omitted as a result in connection with the systematic approach taken by the Site Selection Act, it can only reject or accept the decision of the BfE, it continues, however, to be the

body that decides on the site thus instilling, in the event the procedure is affirmed, legitimacy, trust and acceptance in the procedure up to this point.[1113]
It was also agreed that, based on the requirements of European law, it must be evident on the basis of the provisions of the Site Selection Act, regardless whether this is specifically stated, that the suitability of the project is to be examined in its entirety by the legislator under atomic law during the licensing procedure on the basis of the binding decision on the site in accordance with Section 20 (2) sentence 1.
Following a thorough discussion of the possibilities for achieving this objective, it was decided in the end that the solution is to clarify in Section 20 (3) of the Site Selection Act that, based on the binding decision on the site in accordance with (2) sentence 1, the suitability of the project must be examined in its entirety in the licensing procedure.

For this purpose, it was recommended that Section 20 (3) of the Site Selection Act be kept in its current version and that it be supplemented as follows: ‘The suitability of the project must be thoroughly examined on the basis of this decision during the licensing procedure.”

8.3.3 Legal redress options in domestic law

8.3.3.1 Recommendations of the Commission

The Commission discussed in-depth the question as to whether the option of legal redress provided for in Section 17 (4) of the Site Selection Act to date is to remain intact in addition to the legal redress option recommended by the Commission for Section 19 (2) or whether it is to be replaced by it. Good reasons were provided for both views. During this discussion, it was also shown that citizens have numerous other possibilities for seeking legal remedies in connection with the site procedure and licensing procedure, for example, in the case of operational plan approvals, water use permits in connection with exploration orders to tolerate preparatory work on properties.[1114]
Furthermore, the question of legal redress was also addressed in connection with Section 14 of the Site Selection Act.
In considering all arguments and the legal pros and contras, the Commission believes that a question remains, which in the end must be answered on the basis of political criteria. Against this background, it speaks in favour of preserving the legal redress provided for in Section 17 (4) of the Site Selection Act.

[1113] Cf. 12. Meeting of the ‘Evaluation’ working group on 2 November 2015, verbatim record, p. 28.
[1114] K-Drs. /AG2-27 provides a detailed overview of possible legal remedies.

8.3.3.2 Principles of deliberation

The experts present at the corresponding hearing conducted by the Commission on 3 November 2014 provided differing evaluations of the question regarding the necessity of legal redress options in the site selection procedure, which go beyond what is required by Community Law[1115]: On one hand, it was argued that instead of favouring additional possibilities for legal redress, there should be more focus on conciliation, mediation and a consensus.[1116] On the other hand, further legal redress for achieving the objective of broad involvement of citizens as well as the corresponding high level of acceptance of the procedure was considered necessary.[1117]
In general, from the standpoint of Community law, the legal redress granted to date in Section 17 (4) of the Site Selection Act could generally be refrained from if the recommendations regarding Section 19 of the Site Selection Act were implemented. Keeping such legal redress would, however, allow for a legal evaluation early on and could therefore minimise the risk of reverting to a very early stage of the procedure with legal redress in accordance with Section 19 of the Site Selection Act.[1118] At the same time, an additional legal redress option would build trust in the procedure thus increasing its level of acceptance.[1119]
In its recommendation, the Commission expressed the view that in both cases delays as well as effects on the use of the formats of public participation could result. After in-depth discussion, it spoke in favour of retaining the legal redress in accordance with Section 17 of the Site Selection Act for the overriding reasons described.

8.4 Moratoriums

8.4.1 Initial situation

Section 1(1) of the Site Selection Act [1120] defines the objective of the Act and the site selection procedure stating a ‘site for a facility for disposal […] that guarantees the best possible safety for a period of one million years is to be found by means of a scientifically-based, transparent procedure [...].’
Against this background, the Commission’s task and intention was to protect all potential siting regions as early on as possible to enable the realisation of the disposal facility at the best possible site and prevent any changes in potential regions leading the selection procedure to in fact focus on the Gorleben site,

[1115] Cf. Commission on Storage of High-Level Radioactive Waste. Analysis of the ‘Evaluation of the Site Selection Act’ hearing / summary of views and results, K-Drs./AG2-4a, p. 24 et seqq.
[1116] Cf. Commission on Storage of High-Level Radioactive Waste. Analysis of the ‘Evaluation of the Site Selection Act’ hearing / summary of views and results. K-Drs./AG2-4a, p. 15.
[1117] Cf. Commission on Storage of High-Level Radioactive Waste. Analysis of the ‘Evaluation of the Site Selection Act’ hearing / summary of views and results. K-Drs./AG2-4a, p. 5 and 7.
[1118] Cf. 12. Meeting of the ‘Evaluation’ working group on 2 November 2015, verbatim record, p. 33, 36 and 39.
[1119] Cf. 8th meeting of the ‘Evaluation’ working group on 22 June 2015, verbatim record, p. 13, cf. 9th meeting of the ‘Evaluation’ working group on 7 September 2015. Verbatim record. p. 40.
[1120] Law on the search and selection of a site for a disposal facility for heat-generating radioactive waste and for amending other laws (Site Selection Act - StandAG) of 23 July 2013 Federal Law Gazette BGBl. I p. 2553.

which is the only site on which a moratorium has been placed[1121]. Such a hazard could, for example, be associated with possible other uses being planned for the respective sites or potential sites being rendered useless as the result of fracking, the extraction of gas or raw materials, CCS[1122] or other measures.
Dealing with the situation in Gorleben, the credibility and new start of the search for a disposal facility for high-level radioactive waste materials in Germany poses a particular challenge; equal treatment of all possible sites is one of the key measures for building trust.[1123]
The fact that Gorleben generally continues to remain part of the procedure in accordance with Section 29 of the Site Selection Act is part of the political compromise of identifying, evaluating and, if applicable, subsequently excluding all potential sites on the basis of equal footing in accordance with Section 13 (1) of the Site Selection Act.[1124]
At the same time the above topic was being addressed by the Commission, extending the existing moratorium for Gorleben was also on the agenda: Until 15 August 2015, the Gorleben site was protected as the sole site based on the 'Ordinance on imposing a moratorium to ensure site exploration for an installation for the disposal of radioactive waste in Gorleben's salt dome' (Gorleben Veränderungssperren-Verordnung, Gorleben VSpV) of 25 July 2005. On 25 March 2015, the German Federal Government ruled to extend the existing Gorleben moratorium in accordance with Section 9g Atomic Energy Act by ten years from August 2015.[1125] In accordance with Section 54 (2) of the Atomic Energy Act, the consent of the Bundesrat was needed for this.

8.4.2 Recommendations of the Commission

The Commission, that is, its working group two, dealt with the topics relating to the moratorium in-depth early on. Numerous expert opinions and statements were obtained; furthermore, a hearing on the topic of mining law was held in order to discuss in detail alternatives under mining law. These in-depth discussions led to two resolutions of the Commission in early 2015.
The resolution of the Commission of 20 April 2015:[1126]
'The Commission asks the German Federal Government to immediately draft a legal regulation [...] to permit the protection of siting regions or planning zones for potential disposal sites from an early stage.'
This point was met with broad consensus.
In a second point, a request was issued for the postponement of the vote in the Bundesrat on the extension of the Gorleben moratorium planned for May 2015 to the following meeting of the Bundesrat in June 2015.

[1121] Cf. 4. Meeting of the 'Evaluation' working group on 11 February 2015, verbatim record, p. 3 et seqq.
[1122] Carbon (dioxide) capture and storage; capture of CO2 in a power plant process and subsequent storage in geological structures.
[1123] Cf. 6. Meeting of the 'Evaluation' working group on 13 April 2015, verbatim record, p. 24.
[1124] Preparing the exclusion and consideration criteria, minimum requirements and other decision-making basis for such a search for a site is the task of the Commission in accordance with Section 4 (5) of the Site Selection Act.
[1125] BR-Drs. 136/15, draft regulation of 27 March 2015.
[1126] Cf. Commission on Storage of High-Level Radioactive Waste. Decision, K-Drs. 102 New of 20 April 2015.

After controversial discussion, the Commission reached the following resolution by a narrow majority and without deriving any further mandate to act on 18 May 2015:[1127]
'The Commission asks the German Federal Government and the Bundesrat to determine whether [...] an extension of the moratorium may be refrained from if the Land of Lower Saxony consents to the application of Section 48 (2) of the Federal Mining Act (BBergG) to protect the Gorleben site against changes.'
On 12 June 2015, the Bundesrat discussed the draft regulation of the German Federal Government on 12 June 2015. At the same time, the Länder agreed to extend the moratorium with the proviso that its term of ten years be reduced to two years or that the moratorium end on 31 March 2017. At the same time, the Bundesrat demanded that the German Federal Government draw up a new legal regulation to make it possible to protect the siting regions or planning zones for potential disposal sites from an early stage.[1128] In doing so, the Bundesrat adopted the resolution of the Commission of 20 April 2015 with the same wording.

8.4.3 Principles of deliberation

The discussion focused on how the Gorleben site can be dealt with in the sense of a national open-ended selection procedure in accordance with the Site Selection Act. For the Commission, the fundamental question was how to protect all possible sites as early as possible with respect to the critical relationship between the required legal security on one hand and the principle of equal treatment in terms of the premise of the 'blank map' for the site selection procedure on the other hand. There is a widespread consensus that legal alternatives to the one-sided moratorium in Gorleben should be developed and implemented as soon as possible.
The Commission essentially discussed two points with respect to protecting all potential sites as soon as possible:[1129]
First of all, the possibility of protecting sites from the point in time a law concerning the decision-making basis has come into effect; a possible option in this respect would be a new legal regulation concerning the temporary deferral of applications for mining projects that would affect the siting regions under consideration.
Secondly, potential sites could be protected from the time the project delivery organisation has submitted its proposals for siting regions and a selection of sites for the first time;
a 'supplementation of the basis for authorisation in Section 12 (2) of the Site Selection Act would come under consideration for this, which provides for the placement of moratoriums on locations identified as potential disposal sites.'[1130] From then on, equal treatment of all potential sites could be achieved by means of multiple moratoriums.[1131] One 'could also, for example, consider an express

[1127] Cf. Commission on Storage of High-Level Radioactive Waste. Decision, K-Drs. 106 New dated 18 May 15.
[1128] First regulation amending the Gorleben moratorium regulation, BR-Drs. 136/15, decision (Annex) of 12 June 2015.
[1129] For details, see BMUB, BMWi. Joint statement of the BMUB and BMWi regarding the 'Mining Law' hearing at the 6th meeting of working group two on 13 April 2015. K-Drs./AG2-11 of 14 April 2015, p. 1 et seqq.; restrictions as well as possible reservations were also discussed there.
[1130] Commission Paper K-Drs./AG2-11 dated 14 April 2015, p. 2.
[1131] Keienburg, Bettina follows similar argumentation; cf. 6th meeting of the 'Evaluation' working group on 13 April 2015, verbatim record, p. 11. Alternatively, she suggests granting the Federal Government

legal provision in the Site Selection Act, according to which the legislator is not bound to conflicting plans of the Land or construction management and such plans can be overridden on the basis of a consideration of the conflicting interests.'[1132]
In early 2015, the task for the Gorleben site was primarily to consider and decide whether the existing moratorium would be extended and if not, how to guarantee that the site is otherwise protected in a legally sound manner. The option of limiting the extension of the moratorium on Gorleben until the end of March 2017 was taken. Thereafter, a general provision should be endeavoured.
Unequivocal legal security was considered an argument in favour of the extension as competing uses of the salt dome, which could jeopardise Gorleben as the potential disposal site, could be ruled out with greater legal certainty than using alternative instruments relating to mining law.
Alternatively, the Commission engaged in controversial discussion of the following possibility:
Section 48 (2) of the Federal Mining Act could provide an adequate means for opening up sufficient possibilities in connection with Section 29 (2) of the Site Selection Act for preventing competing uses of the Gorleben salt dome. It would therefore not be necessary to extend the Gorleben moratorium further; such a method would also offer the advantage that it can be applied to any other potential site in the same manner. If necessary, a moratorium could also be imposed at a later point in time.

8.5 Prohibition of export

8.5.1 Initial situation

Section 1 (1) sentence 2 of the Site Selection Act stipulates 'to achieve [the] objective [of disposal in particular of high-level radioactive waste domestically] no agreements [will] be signed between the Federal Republic of Germany and other states, which would, in accordance with the provisions of the 2011/70/EURATOM Directive of the Council of 19 July 2011, enable the transport of radioactive waste including spent fuel outside of Germany for the purpose of disposal by means of a Community framework for the responsible and safe disposal of spent fuel and radioactive waste (Official Gazette L 199 of 2 August 2011, p. 48).' In connection with the obligation to deliver material on the basis of Section 76 of the Radiation Protection Ordinance (StrlSchV), a legal obligation to dispose of, in particular, spent fuel from nuclear plants operated as power reactors, that is, for energy production, exclusively in Germany has been codified in this way. The EU Directive does not extend the principle of domestic storage and reservation of signing international treaties to spent fuel from research reactors.
Section 9a (1) sentence 1 of the Atomic Energy Act codifies that 'incurred radioactive residual materials as well as removed or dismantled plant components [...] will be recycled in a non-hazardous manner or disposed of as radioactive

authorisation to approve underground spatial development plans; however, this option is associated with significantly less legal protection than would be assured by a moratorium (at the place cited, p. 12).
[1132] BMUB. K-Drs./AG2-6 dated 10 February 2015, p. 4.

waste (direct final disposal).' As of 1 June 2005, no spent fuel from nuclear plants for energy production may be surrendered to a facility for the reprocessing of spent nuclear fuel for utilisation without detrimental effect in accordance with Section 9a (1) sentence 2 Atomic Energy Act.
Spent fuel elements from research reactors are excluded from the ban on reprocessing as they are not used for the commercial production of energy.[1133]
Furthermore, the export of spent nuclear fuel from research reactors is generally possible according to applicable law.
The Commission first addressed the topic of the export of spent nuclear fuel due to the upcoming relocation of spent fuel elements from the *Arbeitsgemeinschaft Versuchsreaktor* (AVR) in Jülich. The interim storage facility there must be evacuated as no licence has been granted for further operation due to reasons of safety. As the fuel elements were originally acquired from the USA, returning them to the USA was also considered as was the construction of a new interim storage facility at the Jülich site as well as interim storage at the facility in Ahaus.[1134]
Different views were expressed within the Commission as to whether the AVR Jülich was to be classified as a research or power reactor and is therefore subject to the prohibition on export from the outset.[1135]
However, a number of members of the Commission did not see any legal possibilities for export as the envisaged reprocessing in the USA would not constitute utilisation without detrimental effect in the sense of Section 9a (1) sentence 1 of the Atomic Energy Act. Furthermore, multiple members of the Commission argued that exporting spent fuel from research reactors was not in line with the objective of Section 1 of the Site Selection Act of only disposing radioactive waste domestically.[1136]
For the duration of a period granted by the Land government of North Rhine-Westphalia for further clarification of the situation concerning the Jülich AVR, the Commission initially suspended its discussion of the topic of the prohibition on export.

In May 2015, Working group two once again addressed the topic and in the end, the view was predominantly held that expanding the statutory prohibition on export to spent fuel from research reactors was advisable.

8.5.2 Recommendations of the Commission

At the 16th meeting of the Commission on 2 October 2015, the following resolution was passed by a majority on 2 October 2015:[1137]
'The Commission

[1133] Cf. the substantiation of the resolution of the Commission: General prohibition on export for high-level radioactive waste . K-Drs. 131 NEW dated 2 October 2015, p. 1.
[1134] Cf. 6th meeting of the Commission of 05 December 2014, verbatim record, p. 90.
[1135] Cf. List of nuclear facilities in the Federal Republic of Germany (BfS, 2015), http://www.bfs.de/SharedDocs/Downloads/BfS/DE/berichte/kt/kernanlagen-stilllegung.pdf, abgerufen am 6. Januar 2016.http://www.bfs.de/SharedDocs/Downloads/BfS/DE/berichte/kt/kernanlagen-stilllegung.pdf, accessed on 6 January 2016.
[1136] Cf., among other things, the 7th meeting of the Commission on 11 May 2015, verbatim record, p. 42 et seqq.
[1137] Cf. resolution of the Commission of 2 October 2015, K-Drs. 131 NEW.

1. speaks in favour of the statutory implementation of a general ban on the export of high-level radioactive waste;
2. and calls upon the Federal Government to draft a new regulation for the ban on the export for spent fuel elements from research reactors, which takes into account the imperative aspects of non-proliferation and enabling cutting-edge research (in particular FRM II).'

8.5.3 Principles of deliberation

The Commission and in particular Working group two discussed in-depth the question of expanding the statutory prohibition on export to include spent fuel elements from research reactors with the involvement of the competent departments of the Federal Government and inclusion of the clarification process for the Jülich AVR. The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety submitted a progress report on the remaining waste types and quantities occurring at German research reactors on 7 September 2015[1138] at the request of Working group two, which provided a detailed description of the situation of each of the reactors.
In consideration of the disposal possibilities described in the report of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety for the research reactors in Germany, the Commission came to the conclusion that statutory expansion of the prohibition on export to include spent nuclear fuel from research reactors is advisable in the future.[1139]
The Commission believes that expanding the prohibition on export in this way would provide an important signal emphasising the objective of comprehensive final storage of spent fuel elements within Germany.[1140]
The Commission believes, however, that the extension must be embodied so as to not consequently restrict science and cutting-edge research, for example, important material research and the manufacture of products that are urgently needed such as radiopharmaceuticals for medical purposes (Garching II research reactor Munich) in Germany and that imperative considerations of non-proliferation are accounted for. Therefore, in a particular case where a foreign state makes its supply of nuclear fuel for a research reactor in Germany under non-proliferation considerations based on obligations resulting out of international treaties contingent on the subsequent return of the spent fuel elements to the supplying country, this would, notwithstanding a general prohibition on export, have to be permitted in the interest of securing research in Germany.

8.6 Access to information in the site selection procedure

In order to guarantee the transparency of decisions in accordance with the Site Selection Act, providing general access to the information used in the site

[1138] Cf. K-Drs./AG2-19.
[1139] Cf. 16. Meeting of the Commission on 02 October 2015, verbatim record, p. 73 et seqq.
[1140] The Free State of Saxony refers to the special situation involving the decommissioned research reactors of the Rossendorf research centre whose spent fuel elements will not be exported to Russia as planned. They will therefore be kept in interim storage in the transport container storage facility in Ahaus. The German Federation will be asked to account for this burden in a suitable manner.

selection procedureis of particular importance.[1141] In the view of the Commission, comprehensive access to information is a particularly valuable asset and must be ensured, particularly with respect to the public participation in the site selection procedure.[1142]
The Commission has therefore evaluated whether the existing statutory provisions guarantee adequate access to information[1143] and, at the same time, differentiated in particular between

- access of public bodies to geological data and
- access to information by the public.

8.6.1 Access of public bodies to geological data

With respect to access of public bodies handling the search for a disposal site, including the project delivery organisation, to relevant geological data, in particular access to geoscientific exploration data concerning raw material deposits and access to data from private entrepreneurial explorations was considered.[1144] As to whether this is provided for in accordance with Section 12 (3) sentence 2 of the Site Selection Act or the regulations regarding administrative assistance in accordance with the laws on administrative procedures remains open. With respect to the two legal bases, industrial and business secrets as well as intellectual properties rights must generally be protected in accordance with Section 30 of the Administrative Procedure Act. The Geodata Access Act and the Environmental Information Act, which grant public access to applicable data, also contain corresponding protective standards. These protective standards reflect the constitutional assurance of industrial and business secrets as well as intellectual property rights arising from Article 12 and 14 of the Basic Law.
However, all these protective standards permit use of data, that is, they generally also permit access to industrial and business secrets as well as intellectual property if the public interest in the use of the data outweighs the private interest in their confidentiality.
In the context of the search for a disposal site, comprehensive access to the information by the competent public bodies must be assumed in consideration of the special public interest in long-term safe disposal; the special public interest in long-term safe final storage will in many cases outweigh the private interest in confidentiality and would therefore justify handing over the required data, also based on the current legal situation, even if the data owner has not consented to this.[1145]
In administrative practice, data from private entrepreneurial exploration are generally classified by Land geological offices as industrial and business secrets warranting protection and are only disclosed if required by a law or with the express consent of the applicable holder of rights. In some cases, therefore, these

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[1141] Cf. Commission Storage of High-Level Radioactive Waste. 16th Meeting of the 'Evaluation' working group of 11 April 2016. Verbatim record. p. 38-48. Also: 17th meeting of the 'Evaluation' working group dated 9 May 2016. Verbatim record. p. 53-64.
[1142] Cf. Commission on the Storage of High-Level Radioactive Materials. 16th Meeting of the 'Evaluation' working groupof 11 April 2016. verbatim record. p. 40 et seq.
[1143] Cf. 16th meeting of the 'Evaluation' working group on 11 April 2016, verbatim record, p. 38.
[1144] Cf. 17th meeting of the 'Evaluation' working group on 09 May 2016, TOP 7, verbatim record, p. 53 et seqq.
[1145] Cf. 17th meeting of the 'Evaluation' working group on 09 May 2016, TOP 7, verbatim record, p. 54.

geological data also will not, with reference to business secrets, be handed over where handing them over would be legally permissible.
In consideration of this administrative practice, a legal provision to clarify this must, in the context of the search for a disposal site, be endeavoured in the view of the Commission.

8.6.2 Public access to information

The Site Selection Act, however, does not specifically provide for the public's access to information. Section 8 sentence 2 of the Site Selection Act only provides for viewing of all files and documents of the Federal Office for the Regulation of Nuclear Waste Management (BfE) and the project delivery organisation by the members of the pluralistically composed National Societal Commission.[1146]
Access to information for the general public during the site selection procedure is therefore provided for in accordance with the regulations of the Environmental Information Act (UIG) based on international and European law and the Geodata Access Act. The Environmental Information Law grants an individual claim to access to environmental information. The Geodata Access Act provides for the public availability as well as the manner in which geodata are made available. According to the applicable legal situation, both laws complement one another.
In accordance with Section 3 (1) sentence 1 of the Environmental Information Act, every individual is entitled to free access to environmental information from the offices obligated to provide information without having to explain their special interest therein. The information relevant for the search procedure must be generally qualified as environmental information in the sense of the Environmental Information Act. Likewise, the actors involved in the site selection procedure, particularly the Federal Office for the Regulation of Nuclear Waste Management (BfE) and the project delivery organisation are the bodies obligated to provide information in the sense of the Environmental Information Act.[1147] Furthermore, the geological data required for the search for a disposal site are also the geodata as per Section 3 of the Geodata Access Act.
With respect to the claim to information in accordance with the Environmental Information Act as with the case of availability to the public in accordance with the Geodata Access Act, the protection of industrial and business secrets as well as intellectual property rights must generally be observed in accordance with Section 8 and 9 of the Environmental Information Act and Section 12 (2) of the Geodata Access Act. According to which, it must be determined by comparison whether the request for access to information or making protected data available to the public is to be rejected or whether the public's interest in their disclosure overrides this. Specifically, in this case – unlike in the case of the public offices in connection with the search for a disposal site – the public's interest in a transparent, verifiable selection procedure must be weighed up against the confidentiality interests of the data owners. Administrative practice currently tends to take a restrictive approach to the disclosure of industrial and business secrets.[1148]

[1146] The Federal Environment Ministry points out that the members of the National Societal Commission are to be obligated with respect to confidential procedural documents concerning confidentiality, cf. K-Drs./AG2-30 of 07 April 2016, p. 1.
[1147] Cf. Commission Paper/AG2-30 of 07 April 2016. p.1.
[1148] Cf. 17th meeting of the 'Evaluation' working group on 09 May 2016, verbatim record, p. 56 et seq.

Both the availability of geological data for the tasks of public bodies as well as the public availability of geoscientific data are currently the subject matter of an amendment of the Federal Ministry of Economics and Energy. In connection with this amendment of the Mineral Deposit Act, which has primarily provided for the transfer of geological data from mineral exploration to the Land geological offices to date, the questions above will be raised. A corresponding working draft will be finalised before the 2016 summer break.

8.6.3 Recommendations

The Commission has therefore determined that the applicable legal regulations only partially satisfy the need for transparency. In general, it must be ensured that all data relevant to the decision-making process in connection with the site selection procedure such as for safety studies and safety requirements, regardless of how they have been prepared, are made available to the general public. In the process, it must be made as easy as possible for the public to access the information. The documents of the project delivery organisation and the Federal Office for the Regulation of Nuclear Waste Management (BfE) should therefore also be available to the general public without a need for separate request.[1149] The provision must – regardless of their location – ensure that all relevant documents and information are actively published. Particularly all information taken into account in the comparison of sites must be made accessible to the public.
The result is a fundamental need to perform a check for all official information without a petitioner having to issue a request to access said information. This leads to an increase in the resources required for such a check. However, the Commission recommends creating a public information register for the documents of the project delivery organisation and the Federal Office for the Regulation of Nuclear Waste Management (BfE). The public information register makes it possible for the public to actively examine the material. After all, information can only be effectively examined once the nature and scope of existing information is known. Further explanations regarding this topic can be found in Section B 7.2.5 of this report.
With respect to ensuring access of public bodies to geological data, the Federal Ministry for Economic Affairs and Energy has, with the planned amendment of the Mineral Deposit Act, developed an effective approach for implementing the applicable recommendation, which the Commission supports. In this respect, special consideration must be given to the proposed organisational structure under private law of the project delivery organisation, which was recommended by the Commission. Alternatively – particularly for the purposes of the search for a disposal site – corresponding access rights on the basis of the Geodata Access Act could also be provided for directly in the Site Selection Act.

[1149] Cf. Commission Storage of High-Level Radioactive Waste. 17th Meeting of the ‘Evaluation’ working group on 9 May 2016. Verbatim record. p. 62 et seq.

8.7 Further points of importance for the Site Selection Act

8.7.1 Radioactive waste and free trade agreements

While discussing the design of the official structures and the project delivery organisation, the 'Evaluation' working group of the Commission also addressed the question previously raised during the public dialogue titled 'Site for high-level radioactive waste materials' on 20 June 2015 as to whether and to what extent trade agreements of the EU, particularly TTIP, the Transatlantic Trade and Investment Partnership[1150] or TiSA, the Trade in Services Agreement,[1151] will set out requirements for decisions regarding the storage of high-level radioactive waste. In particular, the question was raised as to whether the possibility could arise through the relatively unrestricted establishment of a project delivery organisation during the search process that competent companies from other countries could potentially also tender for the construction of the disposal facility in Germany; this would in turn lead the project delivery organisation as designed by the Commission on the basis of lengthy discussions, to not be considered in the call for tenders.[1152]
To clarify this, the Federal Government was asked to present the corresponding circumstances to the Commission; this was done with a letter of 27 November 2015 from the Federal Minister of Economics and Technology Sigmar Gabriel.[1153] It stated that the trade agreements of the European Union (EU) had to date not nor would they in the future define the official structure or the selection of a project delivery organisation for the storage of high-level radioactive waste in Germany:
The 'General Agreement on Trade in Services' (GATS), which has been in force for 20 years, includes a special provision for tasks in the interest of the public – in particular including the area of waste storage. According to the provision, public bodies may be granted monopolies for such tasks; private parties may also be granted the exclusive right to perform these tasks. The TTIP agreement and other trade agreements of the EU (CETA,[1154] TiSA) will contain the same provisions; these provisions are viable for the future and also made it possible to assign tasks back to government bodies, which have been previously performed by private parties.
The current binding offer of the EU to the USA for TTIP also contains, at Germany's request, a reservation that applies to all German laws for handling radioactive materials and the production of nuclear energy that exist or are enacted in the future[1155]. The reservation for Germany is independent of any concessions of the USA concerning energy. Germany does not intend to commit

[1150] TTIP is the English abbreviation for 'Transatlantic Trade and Investment Partnership' and describes an international treaty between the European Union and the USA, which has been under negotiation since 2013.
[1151] TiSA is the English abbreviation for 'Trade in Services Agreement' and also describes an international treaty between more than 23 parties including the USA and the EU.
[1152] Cf. Commission on the Storage of High-Level Radioactive Materials; 10th meeting of the 'Evaluation' working group of 21 September 2015, verbatim record, page 35.
[1153] Cf. Commission on the Storage of High-Level Radioactive Materials; letter from federal minister Sigmar Gabriel dated 27 November 2015 to the Commission, K-Drs. 142.
[1154] CETA is the English abbreviation for 'Comprehensive Economic and Trade Agreement' between Canada and the EU, which is currently being negotiated at the same time as TTIP.
[1155] Cf. http://trade.ec.europa.eu/doclib/docs/2015/july/tradoc_153670.pdf), accessed on 11 February 2016, p. 109: 'The EU reserves the right to adopt or maintain any measure with respect to the activities specified in the following: [...] In DE, any measure with respect to the processing or transportation of nuclear material and generation of nuclear-based energy.

to market openings in the aforementioned areas under TTIP or other agreements; the German reservation shall remain decisive for the situation here in Germany. With this reply, the ‘Evaluation’ working group concluded its discussion of the topic at its 13th meeting on 11 January 2016 and observed that a current assessment by the Federal Government, which is considered a commitment on its part or letter of intent with respect to further negotiations concerning future trade agreements, is in place. For the Commission, there was therefore no further need for action or legal clarification.[1156]

8.7.2 Right of future generations to long-term safety

The civil use of atomic energy and particularly the aspect of final disposal is a, if not the central question for the protection of future generations.[1157] Section 1 (1) of the Site Selection Act defines the objective of finding the site for an installation for the final disposal of high-level radioactive waste that guarantees the best possible safety for a period of one million years. This perspective aims to achieve safety that is to be guaranteed over the long term; the question as to whether and to what extent people alive today are entitled to also exercise the rights of their descendants with respect to the final disposal of radioactive waste before a court is of central importance.[1158]

In the past, this question has been the object of judicial review in connection with complaints by private persons as well as cities and communities brought against the plan approval decision concerning the construction and operation of a disposal facility for low-level and intermediate level waste in the Konrad mine. In this respect, such a claim was dismissed in the end with the justification that persons alive today are not affected in terms of their subjective rights by the long-term risks associated with the disposal of radioactive waste and consequently by developments in the far removed future. They are therefore prevented today from citing developments that could be expected to occur no earlier than in several hundred thousand years as grounds for their complaints.[1159]

This case law was and continues to be based on the understanding that fundamental rights are subjective rights, which require a legal entity as their bearer.[1160] This alignment of German legal redress with the protection of individual rights against official authority is clarified by Article 19 (4) of the German Basic Law (GG) and Section 42 (2) of the Code of Administrative Court Procedure (VwGO). According to which, a subjective right must always have been infringed upon in order to access the courts. With respect to future generations, this would mean, in a strictly legal sense, that yet unborn, distant descendants and generations in

[1156] Cf. Commission on the Storage of High-Level Radioactive Materials. 13. Meeting of the ‘Evaluation’ working group on 11 January 2016. Verbatim record.

[1157] Cf. Kleiber, Michael (2014). Der grundrechtliche Schutz künftiger Generationen, p. 18 et seq.

[1158] An extensive paper on the topic of ‘Right of future generations to long-term safety’ was in the possession of the ‘Evaluation’ working group at the 14th meeting on 1 February 2016 as K-Drs/AG2-28 for their discussion on this topic; the text present here is primarily based on it.

[1159] Cf. decision of the High Administrative Court (OVG) Lüneburg of 08 March 2006. file reference: 7 KS 145/02, 146/02, 154/02, 128/02, margin no. 23 and 158.

[1160] Cf. Näser, Hanns Wolfgang; Oberpottkamp, Ulrike (1995). Zur Endlagerung radioaktiver Abfälle – Die Langzeitsicherheit. Deutsches Verwaltungsblatt 1995, p. 136 et seqq.

particular would not be the bearers of subjective rights and also could not derive a legal claim to life and physical integrity against the present day state.[1161] Modifications of this principle and exceptions to the requirement for a subjective infringement of a right are now implemented in international requirements – particularly from the Aarhus Convention and the Directive on the Environmental Impact Assessment (EIA Directive).[1162] The requirements of the Aarhus Convention were implemented in European law by the Directive on Public Accessibility,[1163] which is in turn implemented in Germany with the Environmental Appeals Act (UmwRG).[1164] Pursuant to the Environmental Appeals Act, recognised environmental organisations can file an appeal as prescribed by the Code of Administrative Court Procedure (VwGO) without having to claim an infringement of vested rights.[1165] [1166]Explanations concerning the applicability of the Environmental Appeals Act in connection with the site selection procedure have already been provided in section B 8.3.1.
The Environmental Appeals Act, however, has not led to a change with respect to the rights of private persons to file an appeal; in general, the requirement that a potential infringement of vested subjective rights must be claimed continues to apply. The permissibility of appeals of communities also continues to be determined in accordance with general principles such that they are generally not entitled to file an appeal as the trustee of public interests.
The Site Selection Act in particular, however, expressly provides for an exception to this principle; pursuant to Section 17 (4) sentence 3 of the Site Selection Act, the communities in whose municipal district a proposed site for underground exploration is located and the residents of these communities have the same right to file an appeal as recognised environmental associations. The decision of the Federal Office for the Regulation of Nuclear Waste Management provided for in the applicable Section 17 (4) sentence 1 of the Site Selection Act could be challenged by these communities and their residents without an infringement of vested rights having to be claimed.

1161 Cf. Wagner, Hellmut; Ziegler, Eberhard; Closs, Klaus Detlef (1982). Risikoaspekte der nuklearen Entsorgung, p. 166.
1162 Directive 2011/92/EU of the European Parliament and Council of 13 December 2011 on the Environmental Impact Assessment in connection with certain public and private projects. Official Journal of the European Union no. L 26 of 28 January 2012, 0001-0021.
1163 Directive 2003/35/EC of the European Parliament and Council of 26 May 2003 providing for public participation in respect of the drawing up of certain plans and programmes relating to the environment and amending the Directives 85/337/EEC and 96/61/EC of the Council with regard to public participation and access to justice. Official Journal of the European Union no. L 156 of 25 June 2003, 0017-0024.
1164 Cf. Schmidt, Alexander; Kremer, Peter (2007). The Environmental Appeals Act and the 'broad access to justice'. Zeitschrift für Umweltrecht 2007 (volume 2), p. 57; as well as the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety. Environmental information. Environmental Appeals Act (UmwRG). Can be accessed at: www.bmub.bund.de/N37435/ [Stand:www.bmub.bund.de/N37435/ [as of: 19.02.2016].
1165 Cf. Federal Environment Agency. Topics. Environmental Law. Can be accessed at https://www.umweltbundesamt.de/themen/nachhaltigkeit-strategien-internationales/umweltrecht/rechtsschutz [Stand 19.02.2015]; siehe auch Aarhus Konvention. UfU. Inhalt der Konvention.https://www.umweltbundesamt.de/themen/nachhaltigkeit-strategien-internationales/umweltrecht/rechtsschutz [as of 19 February 2015]; also see the Aarhus Convention. Independent Institute for Environmental Issues (UfU). Content of the Convention. Access to justice. Accessible at http://www.aarhus-konvention.de/aarhus-konvention/inhalt-der-konvention/zugang-zu-gerichten.html [As of 19 February 2015].
1166 Cf. Schrödter, Wolfgang (2007). The legal redress of the communities against regional planning and projects in consideration of new developments in European law, p. 175 et seq.

In a material respect, recognised environmental associations have a claim to comprehensive judicial review in accordance with the Environmental Appeals Act (UmwRG). This also includes an examination of the aspects pertaining to long-term safety to be considered based on the respective stage of the procedure in connection with the safety studies, which will be evaluated as part of the precautions to prevent damage in the selection procedure.[1167] In accordance with Section 17 (4) sentence 3 of the Site Selection Act, this claim also extends to communities in whose municipal district a location proposed for underground exploration is located as well as to the residents of such of communities.
Against this background, the Commission does not presently see a need to amend the Site Selection Act; the option of legal redress recommended for Section 19 (2) of the Site Selection Act[1168] must be modelled according to the applicable Sections 17 (4) sentence 3 of the Site Selection Act. In addition, a provision for the approval of the disposal facility, which is modelled according to Section 17 (4) sentence 3 of the Site Selection Act, cannot be adopted in the Atomic Energy Act.

8.7.3 Environmental assessments during the site selection procedure

The Environmental Impact Assessment Act (UVPG) implements international and European requirements for the design of the procedure for environmental assessments of infrastructure projects with an impact on the environment as well as planning processes, which are environmentally relevant with respect to national law. For the Environmental Impact Assessment (EIA) as well as for the Strategic Environmental Assessment (SEA), it sets out minimum procedural requirements for public participation and the procedural steps to be taken. The details of these requirements may be provided for in specific legislation, but they may not diminished in their extent.[1169] If no concrete requirements have been set out in specific legislation, the general regulations of the Environmental Impact Assessment Act must always be applied.
Two Strategic Environmental Assessments and an Environmental Impact Assessment must be carried out in the site selection procedure in accordance with the Site Selection Act. A Strategic Environmental Assessment is provided for

- before the decision on surface exploration in accordance with Section 14 (2) of the Site Selection Act and
- before the decision on underground exploration in accordance with Section 17 (2) of the Site Selection Act.

The Environmental Impact Assessment must be performed prior to the decision on the site in accordance with Section 20 (2) of the Site Selection Act.
In accordance with Section 9b (2) sentence 3 of the Atomic Energy Act, a further environmental impact assessment is required following the conclusion of the site selection procedure in connection with the license for the disposal facility; this environmental impact assessment can be limited to additional or other substantial environmental impacts of the facility to be licensed.

[1167] Cf. Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (2016). Statement regarding the right of future generations to long-term safety. Commission Paper/AG2-29.
[1168] Cf. Chapter 8.3.2 of this report.
[1169] Cf. Environmental Impact Assessment Act in the version of the publication of 24 February 2010 (Federal Law Gazette I p. 94), which was last amended by Article 2 of the law of 21 December 2015 (Federal Law Gazette I p. 2490). Sections 4 and 14e.

The stipulation of the siting regions and sites for surface exploration[1170] as well as the definition of sites for underground exploration are considered plans or programmes requiring a SEA.[1171] The construction and operation of a facility for the disposal of radioactive waste is a project requiring an EIA.[1172] The legal decision on the site in accordance with Section 20 (2) sentence 1 of the Site Selection Act already provides for part of the approval decision for the licensing procedure in accordance with Section 9b (1a) of the Atomic Energy Act.
For this reason, an environmental impact assessment must be performed in advance of the decision on the site in accordance with Section 18 (4) of the Site Selection Act.
According to the assessment of the expert opinions tasked by the Commission, these requirements comply with those laid down in Community law[1173]; further concretisation should be refrained from[1174]. Notwithstanding the above, the Commission expects that in particular the number and varied nature of the formats for public participation to be coordinated by both sides will significantly increase as a result of the Commission's proposals.
The Commission speaks in favour of deleting Section 11 (3) of the Site Selection Act without replacement. The references to Section (11) of the Site Selection Act regarding the environmental impact assessment are of a purely declaratory nature.[1175] It would also apply without this express reference in Sections 4 and 14e UVPG, which prescribes the application of the provisions of the Law on Environmental Impact Assessment to the extent the legal regulations of the Federal Government or the Länder do not contain any more specific provisions or they do not comply with the requirements of the Environmental Impact Assessment Act. On the other hand, the wording in Section 11 (3) of the Site Selection Act can, however, result in a lack of clarity with respect to the application of the provisions of the Environmental Impact Assessment Act to cross-border participation procedure[1176] and also contains an editorial error in sentence 2: There, according to the explanatory memorandum, reference must be made to Section 18 (3) instead of Section 17 (3) of the Site Selection Act.[1177] Due to the purely declaratory function of Sections 11 (3) of the Site Selection Act, deleting this provision would not result in a change to the legal situation, but would prevent any lack of clarity with respect to the application of the law. This deletion would also rule out a need to correct the provision.[1178]

[1170] Cf. Environmental Impact Assessment Act in the version of the publication of 24 February 2010 (Federal Law Gazette I p. 94), which was last amended by Article 2 of the law of 21 December 2015 (Federal Law Gazette I p. 2490). Annex 3, no. 1.15.
[1171] Cf. Environmental Impact Assessment Act in the version of the publication of 24 February 2010 (Federal Law Gazette I p. 94), which was last amended by Article 2 of the law of 21 December 2015 (Federal Law Gazette I p. 2490). Annex 3, no. 1.16.
[1172] Cf. Environmental Impact Assessment Act in the version of the publication of 24 February 2010 (Federal Law Gazette I p. 94), which was last amended by Article 2 of the law of 21 December 2015 (Federal Law Gazette I p. 2490). Annex 1, no. 11.2.
[1173] Cf. Kümmerlein Rechtsanwälte & Notare (2015). Expert assessment. K-MAT 37b, p. 49; and BBH Rechtsanwälte (2015). Expert opinion. K-MAT 37b, p. 53;
[1174] Cf. 12. Meeting of the ‘Evaluation’ working group on 23 November 15, verbatim record, p. 43.
[1175] Cf. 12th Meeting of the ‘Evaluation’ working group on 23 November 2015, verbatim record, p. 42.
[1176] Cf. Kümmerlein Rechtsanwälte & Notare (2015). Expert opinion. K-MAT 37b, p. 49;
[1177] Cf. 12th Meeting of the ‘Evaluation’ working group on 23 November 2015, verbatim record, p. 42.
[1178] Cf. 12. Meeting of the ‘Evaluation’ working group on 23 November 2015, verbatim record, p. 43.

8.7.4 Site selection and regional planning

Public bodies must always observe the objectives of spatial planning with respect to spatially-significant measures and planning, the corresponding principles and other requirements in the decisions made as the result of consideration and discretionary decisions.[1179] Spatial planning is performed based on the plans of the respective Länder.[1180] As a result, the Federal Government is, with respect to spatially-significant measures and planning, generally bound to the objectives and principles of the spatial planning stipulated by the Lände[1181] and must assess the spatial impact of spatially-significant federal plans and measures in a spatial planning procedure.[1182] Such a procedure may only be refrained from if it is determined that the spatial impact is being assessed otherwise.[1183] For example, this is expressly stipulated e.g. in accordance with Section 28 Grid Expansion Acceleration Act (NABEG) for the modification of very high-voltage lines in accordance with the federal grid plan.

A spatial planning procedure is generally provided for with respect to the construction of an installation for the final disposal of radioactive waste, which requires plan approval in accordance with Section 9 b Atomic Energy Act.[1184] In Section 19 (1) sentence 3 of the Site Selection Act it is also stated that the site proposal of the Federal Office for the Regulation of Nuclear Waste Management must, among other things, include the grounds for the spatial impact.

In this context, the Commission holds the view that the site selection procedure for a disposal facility, particularly for high-level radioactive waste materials has been provided for extensively in the Site Selection Act. The questions of spatial compatibility with the participation of the Länder and communities must be evaluated conclusively in this procedure; in any case, a stand-alone spatial planning procedure in addition to the procedure in accordance with the Site Selection Act does not need to be conducted.[1185] In this procedure, the selection of the disposal site must be primarily oriented towards the safety standard.[1186]

In order to ensure this, the Commission recommends including a provision based on Section 28 sentence 1 of the Grid Expansion Acceleration Act (NABEG)[1187]

[1179] Cf. Spatial Planning Act of 22 December 2008 (Federal Law Gazette I p. 2986), last amended by Article 124 of the Regulation of 31 August 2015 (Federal Law Gazette I p. 1474). Section 4 (1) sentence 1.

[1180] Cf. Spatial Planning Act of 22 December 2008 (Federal Law Gazette I p. 2986), last amended by Article 124 of the Regulation of 31 August 2015 (Federal Law Gazette I p. 1474). Section 8 (1) sentence 1 and sentence 2.

[1181] 3 Cf. Spatial Planning Act of 22 December 2008 (Federal Law Gazette I p. 2986), as amended by Article 124 of the Regulation of 31 August 2015 (Federal Law Gazette I p. 1474). Section 5 (1).

[1182] Cf. Spatial Planning Act of 22 December 2008 (Federal Law Gazette I p. 2986), as amended by Article 124 of the Regulation of 31 August 2015 (Federal Law Gazette I p. 1474). Section 15 (1) sentence 1 and sentence 5.

[1183] Cf. Spatial Planning Act of 22 December 2008 (Federal Law Gazette I p. 2986), as amended by Article 124 of the Regulation of 31 August 2015 (Federal Law Gazette I p. 1474). Section 15 (1) sentence 4.

[1184] Cf. Spatial Planning Act of 22 December 2008 (Federal Law Gazette I p. 2986), as amended by Article 124 of the Regulation of 31 August 2015 (Federal Law Gazette I p. 1474). Section 15 (1); in conjunction with the
Spatial Planning Regulation of 13 December 1990 (Federal Law Gazette I p. 2766), as amended by Article 5 (35) of the Law of 24 February 2012 (Federal Law Gazette I p. 212). Section 1 sentence 2 no. 3.

[1185] Cf. 14. Meeting of the 'Evaluation' working group on 01 February 2016, verbatim record, p. 51.

[1186] Cf. 14. Meeting of the 'Evaluation' working group on 01 February 2016, verbatim record, p. 51 et seq.

[1187] 'Contrary to Section 15 (1) of the Spatial Planning Act in conjunction with Section 1 sentence 2 number 14
Spatial Planning Regulation of 13 December 1990 (Federal Law Gazette I p. 2766), last amended by Article 21 of the law of 31 July 2009 (Federal Law Gazette I p. 2585), a spatial planning procedure for the

in the Site Selection Act. Said provision should be designed so that it, in addition to spatial planning, also accounts for other requirements of planning law, in particular building planning. This should ensure that the Federal Government is not impaired or restricted in determining the site while accounting for the primacy of safety by requirements of planning on the part of a Land or urban land use planning.

8.7.5 Comparative procedure for site selection

Different interpretations of the term 'site with the best possible safety', which is introduced in Section 1 of the Site Selection Act as the objective of the law, but is not defined further, may, in the view of some of the members of the Commission, have consequences for the development of the comparative criteria as well as the design and performance of the search procedure. With respect to the aspect of carrying the costs of a comparative search procedure, which had also been addressed in this respect, the Commission came to the conclusion after lengthy discussion that this aspect is irrelevant with respect to the question of a comparative search procedure.[1188]
During the discussion, the Federal Environment Ministry, the Länder ministers and the members of the Bundestag clarified on several occasions that the consensus existed in the legislative process that a site selection procedure with the objective of finding the 'site with the best-possible safety' had to be a comparative procedure.
According to which, the Site Selection Act has the objective of finding the best site for a facility for final disposal in accordance with Section 9a (3) sentence 1 of the Atomic Energy Act, which guarantees the best possible safety for a period of one million years.
In the view of some of the Commission members, however, the term is not sufficiently defined in the Site Selection Act; furthermore, according to the same view, Section 17 of the Site Selection Act and, in particular, Section 19 of the Site Selection Act are not worded with sufficient clarity so as to clearly express the will of the legislator.
Against this background, the Commission, following an in-depth consultation, agreed on 21 January 2016 to use the following definition for consistent use in the report of the Commission:
The site for a disposal facility, which is the object of the search, in particular for high-level radioactive materials, offers the best possible safety for the long-term protection of people and the environment against ionising radiation and other damaging effects of such waste for a period of one million years people according to the current level of knowledge. This site must be selected in a multi-stage procedure in accordance with the respective requirements including a comparison of the suitable sites in the respective phase. The burdens and obligations for future generations must be limited as much as possible. Guided by the idea of sustainability, the site with the best possible safety according to the state of the art in science and technology will be determined in the selection procedure described in this report and the criteria specified therein, which are to

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installation or the modification of very high voltage lines, for which route corridors or routes have been designated in the federal grid plan does not take place.

[1188] 17th meeting of the 'Evaluation' working group on 9 May 2016 verbatim record. p. 7.

be applied, and safety studies. It must be possible to correct errors during the selection procedure and later at the site that is found.[1189] The working group two has been tasked with discussing possible changes to the Site Selection Act on this basis. Different views regarding this topic were expressed during the discussion. While some members believed that legal clarification of the term 'site with the best possible safety' and, as a result, an amendment of the Site Selection Act was necessary, other members held the view that the applicable Site Selection Act clearly supported a comparative site selection procedure and that an amendment of the law could be refrained from.

Following extensive deliberation, the Commission in the end agreed to the recommendation of working group two at its 27th meeting on 13 May 2016, also in the view of the representative of the Federal Environment Ministry, to acceptable changes to the Site Selection Act for the purpose of further clarification:

6. Section 1 Objective of the Law:

(Sentence 1 will be amended, sentence two will be new)

(1) The objective of the site selection procedure is to find the site with the best possible safety for an installation for final disposal in accordance with Section 9a (3) sentence 1 of the Atomic Energy Act in the Federal Republic of Germany by means of a transparent, scientifically based procedure in particular for the high-level radioactive waste produced domestically. The site with the best possible safety is the site that is found on the basis of a comparative procedure of the suitable sites in the respective phase in accordance with the corresponding requirements and offers the best-possible safety for the long-term protection of people and the environment against ionising radiation and other damaging effects of such waste. This also includes the prevention of unreasonable burdens and obligations for future generations.

7. Section 19 Conclusive comparison of sites:

(New section 1 sentence 1; sentence 2 has been amended: In sentence 1, the comparison will be codified and the criteria will be adopted as an important basis. The part of the sentence 2 'in consideration of the objectives of Section 1 (1)' may be omitted.)

(1) The Federal Office for the Regulation of Nuclear Waste Management proposes, after a conclusive comparison of multiple sites based on the criteria of the law and the safety studies conducted while considering private and public interests as well as the result of public participation, the site offering the best possible safety for the construction of a disposal facility (site proposal).

The site proposal must allow for the expectation that the necessary precautions in accordance with the state of the art of science and technology to prevent damages caused by the construction, operation and decommissioning (...)

8.7.6 Storage of data for documentation purposes

The Commission on the Storage of High-Level Radioactive Materials believes that it is necessary that the data identified in section B 6.7.1, in section B 6.5.8 and documentation be stored for the long term. This is based on the finding that documenting this data constitutes a 'safety measure for the entire chain of nuclear disposal and in particular for a disposal facility'.

[1189] See the definition in the preamble of this report. p. 23.

A corresponding legal framework is required to ensure this. In addition to the existing standards under nuclear and radiation protection law, the Commission recognises a further need for regulation. In particular, the applicable statutory and sub-statutory regulations are not sufficient for establishing a duty on the part of the plant operators to promptly and regularly provide the data and documents to be stored. Key aspects of existing provisions are contained in the ninth section of Chapter 3 of the Radiation Protection Ordinance (StrlSchV) as well as in the Atomic Energy Act (AtG). However, the provisions are limited in many respects or serve other purposes.[1190] Also with respect to time, they do correspond to the described entitlement to long-term storage and availability.[1191]

The Commission therefore recommends the establishment of a central state body, which, as the organisation whose primary task is documentation, permanently stores these data and documents and possesses institutional ‘awareness’ of their importance to safety. In this sense, the Commission has identified the following key points that must be provided for:

- The establishment or naming of the central institution / organisational unit in the area of federal administration whose primary responsibility is documentation.
- The regulation of the supply of all relevant information to this institution / organisational unit by the current information owners. This includes the stipulation as to who provides which information as well as the clarification of rights to access and view information, ownership rights and the rights of the institution / organisational unit, for example, to specifically request certain information.
- The long-term securing of financing.
- The time factor; this includes in particular the beginning of the duty to provide information and documentation, deadlines as well as provisions on the permanence of data storage.
- Documentation occurs as active data storage and in order to be passed on to the next generation.
- The definition of at least two different, suitable bodies for storing documents.

The Commission recommends the following to implement these key points:

- Supplementation of the Atomic Energy Act with a binding provision that accounts for the described requirements. In general, such a provision would also be plausible in the Site Selection Act; considering that this law is, however, already conceived for a finite period alone based on its purpose – while it is to be ensured that data are stored permanently and that they will in some cases acquire their actual importance long after the conclusion of the site selection procedure – the Atomic Energy Act or also the planned Radiation Protection Act are generally better suited.
- To adopt the power to issue statutory regulations in the main law to regulate in particular data and information to be collected specifically by the central state body and to more specifically define duties to provide such data and information in order to permit the flexible adjustment of these elements to current developments.
- For the purpose of uniformity and consistency, adjustments are to be made to existing provisions in the Atomic Energy Act and in other laws.

[1190] Cf. e.g. Section 2c (4) of the Atomic Energy Act, which solely sets out duties to provide information for the preparation of a national disposal programme.

[1191] Cf. e.g. Section 73 (3) of the Radiation Protection Ordinance, which prescribes that the saved data must be kept for one year.

In connection with the new Euratom Directive for radiation protection[1192] to be implemented in national law by 2018, the Federal Environment Ministry is currently working on a draft of a law, which will fundamentally modernise German radiation protection law and design it to permit easy execution.[1193] In the view of the Commission, this offers the opportunity to address and implement the above recommendations in the context of a comprehensive approach.
In the view of the Commission, the period up to 2018 is problematic as the site selection procedure will begin shortly following the review of the Site Selection Act and, in the view of the Commission, requires a comprehensive, binding provision for the storage of relevant data and for the documentation requirements. Against this background, the period until the revised Radiation Protection Law enters into force will be bridged by means of a suitable transitional provision, which already permits the establishment of necessary institutional / organisational structures as well as storage of particularly relevant data records.

8.7.7 Anchoring of safety requirements in the Site Selection Act

8.7.7.1 Initial Situation

The Commission's task of evaluating whether and how general safety requirements are to be statutorily anchored resulted out of Section 4 (2) point 2 in connection with (5) of the Site Selection Act. In some cases, they follow from the recommendation of the Commission regarding the foundations for decision-making[1194] and in some cases, they are already contained in the safety requirements of the Federal Ministry of the Environment from 2010.
As a result, working group 3 of the Commission dealt with the safety requirements concerning the disposal of heat-generating radioactive waste[1195] and, in this respect, the safety requirements of the Federal Ministry of the Environment that were approved, by a majority, by the Länder Committee for Nuclear Energy on 30 October 2010[1196]. It came to the conclusion that these safety requirements generally reflect the state of the art of science and technology and the state of international discussions, but should be updated regularly. The Commission has decided on a number of points to be addressed when revising the safety requirements. To date, the safety requirements do not include the selection procedure. Rather, they apply to the selected site, but are

[1192] Directive 2013/59/EURATOM of the Council of 5 December 2013, which can be accessed at: http://eur-http://eur-
lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2014:013:0001:0073:DE:PDF
[Stand:lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2014:013:0001:0073:DE:PDF [as of: 21.04.2016].
[1193] Cf. BMUB press release no. 173/13 of 5 December 2013, which can be accessed at: www.bmub.bund.de/N50490/www.bmub.bund.de/N50490/
[as of: 22 April 2016].
[1194] Cf. verbatim record of the 18th meeting of working group two of 6 June 2016.
[1195] Cf. Chapter B 6.5.1.
[1196] In this context, the Federal Ministry of he Environment clarified that the safety requirements from 2010 must be applied to high-level, heat-generating radioactive materials. On the other hand, the safety requirements from 1983, which are each to be evaluated as to what extent they reflect the current state of the art of science and technology, apply to low-level and medium-level radioactive waste; cf. verbatim record of the 18th meeting of the working group two of 6 June 2016.

also relevant for the selection procedure because multiple safety studies must be conducted during the procedure. To date, requirements concerning recoverability also follow only on the basis of the safety requirements.

8.7.7.2 Recommendations of the Commission

In addition to directly anchoring general safety requirements in the Site Selection Act, the Commission recommends also establishing a new power to issue ordinances therein to provide for the safety requirements concerning the final disposal of heat-generating radioactive waste relevant to the site selection procedure or to modify the applicable power to issue ordinances already provided for in the Atomic Energy Act for this process.
The ordinance to be drawn up with the participation of the Länder and public must be in place no later than the beginning of step 3 of phase 1 of the site selection procedure. It should be evaluated at least every 10 years and, if necessary, be adapted to the state of the art of science and technology.
The same goes for the codification of the methodology of the safety studies.

8.7.8 Anchoring of the Atomic Energy Act in German Basic Law

The question of directly anchoring the phasing-out of nuclear power in German Basic Law was raised early on in the Commission:[1197] At the expert hearing on the topic of 'Evaluation of the Site Selection Act'[1198], an expert also held the view that the search for a disposal site for radioactive waste should be linked to the phasing out of nuclear energy and the production of additional radioactive waste and that this can best be ensured by a corresponding stipulation in the German Basic Law.[1199]
The 'Evaluation' working group two of the Commission has since dealt with the topic extensively. At its suggestion, the Commission, where different views were also held, resolved to obtain two legal opinions in order to further explore the question of anchoring the phasing-out of nuclear energy in the German Basic Law. In particular, points of reference for an amendment of the German Basic Law including specific recommendations for wording should be identified and evaluated in terms of their advantages and disadvantages as well as their ability to control.
The opinions issued by Prof. Dr. Klaus Ferdinand Gärditz and Prof. Dr. Alexander Roßnagel [1200] were in place in April 2016 and were discussed at the 17th meeting of working group two on 9 May 2016.
In general, both experts see the possibility of anchoring the phasing out of nuclear energy in the German Basic Law. According to them, this is possible under the conditions set out in Article 79 of the German Basic Law. Future legislators amending the constitution shall, however, still have the freedom to decide to return

[1197] Cf. K-Drs./AG2-19. p. 5.
1198 Cf. Commission Storage of High-Level Radioactive Waste Materials. 5th Meeting of the Commission of 3 November 2014.Verbatim record. p. 16-99.
[1199] Cf. K-Drs. 54. p. 3.
[1200] Cf. Gärditz, Klaus (2016). Verankerung des Atomausstiegs im Grundgesetz? K-MAT 61. And: Roßnagel, Alexander (2016). Kurzgutachten zur Verankerung des Atomausstiegs im Grundgesetz. K-MAT 62.

nuclear power in accordance with Article 79 (2) of the Basic Law. The frequently expressed wish to make the phasing-out of nuclear power 'irreversible' could therefore not be fulfilled constitutionally.[1201] However, a more substantial de facto binding effect would result from a corresponding amendment of the German Basic Law as prescribed by Article 79 (2). The principle of democracy does not impair this; a ban on the part of the current legislator on taking decisions today that have long-term consequences and which essentially bind future legislators and generations, cannot be inferred from the German Basic Law.

While the legal opinion of Prof. Dr. Roßnagel focuses on concrete possibilities for amending the German Basic Law, the legal opinion of Prof. Dr. Gärditz presents the points for and against anchoring the phasing-out the use of nuclear energy in the Germany Basic Law. In the end, he expresses the preference of leaving the German Basic Law unchanged.[1202]

With respect to the question of 'whether', the following considerations must be taken account of:

On one hand, a plausible objective on a constitutional level would be to utilise the symbolic effect of the German Basic Law to emphasise that the phasing-out of nuclear power is a value-based decision of fundamental importance to society as a whole. An amendment of the constitution could also make it clear that nuclear energy will also lose its approval under the constitution once the energy generation and supply infrastructure has been transformed.

Some of the Commission members also held the view that this could be a highly effective measure for building trust, also with respect to the credibility of the procedure.

From the standpoint of democratic theory, a constitutional amendment should not be used solely for the purpose of depolarising a situation where other democratic means have proven ineffective. Furthermore, the legislator would make it even more difficult to respond to unforeseeable developments by constitutionalising the phasing-out of nuclear energy and giving minorities a veto right in connection with energy policy without a material reason.

If there is qualified political willingness of a majority to anchor the phasing-out of nuclear energy for generating electricity in the German Basic Law, a number of points of reference would generally come under consideration; possible regulatory methods have been discussed in the expert opinions and by working group two:

- Definition of the state objective of Article 20a of the German Basic Law
- Redefinition of the state objective of Article 20b of the German Basic Law
- Supplementation of the basic right to life and physical integrity in a new sentence 4 in Article 2 (2) of the Basic Law
- Amending the competence standard of Article 73 (1) number 14 of the German Basic Law

[1201] K-MAT 61, page5, 19 et seq.

[1202] For relevant explanations and considerations in the expert opinions cf. K-MAT 61, p 24-49; K-MAT 62. p. 11-25. Member of the Bundestag Kanitz expressed a critical view in a letter to the chairman of the working group, cf. K-Drs./AG2-22.

- Supplementation of the competence standard of Article 87c of the German Basic Law

Overall, in the view of the experts, anchoring the phasing-out of nuclear energy is generally possible as well as permissible in all five variations; anchoring the phasing-out of nuclear energy in basic rights, particularly in the general freedom of action in accordance with Article 2 of the German Basic Law, could, however, be perceived as an inconsistency in connection with this provision. Similar concerns could indirectly oppose the anchoring of the phasing-out of nuclear energy in the competence standards of Article 73 (1) no. 14 and 87c of the German Basic Law.

In general, a breach of the respective anchoring could also be claimed before the Federal Constitutional Court. However, there are differences as to who can initiate this review. The aforementioned alternatives differ greatly in terms of their legal effect. With respect to the stipulation of a provision for a state objective, it would also have to be considered that linking the phasing-out of nuclear energy with aspects of climate change would raise numerous further questions and that the protection of the climate is already handled by the applicable Article 20a of the German Basic Law. A ‘state objective of energy transition’ would give rise to similar difficulties.

With respect to the limits of a constitutional amendment with respect to supranational and international law, it must be made clear in the assessment of the experts that European law does not contain any requirements that would stand in the way of anchoring the phasing-out of nuclear energy in the German Basic Law. The protection of property under international law in accordance with the European Convention on Human Rights also does not establish any regulatory barriers, which would invalidate a constitutional amendment from the outset.[1203]

Overall, the Commission holds the view that the statutory anchoring of the phasing-out of nuclear energy in the German Basic Law would be possible in principle. Anchoring in the German Basic Law would not make the phasing-out of nuclear energy irreversible, but establish a substantial de facto binding effect. The final decisive consideration whether to use the symbolic effect of a constitutional amendment to satisfy society in light of the reservations of constitutional policy associated with depolarising the topic is a highly political decision, which the Commission – also in consideration of its statutory mandate – should not and does not intend to decide on. The Commission therefore recommends that the legislator thoroughly evaluate the considerations presented in the two expert opinions and include them in its decision regarding a need for action.

8.8 Recommendations of the Commission to the legislator

In accordance with Section 4 (1) of the Site Selection Act, the Commission will conduct a review of the law and provide recommendations to the Bundestag and Bundesrat for the amendment, which will form the basis for the review of the law by the Bundestag in accordance with Section 4 (4) of the Site Selection Act. Except for the recommendations regarding the relevant foundations for decision-making relating to the course of the site selection procedure and for the participation of the public described in sections B 6 and B 7, these recommendations are summarised below as follows.

[1203] Cf. in detail K-MAT 61. p. 72-85. as well as K-MAT 62. p. 55-58.

8.8.1 Organisational structure

The organisational structure laid down in the current Site Selection Act is in need of amendment. In particular, the official structure set out is not suitable for resolving the wide range of tasks in connection with the disposal facility in a competent and timely manner.[1204] The Commission therefore recommends that:[1205]

- the operator tasks of the Federal Office for Radiation Protection (BfS), Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe mbH (DBE, the German Service Company for the Construction and Operation of Disposal Facilities), and Asse-GmbH are bundled in a Federal Company for Nuclear Waste Management (Bundes-Gesellschaft für kerntechnische Entsorgung, BGE). The new company will be federally owned.
- The new federally owned company will be established, to the extent possible, in particular with the consent of the current owners of the DBE. It will not be privatised in the future.
- For the sake of transparency, the waste producers and, if applicable, other institutions will be involved before any decisions are taken by the federally owned company. This could be achieved in a suitable manner e.g. by means of a clearing centre.[1206]
- All tasks and resources of the BfS as the operator, the DBE and Asse GmbH as the administrative aide in connection with planning, construction, operation and decommissioning of disposal facilities as well as the BfS as the project delivery organisation in accordance with the Site Selection Act will be immediately transferred to the new company.
- The BGE will be run under private law. Its main task is site selection as well as the construction, operation and decommissioning of disposal facilities for radioactive waste materials. It is not directly bound to the federal budget.
- Public participation in accordance with the Site Selection Act must be ensured.
- The state regulatory, licensing and supervisory tasks in connection with the safety of the disposal

of spent fuel and radioactive waste are – to the extent not handled by the Länder - bundled in one federal office. The Federal Environment Ministry is asked to provide a recommendation as to how this regulatory authority is to be designed with respect to scope, organisation and structure including a timeline; adequate provision of staff and finances must be ensured. This does not mean that the responsibilities between the German Federation and Länder provided for in the Site Selection Act would have to be modified.
Independence must be ensured in accordance with the requirements of the Directive 2011/70/Euratom.

The importance of trade agreements of the European Union for the organisational structure:

[1204] Cf. Commission on the Storage of High-Level Radioactive Materials; framework paper on the topic of 'Official structure'. K- Drs./AG2-9.
[1205] Cf. Commission on the Storage of High-Level Radioactive Materials; K-Drs. 91 NEW.
[1206] This recommendation does not yet account for the recommendations of the Commission on the Financing of the Phasing-Out of Nuclear Energy (KFK), which also provides for changes with respect to the responsibility for the disposal of radioactive waste.

In connection with deliberations regarding the design of the official structure and the project delivery organisation, the Commission also dealt with the question as to whether and to what extent the planned trade agreements of the EU (CETA, TTIP and TiSA[1207]) provide guidelines for decisions regarding the storage of high-level radioactive waste[1208]. Specifically, the question was raised as to whether, through the relatively unrestricted establishment of a project delivery organisation as a company under private law during the search procedure, companies from other countries could potentially also tender for the construction of a disposal facility in Germany. This could in turn lead the project delivery organisation, which the Commission proposed as a federally owned company following in-depth discussion, to not be considered in the call for tenders.[1209]
In his letter of 27 November 2015, Minister for Economic Affairs and Energy Sigmar Gabriel clarified, at the request of the Commission, that the trade agreements of the European Union may not stipulate or influence the current or future structure of authorities or the selection of a project delivery organisation for the storage of high-level radioactive waste in Germany.[1210] The Federal Government will see to this in future trade agreements. An assessment from the Federal Government is therefore at hand, which is deemed a voluntary commitment or a declaration of intent for further negotiations regarding future trade agreements. As a result, there is no further need for action or legal clarification on the part of the Commission.

8.8.2 Legal redress including the right of future generations to long-term safety

The topic of appropriate legal redress in the selection procedure in accordance with the Site Selection Act as well as in the ensuing licensing procedure in accordance with the Atomic Energy Act (AtG) was handled separately according to 'Compatibility of the existing legal provisions with the requirements of Community law'.
Implementation of Community-law requirements: The Commission determined that the legal redress currently granted under the Site Selection Act does not meet the Community-law requirements of the EIA Directive and Article 9 (2) of the Aarhus Convention. The legal redress requirements of the EIA Directive in connection with the implementation of Article 9 (2) of the Aarhus Convention stipulate that, with respect to project licenses for which an environmental impact assessment is required, non-governmental organisations may have the substantive and procedural legality of the concluding act of a licensing procedure undergo a judicial review. Against this background, the Commission recommends, through the implementation of a new possibility for legal redress modelled according to Section 17 (4) of the Site Selection Act,

[1207] TTIP is the English abbreviation for 'Transatlantic Trade and Investment Partnership' and refers to an international treaty between the European Union and the USA, which has been negotiated since 2013; TiSA is the English abbreviation for 'Trade in Services Agreement' and also refers to an international treaty between more than 23 parties including the USA and EU.
[1208] Cf. for further details Chapter B 8.7.1.
[1209] Cf. Commission Storage of High-Level Radioactive Materials. 10. Meeting of the 'Evaluation' working group dated 21 September 2015. Verbatim record. Page 35.
[1210] Cf. Commission on the Storage of High-Level Radioactive Materials. K-Drs.142.

comprehensive changes to Sections 19 and 20 of the Site Selection Act. This would account for Community-law requirements.

Legal redress options in national law: The Commission extensively discussed the question as to whether the option for legal redress provided for to date under Section 17 (4) of the Site Selection Act will be preserved in addition to the option for legal redress recommended by the Commission for Section 19 (2) or whether it will be replaced by it. Good reasons were provided for both views. During this discussion, it was also shown that there are numerous other possibilities for lodging an appeal in connection with the site selection and licensing procedure for citizens, for example, in the case of operating plan approvals, exploration permits under water law, orders to tolerate preparatory work on properties.[1211] Furthermore, the question of legal redress was also brought up in connection with Section 14 of the Site Selection Act.

In considering all arguments in terms of the legal pros and contras, the Commission found in the end that this was a question that must be answered on the basis of political criteria. Against this background, it supports keeping the legal redress granted to date under Section 17 (4) of the Site Selection Act in place and not changing this.

The question regarding the need for options for legal redress in the site selection procedure that goes beyond what is required by Community law led differing views to be expressed by the experts present at the corresponding hearing conducted by the Commission[1212] on 3 November 2014: On one hand, it was argued that instead of opting for additional possibilities for legal redress, the focus should be on arbitration, mediation and reaching a consensus.[1213] On the other, further legal redress for achieving the objective of broad participation of citizens as well as the corresponding high level of acceptance of the procedure were considered necessary.[1214]

In general, the legal redress granted to date in Section 17 (4) of the Site Selection Act would in principle be superfluous in the event of the implementation of the recommendations regarding Section 19 of the Site Selection Act from the standpoint of Community law. Preserving this legal redress would, however, allow for legal evaluation early on and could therefore minimise the risk of reverting to a very early stage of the procedure in the event of legal redress pursuant to Section 19 of the Site Selection Act.[1215] At the same time, an additional option for legal redress would strengthen the trust in the procedure thus increasing its level of acceptance.[1216]

In its recommendation, the Commission found that in both cases delays as well as impacts on the use of the formats of public participation could result. Following in-depth discussion, it spoke in favour of keeping the legal

[1211] K-Drs. /AG2-27 provides a detailed view of legal redress possibilities.

[1212] Cf. Commission on Storage of High-Level Radioactive Waste. Analysis of the 'Evaluation of the Site Selection Act' hearing / summary of views and results, K-Drs./AG2-4a, p. 24 et seqq.

[1213] Cf. Commission on Storage of High-Level Radioactive Waste. Analysis of the 'Evaluation of the Site Selection Act' hearing / summary of views and results. Commission Paper /AG2-4a, p. 15.

[1214] Cf. Commission on Storage of High-Level Radioactive Waste. Analysis of the 'Evaluation of the Site Selection Act' hearing / summary of views and results. K-Drs./AG2-4a, p. 5 and 7.

[1215] Cf. 12th meeting of the 'Evaluation' working group on 2 November 2015, verbatim record, p. 33, 36 and 39.

[1216] Cf. 8th meeting of the 'Evaluation' working group on 22 June 2015, verbatim record, p. 13, cf. 9th meeting of the
'Evaluation' working group on 7 September 2015. Verbatim record. p. 40.

redress provided for in accordance with Section 17 of the Site Selection Act in the interest of the comprehensive reasons described above.
The right to an evaluation of the long-term safety as part of precautions to prevent damages in the selection procedure on the part of associations, affected communities and their residents is provided for in the corresponding provisions of applicable law. An amendment of the Site Selection Act is not required to this end. The Commission also recommends adopting such a regulation in the Atomic Energy Law.

8.8.3 Early protection of potential sites

Based on its discussion of the topics relating to the moratorium[1217], the Commission, with its resolution of 20 April 2015, asked the Federal Government to 'immediately draw up legal provisions [...] that permit the protection of siting regions or planning zones for potential disposal sites.'[1218] The Bundesrat adopted the wording in its resolution on the First Regulation amending the Gorleben Moratorium Ordinance of 12 June 2015.[1219] At the same time, the Bundesrat only gave its consent to extend the moratorium for Gorleben subject to the proviso that it would expire on 31 March 2017. The Federal Government agreed to ensure that this recommendation would be promptly implemented.

8.8.4 Prohibition on export

In accordance with applicable law, there is a ban on the reprocessing and export of spent fuel elements from reactors for energy production (power reactors). Against this background, the Commission discussed in-depth the question of expanding this ban to include research reactors and adopted a resolution by a majority:
'The Commission
1. speaks in favour of the introduction of a general statutory prohibition on export for high-level radioactive waste;
2. calls on the Federal Government to establish a new regulation imposing a prohibition on the export of spent fuel elements from research reactors, which accounts for the imperative aspects of non-proliferation and enables cutting-edge research (in particular FRM II).'[1220]
The Commission believes that such expansion sends an important message emphasising the objective of comprehensive disposal of spent fuel elements domestically. At the same, the Commission believes it is imperative that science and cutting-edge research e.g. material research and research for medical purposes not be restricted in Germany.

[1217] Cf. for further details Chapter B 8.4.
[1218] Cf. Commission Storage of High-Level Radioactive Materials. resolution, K-Drs. 102 NEW In a second point, a request was issued for the postponement of the vote in the Bundesrat on the extension of the Gorleben moratorium planned for May 2015 to the following meeting of the Bundesrat in June 2015.
[1219] Cf. First Regulation amending the Gorleben Moratorium Ordinance, BR-Drs. 136/15, decision of 12 June 2015; in accordance with Section 54 (2) of the Atomic Energy Act, the consent of the Bundesrat was required for the regulation.
[1220] Cf. Commission Storage of High-Level Radioactive Materials. resolution, K-Drs. 131 NEW

8.8.5 Storage of data and access to information

The storage of data is a critical safety measure for the entire chain of nuclear disposal. It is also of immense importance for the participation of the public in the site selection procedure.
For the improved storage of data for the purpose of documentation[1221], the Commission also believes there is also a further need for legislative action in addition to the standards currently provided for under nuclear and radiation protection law. It recommends establishing a suitable central body whose primary responsibility is said documentation. The current information owners must provide the relevant information for this body. In the process, further details such as rights to access, view and ownership rights must be clarified. Finally, this will ensure the active, long-term storage of information for future generations.
The Commission proposes that the Atomic Energy Act or the new Radiation Protection Act currently being drawn up by the Federal Government be supplemented with the corresponding provisions. In this respect, it is recommended that power to issue statutory ordinances is set out for these provisions.
With respect to access to information in the site selection procedure[1222], a distinction must be made between access to geological data by public bodies and access to information on the part of the public.
With respect to the search for a disposal site, the special public interest in a disposal facility guaranteeing long-term safety, comprehensive access to information on the part of the responsible public bodies must be assumed. The special public interest in final disposal guaranteeing long-term safety would therefore regularly outweigh the private interest in confidentiality alone on the basis of applicable law and therefore permit the handover of the required data even if the data owner has not consented to this. With respect to common, but not always clear administrative practice, it is recommended a legal provision that clarifies this issue be formulated.
Also with respect to the public's access to information, the Commission recommends supplementing the applicable law accordingly. In the process, a public information register for the documents of the project delivery organisation and the Federal Office for the Regulation of Nuclear Waste Management (BfE) should be provided for so that the public can participate in connection with the pending issues. The provision must ensure that all relevant documents and information are actively disclosed, which are referred to in the comparative site selection procedure.[1223]

8.8.6 Environmental assessments and regional planning in the site selection procedure

The Commission holds the view that the site selection procedure for a disposal facility, in particular for high-level radioactive waste materials including site selection and spatial planning[1224] is provided for extensively in the Site Selection

[1221] Cf. for further details section B 8.7.6.
[1222] Cf. for further details section B 8.6.
[1223] Cf. also section B 7.3.5.
[1224] Cf. for further details section B 8.7.4.

Act. The questions of spatial compatibility must be evaluated conclusively in this procedure with the involvement of Länder and communities; in any case, stand-alone a spatial planning procedure in addition to the procedure in accordance with the Site Selection Act does not need to be conducted[1225] In this procedure, the selection of the disposal site must be primarily oriented towards the safety standard.[1226] To ensure this, the Commission recommends adopting a provision based on Section 28 sentence 1 of the Grid Expansion Acceleration Act (NABEG) in the Site Selection Act. This regulation should be formulated so that it also covers other provisions of planning law, in particular urban land use planning.

8.7.5 Comparative procedure for the site selection

The Site Selection Act has the objective of locating a site for an installation in accordance with Section 9a (3) sentence 1 of the Atomic Energy Act for the final disposal of high-level radioactive waste materials, which, based on today's current level of knowledge, offers the best possible safety for the long-term protection of people and the environment from ionising radiation for a period of one million years. Some of the Commission members hold the view that the term 'site with the best-possible safety' has not been sufficiently defined in the Site Selection Act; furthermore, Section 17 of the Site Selection Act and in particular, Section 19 of the Site Selection Act, are formulated such that this will of the legislator is not expressed with sufficient clarity. Other members, on the other hand, held the view that the applicable Site Selection Act clearly favours a comparative site selection procedure and that there is therefore no need to amend the law.
After extensive discussion, the Commission resolved, in light of the above, to recommend that Sections 1 and 19 of the Site Selection Act be described in detail as in section B 8.7.5.

8.8.8 Anchoring of safety requirements

In accordance with Section 4 (2) point 2 in connection with (5) of the Site Selection Act, the Commission must evaluate the task as to whether and how general safety requirements are to be anchored in the law. Some of which result out of the recommendation of the Commission regarding decision-making basis[1227] and in some cases, they are already contained in the safety requirements of the Federal Ministry of the Environment from 2010.
They should therefore be immediately anchored in the Site Selection Act. The Commission also recommends creating a new power to issue ordinances to provide for the relevant safety requirements for the disposal of heat-generating radioactive waste in connection with the site selection procedure or to modify the existing power to issue ordinances already provided for in the Atomic Energy Act to this end. The ordinance, which is to be drawn up with the participation of the

[1225] Cf. Commission on the Storage of High-Level Radioactive Materials. 14. Meeting of the 'Evaluation' working group of 01 February 2016. Verbatim record. p. 51.
[1226] Cf. Commission Storage of High-Level Radioactive Waste Materials. 14th Meeting of the 'Evaluation' working group of 01 February 2016. Verbatim record. p. 51 et seq.
[1227] Cf. verbatim record of the 18th meeting of working group two of 6 June 2016.

Länder and public, must be in place no later than at the beginning of step 3 of phase 1 of the site selection procedure It should be evaluated at least every 10 years and, if necessary, be adapted to the state of the art of science and technology.

8.8.9 Anchoring of the Atomic Energy Act in the German Basic Law

The question of anchoring the phasing-out of nuclear energy in the German Basic Law was brought up early in the Commission and discussed in detail. As a result, the Commission considers the anchoring of the phasing-out of nuclear energy in the German Basic Law to be possible in principle. Various views are held regarding the question as to how this should be done. Anchoring the phasing-out of nuclear energy in the German Basic Law would not make it irreversible, but create a substantial de facto binding effect. The decisive consideration of using the symbolic effect of a constitutional amendment to satisfy society in light of the constitutional reservations associated with depolarising the issue is a highly political decision, which the Commission - also with respect to its legal mandate - should not nor does it intend to decide on. The Commission therefore recommends that the legislator thoroughly evaluate the considerations presented in the two expert opinions commissioned in connection with this issue[1228]and take them into account in its decision regarding any further need for action.

9 ASSESSMENT OF TECHNICAL CONSEQUENCES AND TECHNOLOGY DESIGN

9.1 Changes to the understanding of technology

The conflict surrounding nuclear energy must be considered against the background of a fundamental change in society. While the attitude towards technology was not the subject of dispute until the early 1970s, this has since changed fundamentally. While there had been no reservations about technical and scientific advancement until then and it had also been affirmed, for example, through the concrete achievements of the post war era – rapid reconstruction, the *Wirtschaftswunder* and growing prosperity, the risks and hazards associated with technology have since become increasingly subject to debate.
The belief in progress of the European modern age was legitimated by a linear utopian mindset where the development of the economy and technology as well as resulting growth of goods and services were simply projected into the future. This was based on the hope that more and more people would be able to share in rapidly increasing material prosperity, which would in turn improve the freedoms they have and better preserve their health, provide them with greater social security and lead to a general improvement in the quality of life.
In the last two centuries, the idea of progress became the guiding principle of the European modern age, which was closely linked to goals of emancipation (the liberation of man). The unleashing of productive potential, that is, technical

[1228] Cf. Gärditz, Klaus (2016). Verankerung des Atomausstiegs im Grundgesetz? K-MAT 61. And: Roßnagel, Alexander (2016). Kurzgutachten zur Verankerung des Atomausstiegs im Grundgesetz. K-MAT 62.

progress and economic growth has paved the way since the Industrial Revolution. Above all, it became the strategic response to the 'social question' ('Mit uns zieht die neue Zeit' (translator's note: song of the German Youth Movement)). Reflection, if any, on the side-effects of technical progress occurred after the fact. Nuclear energy is, however, an example where not only the opportunities, but also hazards must be recognised. Of course, there is no question that every society is in need of technological advancement, but it must be of a responsible nature and therefore take into account both social and ecological aspects. In light of the increase in technical power, this challenge is different than back in the early European modern age. Back then, the combination of the skills of craftsmen with the ideas of the European Enlightenment [1229] led to a tremendous advancement of society. The discovery of natural laws for understanding nature and the development of technology made it possible for people to realise their social and democratic rights. The Age of Enlightenment and Reason led to more freedom, equality and fraternity.

The Industrial Revolution led to the systematic use of work, technology and resources to revolutionise production methods. The consequences of this 'Great Transformation' (Karl Polanyi)[1230] were fundamental social and economic changes, which led to the continued 'Self-Production of Society' (Alain Touraine[1231], which could be shaped politically as a result. Indeed, the Industrial Revolution gave new momentum to the ideas of the European modern age[1232]. As a result, it appeared that 'for a long time, technical and societal progress were synonymous[1233]. Making the future available with an increasing amount of knowledge and technology is, according to social scientists Adalbert Evers and Helga Nowotny, 'a relatively new invention. It coincides with the emergence of the idea of progress in the 18th century as representing unlimited possibilities and a more or less linear path towards better and more ambitious achievements. Its momentum came from the critical relationship between what had been achieved ... and the expectations ahead, which it was to live up to'[1234].

Technological advancement did indeed provide a long impressive list of examples of progress: 'The promise of a better life that was in many ways associated with technology emerged no later than with the Industrial Revolution providing relief from physical labour through the use of technical tools, leading to the growth of individual and societal prosperity through new and more efficient forms of value creation, liberation from the reliance on nature's caprices, liberation from the constraints of gainful employment and presently, above all, serving as a medium of global communication'[1235].

The development of productive potential became the benchmark for progress although there were plenty of critical voices warning of the consequences and

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[1229]Cf. in particular: Bacon, Francis (1620). Novum organum (scientiarum). And: Hume, David (1738 – 1740). Treatise of Human Nature.

[1230] Cf. Touraine, Alain (1943): The Great Transformation.

[1231] Cf. Touraine, Alain (1972): The Self-Production of Society.

[1232] Particularly worthy of mention are: Bacon, Francis (1620). Novum organum (scientiarum). Or: Hume, David (1738 – 1740).Treatise of Human Nature.

[1233] Ropohl, Günter (1982). Zur Kritik des technologischen Determinismus. In: Rapp, Friedrich; Durbin, Paul T. (publisher).Technikphilosophie in der Diskussion. p. 3 et seq.

[1234] Evers, Adalbert; Nowotny, Helga (1987). Über den Umgang mit Unsicherheit. p. 30.

[1235] Grunwald, Armin (2000): Technik für die Gesellschaft von morgen. p. 13.

presenting other visions of progress[1236]. However, the benefits resulting from the tremendous expansion of the economy and technology dismissed any concerns about disproportionate consequences as unfounded, particularly considering the apparently unlimited abundance of potential technical innovations, including ones that could contain potential hazards. The idea of progress was based on the assumption that in the end, things would always work out for the benefit of all. Technology did indeed seem to advance in a safe and nearly perfect manner under the paradigm of 'controlling technology with technology[1237], not least due to standards prescribed for the most part by committees appointed by engineers. Only in the early 1970s did the call to rethink prior assumptions grow louder, particularly considering the plethora of technologies whose development was not considered positive or as contributing to progress, but which could have negative repercussions both socially and ecologically.
Since the 1970s, awareness of the ambivalent nature of technology has grown. This has led to the central demand for technology that is error-friendly, particularly considering that its development may not be considered to be required in a deterministic sense. This is consistent with the fact that social science is based on the assumption that the development of technology represents 'social process'[1238]. The development of technology combines state of the art of research and development, the innovative capacity of science and the industry, social acceptance and prevailing cultural values. The specific embodiments are subject to a constant state of flux as the result of technological advancement, political frameworks and social power structures as well as other influential factors such as education, information systems, commodity dependence, etc.[1239].
It would be wrong to dismiss critical objections as 'technophobic', rather they call for a willingness to engage in dialogue and the ability to reflect[1240]. It was not without reason that the debate at the time was also accompanied by projects to humanise work, not in the sense of the management of social consequences, but in order to directly improve the working world.
The transition from a one-sided optimistic view to a reflective if not in part sceptical assessment of technology has already been provided for in the critical theory of the Frankfurt School. In 1967, the philosopher Herbert Marcuse feared that 'the liberating force of technology—the instrumentalisation of things—turns into a fetter of liberation; the instrumentalisation of man[1241]. Early on, there was a call for putting technical development into a societal context because, as the social philosopher Jürgen Habermas puts it, the respective 'system of sciences can [however only] be an element of one comprehensive life context'[1242], which must first be interpreted by the humanities. He stated that reality can only be found if the

[1236] Cf. in particular Mill, John Stuart (1884). Principles of Political Economy. Keynes, John Maynard (1930). Economic Possibilities for our Grandchildren. Or: Georgescu-Roegen, Nicolas (1971): The Entropy Law and the Economic Process.
[1237] Zweck, Axel (1993): Die Entwicklung der Technikfolgenabschätzung zum gesellschaftlichen Vermittlungsinstrument. Opladen, p. 11.
[1238] Weingart, Peter (publisher. 1989): Technik als sozialer Prozess. Frankfurt am Main.
[1239] German Bundestag (2011): Final Report of the Commission of Inquiry on Growth, Prosperity and Quality of Life. p. 354.
As well as: Dolata, Ulrich; Werle, Raymund (publisher 2007): Gesellschaft und die Macht der Technik.
[1240] The Commission of Inquiry on Future Nuclear Energy Policy described the need for a discursive review. The interim report of the Commission of Inquiry on Future Nuclear Energy Policy. BT-Drs. 8/4143.
[1241] Marcuse, Herbert (1967). One-Dimensional Man. p. 174.
[1242] Habermas, Jürgen (1968). Knowledge and Human Interests. p. 179.

'self-reflection of science'[1243] is achieved and if the technical interest of science merges with the societal interest of the humanities[1244].
Habermas seeks to disprove the prevailing pessimistic conclusion from the Dialectic of Enlightenment[1245] that man is incapable of creating a world worthy of human beings. Habermas justified his view in the theory of discursive reason. He considers the source of progress to be communication between people, which however can only work if the process of understanding is organised on the basis of reason. In referring to Habermas, Armin Grunwald, director of the Institute for Technology Assessment and Systems Analysis (ITAS) Karlsruhe speaks of the need for 'discursive rationality'[1246] in order to clarify the relationship to the respective technology.
Not only the critical theory or theories of reflexive modernisation[1247] have changed the attitude towards technology; in the 1970s, the ecological debate began, which was sparked by Rachel Carson's studies on dioxin[1248] and in 1963, Jane Jacobs with her bestseller 'Death and Life of Great American Cities'[1249]. The greatest catalyst was the study by the American MIT for the Club of Rome concerning the 'Limits to Growth'[1250] in 1972, which was followed by numerous warnings about the catastrophic destruction of our natural basis for life[1251]. Also in the 1970s, the discussion regarding nuclear energy began[1252], followed later by the debate surrounding genetic engineering[1253] and the consequences of digitalising the economy and society[1254]. This led the assessment of technology to become a central sociopolitical question.

[1243] Habermas; Jürgen (1968). Knowledge and Human Interests. p. 121.
[1244] Habermas, Jürgen (1968). Knowledge and Human Interests. p. 244.
[1245] 1218 Cf. Adorno, Theodor W.; Horckheimer, Max (1943): Dialectic of Enlightenment.
In particular, the explanations regarding the system of rule.
[1246] Grunwald, Armin (1999): TA-Verständnis in der Philosophie. In: Bröchler Stephan; Simonis, Georg; Sundermann
Karsten (publisher): Handbuch Technikfolgenabschätzung. Volume 1, p. 73.
[1247] See also in Chapter 3: Der Konflikt der zwei Modernen.
[1248] Cf. Carson, Rachel (1962): Silent Spring.
[1249] Cf. Jacobs, Jane (1963): Death and Life of Great American Cities.
[1250] Cf. Meadows, Dennis et al. (1972): The Limits to Growth.
[1251] For example: Council on Environmental Quality (1980): The Global 2000, Report to the President. Washington;
Diamond, Jared (2005). Collapse. How Societies Choose to Fail or Succeed. Rockström, Johan (2009). A Safe Operating Space for Humanity. Stockholm. Randers, Jorgen (2012). 2052: A Global Forecast for the Next Forty Years. IPCC (2015). 5th Asssessment Report.
[1252] Cf. also Radkau, Joachim; Hahn, Lothar (2013). Aufstieg und Fall der deutschen Atomwirtschaft.
[1253] Cf. Mayer-Schönberger, Viktor; Cukler, Kenneth (2013). Big Data. Schmidt, Eric; Cohen, Jared (2013): Die Vernetzung der Welt.
[1254] Cf. e.g.: Kollek, Regine; Altner, Günter; Tappeser, Brigitte (publisher) (1986). Die ungeklärten Gefahrenpotentiale der Gentechnologie. Or: German Bundestag (1987). Commission of Inquiry on the Opportunities and Risks of Genetic Engineering. Final report. Kunzmann, Peter; Odparlik, Sabine (2011). Gentechnik.

Definition of engineering and technology as well as their classification:

There is an important fundamental difference between technology and engineering:

***Technology** is, on one hand, knowledge regarding the manufacture, use and repair of technical devices and, on the other hand, the science of engineering.*

***Engineering** secures and improves the realisation of human life possibilities through the development and application of technical means.*
The basic consensus in the philosophy of engineering is that the desirability or permissibility of a technology does not per se necessarily follow on the basis of the feasibility. The emergence of engineering from technologies – is, in the sense of a 'modal transformation', a 'space of possibility'[1255]. A large part of conventional philosophies of engineering aims to chart the range of possibilities associated with the technical. Terms like technology assessment or technology design, on the other hand, refer to a required understanding of responsibility. 'Hard-line technological determinism' cannot be combined with this[1256].

Still today, a relatively reactive approach is taken to technology to minimise the hazards it carries with it. The use of technology, through its growing complexity and far-reaching effects, gives rise to new hazards, for which technical solutions must be found. This form of technical progress generally tends to remain blind in a normative respect because it fails to raise the question of how the externalised consequences are to be prevented with respect to the preservation of the natural world, social cohesion and political-societal order. On the other hand, Nicholas Stern proved in his study on the economic costs of climate change that the prevention and restriction of global warming is significantly more cost-efficient than adapting to its consequences by limiting the resulting damages, which is becoming increasingly difficult to do[1257].
Today, we know that technical progress is essential and has without question brought about great improvements, but it can also carry with it detrimental effects if its hazards become new large-scale threats. For this reason, there may be no blind faith in technology. Furthermore, it may not in any case be considered progress if the idea of progress is not to be questioned. Technology demands new requirements for reflection on the part of science, politics and society[1258]. The conflict surrounding nuclear energy was a significant catalyst of these changes. Of course, political and state decisions do not per se guarantee that better solutions will follow. However, in order to achieve societal acceptance and long-term responsibility, political frameworks, which define binding technical standards for safety and precautions, account for social and economic contexts in decisions and, at the same time, adequately consider knowledge or uncertainties. With respect to its recommendations for the best possible safety in connection with the storage of radioactive waste, the Commission does not allow itself to be guided either by euphoria or hostility towards technology. Its focus is that technological paths associated with high degrees of uncertainty or a lack of knowledge fraught

[1255] Hubig, Christoph (2006): Die Kunst des Möglichen. Technikphilosophie als Reflexion der Medialität. Bielefeld. p. 160.
[1256] Definition according to: Barbara Skorupinski/Konrad Ott (2000): Technikfolgenabschätzung und Ethik. Zurich, p. 20 – 21.
[1257] See also Stern, Nicholas (2006): The Economics of Climate Change.
[1258] Grunwald, Armin (2000). Technik für die Gesellschaft von morgen. p. 15

with risk are not permitted and that alternative approaches are adopted from the outset.

9.2 The development of technology - a social process

Technical and scientific activities are integrated in historical processes, societal contexts, prevailing cultural values as well as through the use of natural resources and stress on natural sinks linked to ecological cycles or the environment created by man. The conflicts surrounding nuclear energy have made it clear that deep tears may result in this web of relationships.
The resulting finding is: The technologisation of life is leading to increasing requirements in terms of compatibility with the future. The realisation of productive potential in industry has led to the increasingly far-reaching removal of limits on human activities in terms of the space, time and materials. The consequences are differentiation, specialisation, internalisation, acceleration and complexity with long-term, far-reaching effects[1259]. Reflection therefore demands a much higher level of quality in terms of coordination and integration in order to ensure that the resulting decisions are as compatible as possible long-term with the interest of future generations.
Progress can therefore no longer be simply limited to the meaning horizons and regulation systems that emerged in the 18th and 19th century as a general legitimisation of growth, technical progress and societal advancement. It is just as correct to refer to ecological hazards as well as new social, political and societal challenges in globalised world, which must be considered. For this reason, technical progress today is no longer a question of possibilities, but also of social and ecological compatibility with an increasingly interdependent yet fragile and overstressed world[1260]. Only then can unreasonable consequences at the expense of third parties, particularly future generations, be avoided.
The Commission's task is also to build new fundamental trust with respect to how technology is handled. The criteria recommended in the report should be seminal with respect to handling complex technologies in a reflexive manner. To the extent possible, the first step is to think things through 'to the end', particularly if the respective decisions are associated with a lack of knowledge and uncertainty. The Director of the Office of Technology Assessment at the German Bundestag, Prof. Armin Grunwald, has prepared a list of fundamental questions that must be asked to this end[1261], in particular:

Can technological advancement be guided in a direction that is 'desirable for society' or does technology have its own unbridled momentum?
Where are the ethical boundaries of technology if they exist at all or does technology possess its own unbridled momentum?

- Which societal authority would be legitimated to subject persons or groups (e.g. residents living near a nuclear disposal facility) to such a risk?
- How is the problem associated with the long-term consequences of technological developments to be dealt with in light of the discussion regarding responsibility for future generations?

[1259] Berger, Johannes (1986): Gibt es ein nachmodernes Gesellschaftsstadium?
[1260] Ausgangsthese im Brundtland-Bericht der UN-Kommission Umwelt und Entwicklung. Also see Volker Hauff (1987). Unsere Gemeinsame Zukunft.
[1261] Grunwald, Armin (2000). Technik für die Gesellschaft von morgen.

- How should one deal with unavoidable residual risks? Does the ‘primacy of the worst-case scenario’ apply (Hans Jonas)?

The production and utilisation of knowledge and technology dominate our life. Science and technology have advanced to become the most important factors in production such that today, we live in a ‘scientific society’. The ‘science-technology-industrialism paradigm’, according to the social scientist Rolf Kreibich, became the supreme progress paradigm of industrialised societies[1262]. How it develops in relation to nature and which long-term social and democratic consequences this may have or is predicted to have is of decisive importance and as yet unknown[1263].
After all, technical-scientific progress is not only associated with a better life, but also new hazards that threaten social cohesion and people’s natural basis for life. Nuclear energy is a striking example that technical advancement per se is no guarantee for progress, but is by its very nature ambivalent[1264]. The complex technological ramifications are in many cases of a long-term, manifold, surprising and inconceivable nature. The social scientist Carl Böhret wrote: ‘The nature and magnitude of the Chernobyl disaster exposed central shortcomings in the ability of political and administrative bodies to manage consequences. [...] The long-standing dominance of utility is put into perspective by criticism based on the damages: The likelihood of opportunity pales in comparison to the magnitude of the risk.’[1265].
The intensification and expansion of technology assessment and technology design are therefore of central importance. This task is, however, difficult due to three key reasons:

- The increasing pace at which knowledge is converted as a result of modernisation and rationalisation processes also augments the unpredictability of future developments.
- An increasing number of decisions are subject to short timeframes, which fundamentally hampers the ability to reflect on processes and their consequences. The American social scientist Richard Sennett raises the question: ‘How do we decide what is of lasting value in ourselves in an impatient society that is focused primarily on the immediate moment?’[1266].
- The understanding of progress to date is focused on growth and acceleration, technology design, however, also requires deceleration, limitation, moderation and prevention[1267]. Not only partial corrections, but also a new line of thought are needed.

The experience of serious technological conflicts gives ‘rise to the question as whether it is possible to avoid such conflicts a priori, that is, when they arise instead of having to attend to the consequences of these conflicts at greater expense later

[1262] Kreibich, Rolf (1986). Die Wissenschaftsgesellschaft. p. 10.
[1263] Cf. also: Becker, Egon; Jahn, Thomas (2006). Soziale Ökologie.
[1264] Meyer-Abich, Klaus Michael/Berthold Schefold (1986): Die Grenzen der Atomwirtschaft.
[1265] Böhret, Carl (1988): Technikfolgen als Problem für die Politiker. In: Zöpel, Christoph. Technikkontrolle in der Risikogesellschaft. Bonn. p. 85 et seqq.
[1266] Sennett, Richard (1998): The Corrosion of Character. p. 10
[1267] Cf. also Müller, Michael/Peter Hennicke (1994): Wohlstand durch Vermeiden. p. 113 et seqq. Tim Jackson (2011):Prosperity without Growth. p. 179 et seqq. Elinor Ostrom (2011): Was mehr wird, wenn wir teilen. p. 47 et seqq. Gerhard Scherhorn (2015): Wachstum oder Nachhaltigkeit. Erkelenz. p. 153 et seqq. Giacomo D’Alisa et al. (publisher 2016): Degrowth. A Vocabulary for a new Era.

on'[1268]. Prospective studies serve to determine the acceptance-oriented technology design, which would make technology, along with its hazards and other disadvantages, reasonable and acceptable. 'To this extent, the results of attitude and acceptance research are, without a doubt, a significant part of social compatibility assessments; reconnecting with the climate of opinion is imperative'[1269].
Experiences with the inability to forecast or extrapolate acceptance behaviour as well as the problems associated with interpreting acceptance behaviour led, however, to a new, participation-oriented procedure in the decision-making process[1270]. According to which, this does not concern a prospective 'measurement' and extrapolation of acceptance behaviour, but the direct inclusion of those affected by a technological development (consumers, citizens, political parties, authorities, associations, social movements etc.) in the decision-making processes. The difference between decision-makers and those affected by the decision should, to the extent possible, be abolished in this manner.
For this reason, not de facto acceptance, but normative acceptability is fundamental: 'Acceptability is a normative term, which defines the acceptance of options that carry risks as rational criteria of acting under conditions of risk'[1271].
Technology assessment is not oriented towards 'actual acceptance, but to the acceptability of decisions'[1272]. This is at odds with short-term trends in that it formulates and justifies acceptance thresholds that apply to everyone. In the view of the Commission, they result on the basis of the key objective of sustainability and consequently the long-term social and ecological compatibility of techno-economic decisions.
The work of the Commission contributes to the early recognition of unreasonable hazards and, to the extent possible, their prevention in the future. The Site Selection Act and the resolution of the Bundestag emphasise the significant importance of evaluation, discourse and understanding. The Commission shows that it has learned from past mistakes. After all, the 'drama of progress' also means that not every technical innovation and its economic exploitation contributes to progress[1273].

9.3 Technology assessment and technology design

In the early 1970s, the debate over technology assessment emerged in politics and business. In 1973, the CDU/CSU parliamentary group requested the creation of an office for the assessment of technological developments at the German Bundestag[1274]. The Office of Technology Assessment (OTA) of the US Congress

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1268 Grunwald, Armin (2005). Zur Rolle von Akzeptanz und Akzeptabilität von Technik bei der Bewältigung von
Technikkonflikten. p. 54.
1269 Jaufmann, Dieter (1999): Technikakzeptanzforschung. In: Stephan Bröchler/Georg Simonis/Karsten Sundermann
(publisher): Handbuch Technikfolgenabschätzung. Berlin. volume 1. p. 220.
1270 Simonis, Georg (1999): Sozialverträglichkeit. In: Stephan Bröchler/Georg Simonis/Karsten Sundermann (publisher):Handbuch Technikfolgenabschätzung. Berlin. volume 1. p. 105 – 118.
1271 Gethmann, Carl Friedrich/Thorsten Sander (1999): Rechtfertigungsdiskurse. In: Grunwald, Armin/Stephan Saupe
(publisher): Ethik der Technikgestaltung. Heidelberg. p. 117 – 151.
1272 Cf. Grunwald, Armin (2008): Technik und Politikberatung. Frankfurt am Main.
1273 Strasser, Johano (2015): Der reflexive Fortschritt. Manuskript. Berg/Berlin.
1274 German Bundestag (1973): Drucksache 7/468.

in Washington served as an example. This was also intended to achieve a more systematic approach to evaluating
the consequences of scientific-technical transformation in politics and society, in particular the consequences for the social and natural environment.
Following year-long debates over such an establishment, the Enquete Commission on the ‘Assessment and Evaluation of Technology. The definition of a framework for technological development’ was appointed in the Bundestag on 14 March 1985[1275]. In 1987, the Committee on People and Technology at the Landtag of North Rhine-Westphalia also began work[1276]. Both bodies marked the attempt to anchor the evaluation and assessment of technology in legislation[1277]. This led to the establishment of the ‘Office of Technology Assessment at the German Bundestag’ (TAB), which is linked to the parliament via the Committee for Education and Research.
The TAB, which was incorporated in the Karlsruhe Institute of Technology, advises the German Bundestag on matters of research and technology policy. It provides analyses and opinions. Since 1990, the TAB has been coordinated by the Institute for Technology Assessment and Systems Analysis (ITAS) of the Karlsruhe Institute of Technology (KIT). Since September 2013, it has cooperated with the Helmholtz Centre for Environmental Research, the Institute for Future Studies and Technology Assessment as well as the VDI/VDE Innovation + Technology. Via the research committee, the technical committees of the German Bundestag recommend topics for exploration, deliberate over findings and open a debate during a plenary sitting. The objectives are:

- to analyse the potentials of new scientific-technical developments and to exploit the associated opportunities;
- to investigate societal, economic and legal boundary conditions for the realisation and application of scientific-technical developments;
- to analyse potential effects in-depth and with foresight in order to identify opportunities resulting from the use of technologies as well as possibilities for avoiding or mitigating their hazards;
- to develop on this basis options for action and the design of political decision-making bodies.

The number of committees, for which TAB conducts studies, has grown significantly over the years. Suggestions come primarily from the sectors of nutrition and agriculture, economy and energy as well as environment and nature conservation. The work results are documented in the reports to the Bundestag and in other publications. Such establishments now exist in most EU states.
However, this was not an entirely new idea. In 1921, the Reichskuratorium für Wirtschaftlichkeit in Industrie und Handwerk (RKW) was founded. Its primary objective was to promote technological progress and rationalise production methods. Based on the high level of mass unemployment as a result of the global economic crisis, questions of the social and health-related consequences of technical-economic development also shifted into focus after 1930[1278].

[1275] German Bundestag (1986): Report of the Commission of Inquiry ‘Assessment and Evaluation of Technology’.
Drucksache 10/5844.
[1276] Landtag North Rhine-Westphalia (1987). Sozialverträgliche Technikgestaltung. Drucksache 10/1471.
[1277] Mai, Manfred (1999). Umsetzung der Technikfolgenabschätzung in die Politik. In: Bröchler, Stephan; Simonis, Georg;
Sundermann, Karsten (publisher). Handbuch Technikfolgenabschätzung. Volume 1, p. 343.
[1278] Cf. Ropohl, Günter/Wilgart Schuchardt/Rainer Wolf (1990): Schlüsseltexte zur Technikbewertung.

In 1932, the Association of German Engineers (VDI) recommended a chamber of technology be founded; two years later, economist Werner Sombart presented the concept envisaging a Supreme
Culture Council. Both initiatives sought to control technology in a way that would be shared between the state, science and industry. In fact, the work continues to be shared today with the technical-economic bodies responsible for standardisation and the state for defining the framework[1279].
The discussion surrounding technology consequences and technology design that again emerged in the 1970s was not only due to technical hazards, it was also a response to the call for the humanisation of the working world by unions as well as a reaction to public controversy over the technological paths to be taken[1280].
The VDI guideline 3780 from 1991 provides the definition of technology assessment. The goal of 'all technical activities (should) be to safeguard and improve human life possibilities through the development and sensible application of technical means'[1281]. Technology assessment was defined as 'a planned, systematic and organised process that analyses the state of the art of technology and the possibilities for its further development, estimates direct and indirect technical, economic, health-related, ecological, human, social and other consequences of such technology and possible alternatives and evaluates these consequences based on the defined goals and values.'
At its core are risk research and assessment, which are considered in terms of the anticipated advantages of new technologies, particularly in light of social and ecological requirements of the design of technical processes. Earlier models of risk research were based on the analysis and handling of problems from the standpoint of economical-technical optimisation. The 'compatibility of technology with its social and natural surroundings'[1282] (Klaus-Michael Meyer Abich), however, was neglected for the most part. This objective has shifted into focus particularly though the debate regarding sustainability.
Technology evaluation, technology assessment[1283] and technology design were developed further in recent years and today, are much more widely accepted e.g. in national and European programmes for promoting research, at the German Institute for Standardisation and the National Academy of Science and Engineering. They can make a considerable contribution to the sustainable development of the economy and society. The requirements for this are comprehensive information and communication, active and open forms of participation, also through equality of the societal and social groups as well as the equivalence of expertise and local empirical knowledge.

9.4 Example: Energy revolution

An important starting point for the Commission's work is the phasing-out of nuclear energy, which today all Bundestag parties are in agreement with[1284]. This

[1279] Dierkes, Meinolf; Knie, Andreas provided an overview; Wagner, Peter (1988). Die Diskussion über das Verhältnis von Technik und Politik in der Weimarer Republik. In: Leviathan, volume 1/1988.
[1280] Ropohl, Günter/Wilgart Schuchardt/Rainer Wolf (1990). Schlüsseltexte zur Technikbewertung. p. 7.
[1281] Society of German Engineers (1991): Directive 3780.
[1282] Meyer-Abich, Klaus Michael (1999): Akzeptabilität von Techniken. In: Stephan Bröchler/Georg Simonis/Karsten Sundermann (publisher). Handbuch Technikfolgenabschätzung. Volume 1, p. 310 et seqq.
[1283] Cf. Grunwald, Armin (2010): Technikfolgenabschätzung – eine Einführung.
[1284] On 30 June 2012, the German Bundestag ruled by a large majority of all parliamentary groups to phase out nuclear power by 2022.

is closely linked with the energy revolution, which is one of the most important tasks with respect to technology design. It demonstrates that the challenges go far beyond mere technical issues.

The energy revolution must embody an intergenerational contract that takes into account future hazards. It designs and finances the reorganisation of the energy supply so that the risks in connection with the nuclear fuel cycle, climate change and the reliance on imports are reduced for future generations. There is no historical example of an energy revolution, but it can become a positive model for the social-ecological design of modern industrialised society that reaches around the world. As at the dawn of the industrial era – it creates an infrastructure that will extend far into the future.

In 1975, Amory Lovins had already come up with the idea of the Soft Energy Path[1285] and in 1980, the Öko-Institut presented the first study 'Energy revolution for growth and prosperity without crude oil and uranium'[1286]. This scenario became the basis for path 4 of the Commission of Inquiry on Future Nuclear Energy Policy of the German Bundestag[1287]. It did not link energy consumption to economic growth. In 1985, the second follow-up study of the Öko Institut confirmed the feasibility of a potential conversion[1288], which was met with widespread consensus in the recommendations of the climate inquiry of the German Bundestag. The cabinet decision of 1991 on national climate protection is based on a long-term combination of saving, increasing efficiency and renewable energy.

The energy revolution is based on decades of preparations and debates. As it is much more than a technical-economic project, politics and the public must also be aware of the magnitude of the changes as well as the challenging, long-term conversion. However, 'the energy system does not run 'in the background', but is associated in many respects with society - that is, with us'[1289]. The energy revolution is not a task solely for engineers and managers, but must become a joint effort[1290].

Principles such as the ability to learn, transparency and democratic discourse are essential for the success of the energy revolution[1291]. However, a master plan for its implementation doesn't exist, the energy revolution requires a learning approach that is oriented towards the concept of a sustainable energy supply. The fact that the Commission may become sidetracked on the path towards achieving its objective and that miscalculations may also occur should not come as a surprise. Recognising early on when it is off course and quickly drawing corresponding conclusions is of decisive importance[1292].

The phasing-out of nuclear energy and the energy revolution are important foundations, which the Commission builds on in order to achieve the best possible

[1285] Lovins, Amory (1997). Soft Energy Paths.

[1286] Krause, Florentin; Bossel, Hartmut; Müller-Reißmann, Karl-Friedrich (1980). Energiewende. Wachstum und Wohlstand ohne Erdöl und Uran.

[1287] German Bundestag (1982): The interim report of the Commission of Inquiry on Future Nuclear Energy Policy.

[1288] Hennicke, Peter; Johnson, Peter; Kohler, Stephan; Seifried, Dieter (1985). Die Energiewende ist möglich.

[1289] Grunwald, Armin (2016): Warum die Energiewende so schwer ist. Manuskript.

[1290] Bartosch, Ulrich; Hennicke, Peter; Weiger, Hubert (publisher 2014). Gemeinschaftsprojekt Energiewende. p 43 et seqq.

[1291] Renn, Ortwin (publisher 2015): Aspekte der Energiewende aus sozialwissenschaftlicher Perspektive.

[1292] Acatech; Leopoldina; Akademieunion (publisher 2015). Auf dem Weg in ein nachhaltiges Energiesystem.

storage of radioactive waste. They are an important part of understanding and building trust on the path towards the sustainable development[1293] our country needs.

9.5 Conclusions in politics and society

The Commission on the Storage of High-Level Radioactive Materials recommends that the Bundestag strengthen the institutions for technology assessment and technology design, in particular the Office of Technology Assessment (TAB) giving it more clout in the public debate and in the political-parliamentary decision-making process. They have the importanttask of improving the requirements, associated with the assessment of technologies, for reflexive modernisation as well as the framework for political, economic and societal decisions. As a result, the German Bundestag can better fill its role as a reflexive body for a societal modernisation process.
The Commission recommends that a debate on a focus topic to be defined will take place in the German Bundestag once annually and will address the requirements and consequences of our scientific society. The Bundestag is thus strengthened in its role as a thought leader with respect to important questions concerning the future.
The guiding principle of sustainability requires that more time be given to the comprehensive, long-term evaluation of complex processes. Based on this, people can also decide for themselves to slow down life that is driven by technology and consciously opt in favour of qualitative options. This will strengthen social cohesion. Decisions based on self-reflection are not only enriching on a personal level, they are also the obvious and reasonable solution to numerous societal and ecological problems[1294]. To achieve this, the objective of sustainability should be anchored and elaborated to a greater degree in politics[1295].
The Commission furthermore suggests that more time and attention be given to the work of the TAB and comparable institutes in the political and public debate. The TAB and other scientific institutions should allow citizens to participate to a greater degree in their work as the Commission does. At the same time, critics of technical developments in the field of science, from societal associations as well as social-ecological movements should be involved. The Commission asks the Bundestag to determine whether and how the TAB or comparable institutions can be strengthened, also because they represent an investment in the future, open up considerable opportunities and help to avoid high consequential costs.

[1293] Grundwald, Armin (2013). Mit Energie zur nachhaltigen Entwicklung. In: Mitschele; Kai; Scharff, Sabine (publisher).
Werkbegriff Nachhaltigkeit. Resonanz eines Leitbilds. p. 95 – 112.
[1294] Substantiated in detail: Markus Vogt (2009). Prinzip Nachhaltigkeit. Ein Entwurf auf theologisch-ethischer Perspektive.
[1295] Cf. Töpfer, Klaus et al. In: Das Parlament of 26 May 2015. Nachhaltigkeit muss ins Grundgesetz

10 DISSENTING OPINIONS

10.1 Dissenting opinion of Klaus Brunsmeier (BUND)

Dissenting opinion of Klaus Brunsmeier (BUND) regarding the report 'Commission on the Storage of High-Level Radioactive Materials'
Friends of the Earth Germany (BUND) collaborated on the Commission on the Storage of High-Level Radioactive Materials over the last 2 years in a constructive and engaged manner in order to improve the applicable Site Selection Act, which it had criticised heavily. In so doing, Friends of the Earth Germany (BUND) intended to support efforts to reach a societal consensus based on the majority decision of the German Bundestag that allows for a genuine new start in the search for a Site Selection Act for the high-level radioactive materials.
In the view of BUND, the report of the Commission contains important recommendations for the improvement of the applicable Site Selection Act. However, BUND also believes that the report suffers from serious shortcomings, incorrect decisions and foundations:

- **The exact nuclear waste, for which a repository is to be found, remains unclear**

For over two years, the Commission worked on criteria and a procedure for the search for a repository for high-level radioactive waste materials. In the end, however, the Commission also recommends integrating the waste from the Asse mine, from uranium enrichment and for other 'non-Konrad compliant' waste in the procedure without being able to recommend corresponding criteria or a refined procedure.

- **No scientifically based inclusion of crystalline rock as a host rock.** The Commission did not actually solve the task of finding an equivalent approach for all rock types, but essentially passed formal compromises. BUND demands that underground exploration and the development of a concept for granite, clay and different salt structures be required by the Site Selection Act.

- **No legal redress after every phase of the procedure**

The three-phase site selection procedure will span a number of decades. The Commission recommends that the affected citizens, property owners and regional authorities from the affected regions are given the possibility of having the site selection procedure judicially reviewed after phase 2 and at the very end. This is a good thing. But such a possibility continues to be missing following the conclusion of the first phase with the selection of the sites for surface exploration. This also invalidates the new approaches for public involvement, which in this form continues to remain without rights in the first phase that is important for trust building.

- **Gorleben continues to burden the future procedure.**

The concrete work of the Commission has shown that the Gorleben site cannot remain in the procedure without becoming a massive burden. With respect to working out the criteria, the underlying question was always what this would mean for the one site that is known. A problem-free procedure, which involves Gorleben, is not possible. BUND believes that it will not be possible to reach the endeavoured societal consensus with Gorleben and that keeping this site in the search procedure will continue to delay it.

- **Lack of anchoring of the phasing-out of nuclear energy in the German Basic Law**

The central basis for the future search procedure is the phasing-out of nuclear energy. To provide a lasting safeguard, BUND recommended anchoring the phasing-out of nuclear energy in the Basic Law. The Commission believes this is possible and permissible, but only managed to issue a recommendation for a review to the German Bundestag.

BUND <u>is therefore not</u> in agreement with this final report of the Commission on the Storage of High-Level Radioactive Materials.

The goal of BUND is to bring about a new comparative site search for a repository for the high-level radioactive waste in Germany. BUND does not wish for its dissenting opinion regarding the Commission report to be understood as indicating that the process is at a standstill. BUND calls upon the members of the German Bundestag and the Federal Government to promptly begin with the urgent revision of the Site Selection Act and, in the process, to adopt as many of the good recommendations of the Commission and, above all, the further demands of BUND as possible.

Why did BUND collaborate in the Commission?

Along with numerous anti-nuclear initiatives and environmental associations, BUND rejected the Site Selection Act, which was developed for the most part while excluding any involvement of the public, and also criticises the composition of the Commission. Without changing its highly critical stance with respect to the Site Selection Act, BUND, by way of a decision of the entire council on 12 April 2014, decided to participate in the Commission after the members of the German Bundestag addressed some of the demands and clarified in a motion for a resolution that the central task of the Commission is to organise a broad societal dialogue and to review the Site Selection Act to date. Furthermore, the Federal Environmental Ministry withdrew a complaint submitted by Ex-Minister of the Environment Peter Altmaier that would have reinforced the special role of the Gorleben site. Exploration of the Gorleben site was stopped and the old plan approval procedure was declared to have been concluded. The new Federal Agency for Nuclear Waste Management (BfE) provided for in the law was initially set up on a provisional basis. BUND had decided to take these announcements by the political body literally and push for their implementation as well as improvement of the Site Selection Act .

The BUND sent its deputy chairman Klaus Brunsmeier to the Commission, which began work on 22 May 2014. In November 2014, the Federal Delegates' Assembly (BDV) of the BUND confirmed this decision following in-depth, critical debate. However, the BUND expressed a critical interim view at the 2015 Federal Delegates’ Assembly in 2015 and formulated specific demands on politics.

What did the BUND aim to achieve?

In actively collaborating on the Commission, BUND intended to bring about a prompt review and revision of the Site Selection Act. Gorleben should not have a special role; this entirely unsuitable site must be quickly excluded from the search process. An in-depth societal debate regarding a suitable search procedure for a disposal site for nuclear waste should be initiated at last. At the same time,

the interim storage of high-level radioactive waste as well as other types of nuclear waste should be taken into account.
A general evaluation of the Site Selection Act and short-term recommendations for the amendment of the Act should have the following focuses:

- Sufficiently long term for the Commission
- Improvement of legal redress possibilities.
- Public participation with actual influence.
- A new structure of authorities
- Potential disadvantages for the Gorleben site must be avoided
- Export ban

In the work of the Commission, it became clear to an increasing degree that focusing solely on the search for a repository for high-level radioactive waste would not suffice when it came to effectively managing this challenge. Instead, significantly more attention must be given to nuclear waste in its entirety. With respect to the interim storage facilities for high-level radioactive waste, there is an increasing number of safety problems affecting interim storage facilities and it is entirely unclear what will happen when their limited-time licence expires. As for the waste that will be retrieved from the Asse mine, the waste from the uranium enrichment plant in Gronau and the ‘non-Konrad compliant’ waste from the dismantling of the nuclear power plants, it has not been clarified in the slightest as to whether it will be emplaced in the storage facility for heat-generating high-level radioactive waste or whether an additional storage facility will be required for this. BUND demanded that the Nuclear Waste Commission actively addresses these questions as part of its work.

Problematic environment

The Commission should enable a new start in the search for a nuclear waste repository, which provides for in particular the serious, in-depth involvement of the public. In actuality, however, BUND, as a large network of organisations with numerous active parties directly on location at the nuclear sites, has observed that almost nothing has changed in terms of transparency and public participation in the specific procedures. The nuclear regulatory authorities of the Federation and the Länder deny the safety problems of the interim storage facilities. They are not willing to take serious action based on the cancellation of the licence for the interim storage facility in Brunsbüttel by the Upper Administrative Court of Schleswig. The same ritualised hearings as always take place in the dismantling procedure at the nuclear power plant sites while safety concerns about prolonged interim storage and the practice of clearance are not explored in a diligent manner. The announcement of the intention to export nuclear waste from the AVR nuclear power plant in Jülich has greatly burdened the work of the Commission. Finally, the BMUB announced that it does not consider the emplacement of WAA castors in the on-site interim storage facilities to be a ‘substantial change’ in accordance with the Atomic Energy Act and therefore believes that the public does not need to be involved in the required licensing procedure.
This reality significantly contradicts the many lofty words and objectives expressed in the Commission report.

General points of criticism

1. The Commission has failed to initiate a broad societal debate and reach a societal consensus regarding the site selection procedure.

BUND has declared the primary objective of the Commission's work to be the initiation of the as yet non-existent societal debate with the goal of reaching a societal consensus as broad as possible regarding the proposed search procedure. This goal was also explicitly addressed and specified in the motion for a resolution of the German Bundestag for the appointment of the Commission. BUND provided the recommendation at the beginning of the Commission's work as to how this might occur[1296.] However, this suggestion went much too far for most of the parties on the Commission. In addition to the numerous practical problems of organising large-scale participation as a Commission, BUND believed that it came down to one point in particular: The Commission hesitated to foster concern and initiate an in-depth debate at a location where people are currently affected or will be potentially affected by the storage of nuclear waste in the future.
In conclusion, the Commission failed to initiate a broad societal debate regarding the site selection procedure. As a result, the urgently needed societal consensus regarding the site selection procedure following the conclusion of the Commission's work is also lacking. From the viewpoint of BUND, this shortfall places even greater demands on a future search procedure.

2. An in-depth revision of the Site Selection Act did not take place during the Commission's term.

Contrary to the demand of BUND before it joined the Commission, no advance revision of the Site Selection Act took place. This possibility was expressly specified in the application for a resolution of the German Bundestag upon the appointment of the Commission. An advance revision would have been an important step towards building trust. This is due in part to the blocking of certain topics within the Commission. That is, the representatives of the nuclear power plant operators blocked decisions to statutorily anchor the comparative search procedure as well as decisions in favour of legal redress. Early decisions of the Commission would have made a faster revision possible (relating to the structure of authorities, the prohibition on exports and protecting potential storage sites). Only now, a few days before the Commission will be wound up in June 2016, but two of its recommendations have been implemented legally by means of an amendment concerning the recommended official structure and the advance appointment of the new National Advisory Committee.
BUND criticises the Federal Government for not making any effort to legally implement the general export ban[1297] demanded by the Commission.

[1296] Cf. Federal Government recommendation: 'Evaluierung des Standortauswahlgesetzes in einer breiten gesellschaftlichen Debatte' of 26 June 2014.
[1297] Cf. Resolution of the Commission of 2 October 2015

3. The representatives of the nuclear companies in the Commission are hampering and blocking the procedure

The work of the Commission in dealing with the relevant topics was complicated by the attempts of the nuclear power plant operators to evade the costs associated with the storage of nuclear waste as well as the search for a site with lawsuits and planned division into sub-companies. The nuclear power plant operators had no interest in carrying the costs of a new comparative search procedure. Up to the report of the 'Commission to Review the Financing for the Phase-out of Nuclear Energy' (KFK), they pursued a strategy of blocking the central issues dealt with in the Commission's work. This particularly concerns the critical legislation of a comparative search procedure with a focus on safety. Although the Commission appointed its own ad-hoc working group to deal with the lawsuits of the nuclear power plant operators, the latter failed to present a reasonable recommendation for dealing with this problem. BUND demanded that the representatives of the nuclear power plant operators are not to be given a voting right for issues directly or indirectly affecting them.

4. The term of the Commission was not renewed to the end of 2016 as demanded by BUND.

Only on 22 Mai 2014 - six months after the Bundestag election in September 2014 and nearly one year after the resolution of the Bundestag regarding the Site Selection Act and the establishment of the Commission - did it begin its work following a significant delay. The submission of the report was originally planned for the end of 2015. The Commission took advantage of the possibility provided for in the Site Selection Act (StandAG) to extend its term by half a year and to complete the report by the end of June 2016. At the time the Commission began its work, BUND had already warned that the Commission's term is not of sufficient length for drawing up a report and then discussing it in-depth with the public. The majority of the Commission was not in agreement with the demand of BUND to extend its term until the end of 2016.
This led, on one hand, to massive time pressure with respect to the preparation of the report. Above all, due to time constraints, the public will no longer be comprehensively involved in the preparation of the report by the end of the Commission's term. The envisioned compromise where the BfE provides for public involvement in the report and the former members of the Commission, at the invitation of the Bundestag environmental committee, convene again on 28 September in order to discuss the outcome of the public involvement process, does not make up for this shortfall and represents a serious shortcoming in the work of the Commission.

5. The mistakes of the past were not adequately dealt with[1298].

A new start, as was stressed on many occasions, must take place once the mistakes of the past have been dealt with. Only once this has been done, is it possible to not repeat the same mistakes in the future. However, this did not occur. Though the Commission, in the sections of its report concerning the

[1298] Cf. sections B 4.2.1, B 4.2.4., B 6.4., B 6.5.and B 6.9 of this report.

individual national experiences with disposal projects, dealt with their history and invited ‘parties with experience’ from the regions of Gorleben, Asse and Morsleben to serve as regular guests on the working group, the Commission visited the Asse and Konrad mine sites. The different experiences of individual Commission members with the Gorleben site also played a significant role in the discussion and decisions of the Commission. Overall, all members of the Commission also consider the new site selection procedure to be the solution to the failure of the disposal project in Gorleben. The reasons for this vary greatly. An in-depth review of the mistakes of the past, which would have returned common conclusions and lessons, did not take place.
The fact that a review of the past is mainly considered to be a political question and in the end, a question of fault and not a technical and methodical prerequisite for a new start, which would in particular also have to be achieved by the scientists involved, is viewed in a critical light. As a result, the critical review of decisions that were taken with respect to the critical relationship between politics, administration and science[1299] or the preoccupation with the unique nature of five decades of salt research, whose tradition the AKEnd also followed, did not take place. Reducing the criticism expressed by society and at the sites to a predominantly emotional, defensive stance, which is perhaps understandable, overlooks the fact that it provided important technical impulses. It must be pointed out that though politics failed in its attempts to evaluate its role with the investigative committees on Gorleben (Bundestag) and ASSE II (Lower Saxony), the scientific fields involved made no attempt to partake in critical self-reflection and have refused to do so to date. Advocating ‘a system that questions itself’ for the future does not prove to be very credible if one is neither prepared nor capable of questioning one’s own role.

6. An anchoring of the phasing-out of nuclear energy in the German Basic Law[1300] is missing.

During the nuclear energy conflict, citizens and the public have too often seen one-sided political decisions taken in favour of nuclear energy. In particular, reference is made in this respect to the debate surrounding the extension of the remaining operational periods of nuclear power plants following the red-green consensus with the nuclear industry for the incremental phasing-out of nuclear energy. As a result, the companies and the state have significantly contributed to a massive loss of trust. For this reason as well, BUND has called for the anchoring of the phasing-out of nuclear energy in the German Basic Law as an important signal and fundamental prerequisite for starting the search for a nuclear waste repository. Though anchoring the phasing-out of nuclear energy in the German Basic Law would not make a return to nuclear energy irreversible, it would provide the greatest amount of legal protection against this. The amount of nuclear waste concerned with respect to storage would also be provided for in the German Basic Law. The Commission has ordered two legal opinions on the question and believes it is both possible as well as permissible to have this

[1299] For this, see the example of: Möller, Detlev (2009). Endlagerung radioaktiver Abfälle in der Bundesrepublik Deutschland.The dissertation submitted to the University of the Federal Armed Forces Hamburg examines the administrative-political decision-making processes in terms of cost-efficiency and safety.
[1300] Cf. section 8.7.8 of this report.

anchored in the German Basic Law. However, the Commission was not able to agree on a clear recommendation. As a result, it failed to use the considerable chance to send an important, fundamental signal in order to build trust and overcome the existing nuclear conflict.
Against this background, BUND is calling on the members of the Bundestag to accept the review mandate formulated by the Commission and, at the same time as the amendment of the Site Selection Act, implement an amendment to the German Basic Law, which also provides for the phasing-out of nuclear energy.

7. The safety problems of the interim storage facilities are only addressed in a very cautious manner[1301].

From the very beginning of its work on the Commission, BUND demanded that the Commission also address the current and future safety problems of the interim storage facilities. This has long been rejected by the majority of the Commission claiming that this is not part of its mandate. BUND has only in part succeeded in changing this view within the Commission. It is, however, now clear that until the licenses for the interim storage facilities expire, no storage facility will be available for the high-level radioactive waste yet. The Commission has also realised that the incoming storage facility planned by the Federal Government at the location of the nuclear waste storage facility may be a considerable problem with respect to its size because high-level radioactive waste as such continues to be kept in interim surface storage for decades at the very minimum and will therefore have significantly different effects on the affected population. Even if there is a section dedicated to interim storage, the consequences of prolonged interim storage and the effects of a large receiving storage facility on the search procedure are not specified to a large extent in the report.
In the view of BUND, this will likely result in significant problems for the search procedure because it is unclear to those affected as to what exactly will happen at the location: the high-level radioactive waste must remain in interim surface storage facilities, which are not adequately protected, for further decades. The interim storage facilities are not adequately protected against plane crashes or terrorist attacks. Limited refurbishments not involving the public are currently underway. If, in the end, the nuclear power plants are dismantled along with the storage facilities, it will not be possible to repair Castor casks. This is unacceptable as very long periods of interim storage are still expected. BUND demands that conclusions be drawn for all interim storage facilities based on the withdrawal of the operating licence for the Brunsbüttel interim storage facility instead of merely ignoring this fact. Furthermore, no licences may be extended without safety-related refurbishments and the installation of ‘hot cells’.
The further course of action with respect to interim storage must now be discussed in a broad public process as well as whether the old storage facilities have to be replaced with new facilities.

[1301] Cf. section B 5.7 of this report.

Critical points in the recommendations regarding the site selection procedure

1. The type of nuclear waste, for which a repository is required, has still not be defined[1302]

For over two years, the Commission worked on criteria and a procedure for the search for a repository for high-level radioactive waste. In the end, however, it suggested that the waste from the Asse mine and from uranium enrichment be integrated in the search procedure without recommending corresponding criteria or an improved procedure.
The Site Selection Act states that a storage facility for ‘in particular’ high-level radioactive waste should be found. Although BUND called for this time and again, large parts of the Commission failed, for a considerable period of time, to clarify the nature of the additional waste in question and how it should be dealt with in the context of the search for a permanent nuclear waste storage facility on the basis of societal consensus.
Only the presentation of the National Disposal Programme of the Federal Government (draft: December 2014, resolution of the Federal Government August 2015) brought an end in part to the hesitation of the majority of the Commission in this respect. With respect to the waste that would be retrieved from the Asse mine, the uranium waste from Gronau and other ‘non-Konrad suitable’ waste from the dismantling of the nuclear power plants, it had not been clarified at all as to whether the waste would be emplaced in the storage facility for the high-level radioactive waste or whether another storage facility would be needed for this purpose. BUND demanded that the Nuclear Waste Commission actively address these questions in its work. The Commission has also taken on this task[1303], but only actually addressed the topic towards the end of its term.
If there is to be a collective search for further nuclear waste at a location, in the view of BUND, the requirements to be imposed on the storage of this waste must be defined before the search procedure begins. Such criteria do not, however, exist. The Commission has oriented its central requirements towards the foundations for decision-making, the process pathway and public involvement in the exclusive search for a storage facility for high-level radioactive waste. Public involvement in particular has to be redefined in the event of a joint selection procedure. If some of the different sites offer the possibility of storing other waste materials, there is likely considerable political pressure to decide in favour of such sites. After all, the alternative would be to establish a third nuclear waste storage facility for the other waste in a few years or decades. It is therefore doubtful as to whether the primacy of safe emplacement of the highly radioactive waste can in fact be maintained on a practical level.
Based on these requirements, BUND demands a clear decision against storage at the same site and also against the extension of the licence of the Konrad mine. BUND demands that a search specifically for a location for the other radioactive waste is immediately started based on the predefined criteria[1304].

[1302] Cf. section B 6.6 of this report.
[1303] Cf. resolution of the Commission of 19 November. 2015.
[1304] Cf. K-Drs 245a of BUND of 14 June 2016.

2. Possibility for legal redress in each phase of the selection procedure.[1305]

The site selection procedure will span a number of decades in three phases. The Commission suggests that affected citizens and regions are given the possibility of having the site selection procedure judicially reviewed after phase 2 and at the very end of the procedure. This is a clear advancement compared to the currently applicable law, which does not provide for any review of the actual selection decision. As a result, this also remedies the current breach of European legal requirements by applicable law. BUND has advocated the improvement of legal redress. BUND has, however, always demanded that there be a possibility for legal redress after each phase of the Site Selection Act .

We were not able to implement this demand in the Commission. After all, this possibility for legal redress continues to be missing following the conclusion of the first phase with the selection of the sites for surface exploration. This also invalidates the new approaches to public involvement, which in the initial phase that is critical for building trust still lacks any safeguarding of their rights. There is also a lack of a possibility for legal review in the phase where the new structures and institutions (BfE, BGE, regional conferences) are established.

To justify refraining from legal redress in this phase, the Commission agrees with the legal opinion of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety that the possibility for judicial review will also extend back to the preliminary phase despite the interim resolution of the Bundestag. BUND does not share this view and has also contributed an expert opinion to the discussion of the Commission, which came to a different conclusion[1306].

BUND demands that there is a possibility for legal redress following the conclusion of each phase of the site selection procedure. Only in this way, can it be clarified after each phase in the long procedure, in the event of a dispute, whether the procedure and the involvement of the public therein took place in accordance with legal requirements.

3. Gorleben, the only known site, places a burden on the entire procedure.

BUND has shared in the work of the Commission although the political consensus regarding the new start of the search for a site is also based on the fact that Gorleben remains in the procedure. BUND has always criticised this because, in its view, the location is not suitable from a geological standpoint and is politically scorched earth. However, BUND initially went into the procedure with the objective of preventing any 'disadvantages for the Gorleben site'. BUND did so to a great extent e.g. in the debate regarding the extension of the moratorium for Gorleben and possible alternatives. The intervention of the Commission also led the Federal Government and Bundesrat to agree to only extend the moratorium to the end of March 2017. Afterwards, as called for by the Commission, there should be a general provision to secure all potential sites.

However, the further concrete work of the Commission has, in the view of the BUND, shown that leaving the Gorleben site in the procedure would inevitably result in it becoming a massive burden. With respect to working out the criteria, the underlying question was always what this would mean for the one known,

[1305] Cf. section B 8.3.3 of this report.

[1306] Cf. K-Drs. 210 of BUND of 14 April 2016.

controversial site. It was therefore not possible to develop scientifically based criteria as the law rightfully requires. BUND's first-hand experience from over 2 years of work on the Commission have led to the conclusion: A problem-free procedure involving Gorleben is not possible. This situation will also remain unchanged in the future if Gorleben remains in the procedure. All participants in the procedure can and will assess every step at the known site. The provision in Section 29 of the Site Selection Act stating that Gorleben is not to be a reference location will not work in the real context of the procedure. This is why the site must be excluded from the site selection procedure.

4. Unequal data situation for the individual sites and host rocks must not be accepted.

Knowledge of underground geology varies greatly from region to region. There is also significantly less data on the host rocks claystone and crystalline rock, which have been neglected to date in Germany. The Commission is therefore correct in providing the recommendation to set out the possibility for the subsequent collection of data in the first phase of the search procedure. However, this now primarily depends on the assessment of the BGE as the project delivery organisation. BUND demands that none of the potential sites or rock formations under consideration be excluded from the procedure due to a lack of data. This principle must be adopted as a central provision in the revised Site Selection Act.

5. Council of the Regions as an institution and with legally defined rights?[1307]

The creation of the 'Regional Conferences' as permanent and independent institutions in the search procedure, which could also provide balance vis-à-vis the BGE and BfE, is a significant advancement with respect to Commission's recommendation for future public involvement. It therefore makes sense to provide for these institutions by law, to grant them the assured resources and to also grant them special status in the form of the legal right of subsequent examination. In the view of BUND, however, failing to create a comparable structure with the 'Council of the Regions' is neither consistent nor purposeful. The 'Council of the Regions' would also have the chance to act as an important counterbalance and corrective body vis-à-vis the BGE and BfE in the procedure without essentially representing the defensive interests of a region. The Commission did, however, decide in favour of a 'hybrid': though the 'Council of the Regions Conference' mainly consists of representatives from the regional conferences, it is not an independent institution, but is located at the BfE and has neither its own budget nor does it possess legally anchored rights in the procedure.
BUND demands, with respect to the revision of the Site Selection Act, that a 'Council of the Regions' be established as its own institution with its own right of review in the procedure.

[1307] Cf. section B 7.3.3 of this report.

6. Interim phases for the discussion of the exploration programmes and review criteria must remain in place.[1308]

The current Site Selection Act provides for individual interim phases where the site-specific exploration programmes and review criteria for surface and underground exploration are proposed by the BGE, publicly discussed and stipulated by the BfE. In the view of the Commission, these interim steps should be streamlined by combining them with the recommendation of the BGE for the definition of the respective exploration sites.
In the view of BUND, this is the only recommendation of the Commission relating to the procedure, which fails to further improve the applicable Site Selection Act and instead impairs it.
Detailed, site-specific exploration programmes and review criteria can only be developed once the sites have been determined. However, the basic selection decision must be justified at the end of each phase. The quality of the involvement with respect to relevance at the applicable sites always depends on whether the discussion is given time to evolve. This concerns complex interrelated factors. Nothing would be more problematic than 'windows of participation' that only open for a short time and are so overloaded that public opinion only forms once they have closed.
BUND demands a participation process that is as ongoing as possible. The Site Selection Act should therefore not be amended at this point.

7. There is no stipulation stating that all potential host rocks must be explored underground.[1309]

The Commission intends to emplace nuclear waste in deep geological formations. In the past, it was assumed in Germany that salt domes offer the best conditions for the safe, long-term storage of nuclear waste. This concept has been worked on for more than 50 years. In contrast, the Site Selection Act also views claystone and crystalline rock as equivalent alternatives, which have been dismissed to date and for which concepts have neither been developed nor has any practical experience been accumulated.
BUND demands that the underground exploration and development of concepts for granite, claystone and different salt structures be made mandatory.[1310] This is particularly necessary because inevitable technical 'prejudice' must have arisen during the decades spent developing these concepts, which in turn cannot be offset solely with knowledge of experiences abroad, but only through one's own practical experience. The question as to whether there are sufficient homogenous crystalline formations available in Germany for a storage concept primarily oriented towards geological containment can only be determined through additional exploration and not through a review of the records.

[1308] Cf. section B 6.6 of this report.
[1309] Cf. section B 6.6 of this report.
[1310] Cf. K-Drs. 236 of BUND of 20 May 2016.

Criticism of the proposals regarding the foundations for decision-making

1. The criteria must stipulate a second, independent geological component that is effective on its own.

Every location considered to be the ‘best possible’ location must be capable of more than serving as an isolating rock zone. For this reason, the minimum criteria may not only concern the isolating rock zone, but must also consider the entire constellation (redundancies and diversity, structure of the overburden, etc.). While in the case of the multi-barrier system (1983 safety requirements), multiple (also geo-technical) optional barriers should fulfil the protection objective above ground, calculation-based proof of the isolating rock zone concept must be provided to demonstrate the safe containment of the nuclear waste in the (relatively small) defined ‘isolating rock zone’ for 1,000,000 years and that only very small amounts of radioactivity escape from this zone. Properly focusing on the effectiveness of geological containment narrows down (at least in terms of the minimum requirements) to the isolating rock zone. If the isolating rock zone safely contains the nuclear waste for 1,000,000, years, all other aspects are secondary. But what happens if the core component fails? Today’s essential demand for safety technology to be both redundant and versatile has still yet to become a minimum requirement. Redundant means that there must be (at least) a second, equivalent (in this case a geological) component that achieves the same protective effect. Diverse means that this concerns a stand-alone component.
The adoption of the overburden as a criterion for consideration though positive, is insufficient and is also strongly linked to the traditional idea of storage in salt domes.
BUND demands that a second, separate and independently effective geological protection component be adopted in the criteria as a minimum requirement.

2. Recoverability: Lack of definition and consideration in the criteria[1311]

In BUND as well as in the whole of society, there is a wide variety of different, well substantiated views on this question. We believe that this consideration process is still not complete – if it has occurred at all.The decision to shift the focus to retrievability and recoverability must therefore be well justified. The conceptual consequences this has over the short and long-term for our safety as well as which special requirements and criteria result for the search for a site must be described in detail. Nothing in the criteria and the additional papers defining the process and requirements suggests that retrievability / recoverability concerns a system component of the sought-after storage facility.
BUND demands that a separate section of the report shows which effects the retrievability of the nuclear waste can have on the safety of the storage facility. If retrievability and recoverability are system components, this must also be accounted for in the criteria.

[1311] Cf. section B 6.8.4 of this report.

3. Lack of appropriate, scientifically-based inclusion of crystalline rock as a host rock.

Instead of redefining the generally positive concept of geological containment based on accumulated findings and changed requirements in line with the times, the Commission has referred to the AKEnd concept, which is still dominated for the most part by the salt dome mindset. Limitation to defining an isolating rock zone often falls short, particularly because this only concerns a calculation. It has not been investigated as to how effective geological containment can be achieved under the conditions of different rock formations and constellations nor has an attempt been made to develop a new model on this basis or based on the additional requirements (2nd geol. component, retrievability) and boundary conditions (container, seal). Such a comprehensive concept must describe the consequences of human intervention (no storage facility without emplacement) and the demand for recoverability/retrievability on the long-term integrity of the storage facility. At the same time, it must be assumed that the different rock types and constellations have different pros and cons.

Instead the ‘salt-dome isolating rock zone’ was adopted and the attempt was then made to stretch this concept so that it in some way also worked for crystalline rock. Such an attempt is indicative of nothing more than capriciousness. BUND does not speak in favour of or against a particular rock formation, but instead in favour of the legitimate, equivalent handling of all rock formations and constellations that come under consideration.

However, the criteria defined by the Commission primarily concern a salt dome isolating rock zone; its systematic application will always lead to sites with salt domes. Though ‘taking along’ clay stone and crystalline stone sites or their exclusion (at any time in the procedure) is possible, this is a political decision in the end.

4. Improvement of the radiation protection requirements.[1312]

Radiation protection is the key parameter, which all safety requirements must be aligned with, both for the population and those employed in connection with the construction and operation of the storage facility. The Commission has adopted the safety criteria proposed by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU 2010). A hearing on 19 November 2015 arrived at the conclusion that the approaches taken to date have been confirmed – no new findings are said to have arisen (since 2010). The Commission stated the following in the report: ’It has arrived at the conclusion that these safety requirements generally comply with the state of the art in science and technology and the state of international discussion, but should be revised on a regular basis’. A number of points are also listed, which must be considered when revising the safety requirements. In the view of BUND, a key point is lacking.

BUND finds that the assumption of a maximum radiation dose of 10 uSv per person/year is outdated. It was defined when the risk factor for cancer mortality amounted to 0.0125/Sv. This has since been increased to 0.055/Sv. The previously applied dose (rate) reduction factors of 2.0 should no longer be

[1312] Cf. section B 6.5.1 of this report.

applied[1313]. New findings by Japan's RERF Foundation estimate a factor of 0.24/Sv.[1314]. According to which, a radiation risk that is 10-20 times higher is to be assumed.
BUND demands that all safety requirements with respect to the disposal facility, the storage concept, the container concept and radiation protection for the population and employees must currently be evaluated at 10-20 times the radiation risk of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety in 2010. The reference value must be reduced to 0.5-1.0 uSv/year.

Criticism of recommendations for financing the site selection procedure

BUND has always spoken in favour of comprehensive application of the polluter-pay-principle and also adopted the view in the Commission that the nuclear power plant operators, as the polluters, must carry the costs of the new search procedure. Therefore, the finding of the Commission for the review of the financing of the phasing-out of nuclear energy (KFK) to deal with the liability risks of using nuclear energy is sobering. The recommendations of this Commission weaken the polluter-pays principle. Although it has been clearly provided for by law that the nuclear power plant operators carry the consequential costs associated with the use of nuclear energy, they are now being released from comprehensive liability. In so doing, a decade-long basis of significant importance for the construction and operation of nuclear power plants as well as the acceptance of nuclear energy in parts of the population is essentially being revoked and once again destroying trust. This applies all the more because the active safeguarding of nuclear provisions has ceased to exist for well over a decade and, despite large-scale demands, has been ignored by all federal governments since the 1990s.
The risk provisions agreed are much too small. The sum of 23.3 billion Euros to be paid into a fund will not be enough to finance the storage of mountains of radioactive waste long term. This will also place an enormous burden on taxpayers.
BUND demands that the Federal Government improve the recommendations of the KFK.
The Law on Run-off Liability (Nachhaftungsgesetz), which has been put off so far, must finally be enacted.

10.2 The joint dissenting opinion of Dr. h.c. Bernhard Fischer and Prof. Dr. Gerd Jäger

Dissenting opinion of Dr. h.c. Bernhard Fischer/Prof. Dr. Gerd Jäger

The Commission on the Storage of High-Level Radioactive Waste has drawn up a concept for site selection on the basis of its legal mandate in accordance with Section 4 Site Selection Act and approved the report on 28 June 2016.

[1313] Cf. Federal Office for Radiation Protection: Positionsbestimmung des BfS zu Grundsatzfragen des Strahlenschutzes. Leitlinien Strahlenschutz des BfS. 01 June 2005.
[1314] Cf. Ozasa, K., Shimizu, Y., Suyama, A. et al.: Studies of the mortality of atomic bomb survivors, Report 14, 1950-2003: an overview of cancer and noncancer diseases. Radiat Res. 177 (2012) 229-43.

As a representative of industry in accordance with Section 3 (1) no. 2 4th Alt. Site Selection Act, we contributed to preparing the report and overall support it, with the exception of the following dissenting opinion.

Dissenting opinion on the revised consideration criteria: Overburden section 6.5.6.3.5 and good temperature resistance section 6.5.6.3.2

The goal of the Commission on Storage of High-Level Radioactive Waste was to create a science-based procedure. It lived up to this goal for the most part through its thorough work. Comprehensive existing scientific findings, studies, assessments and hearings were evaluated and discussed in order to define the techno-scientific requirements and decision-making criteria based on the current international state of the art of science and technology.
However, it was also shown in the final decision-making process that apparently not only scientific aspects played a role for a number of points to be stipulated.
1. A new consideration criterion, the overburden for protecting the isolating rock zone, was stipulated (see section 6.5.6.3.5) although this protective function is accounted for in the safety studies on the isolating rock zone concept with the criteria of robustness.
From a safety standpoint, this does not offer any additional advantage, but, with respect to the defined systematic approach, only results in unfounded excessive emphasis on this criterion versus the other equivalent robustness criteria. We therefore dismiss the additional criterion of the overburden.
2. A temperature limit for disposal was defined (see section 6.5.6.3.2) although the existing scientific findings have shown that this criterion does not allow for any differentiation between the potential sites in connection with site selection. Furthermore, the limitation of temperature is not necessarily for the purpose of safety. Higher or lower temperatures in the disposal facility carry their own respective advantages and disadvantages. Only if detailed knowledge of the host rock and the disposal concept exists, can they be optimised in connection with the safety studies so as to achieve the greatest possible safety.
Premature stipulation therefore restricts the manoeuvrability with respect to achieving the best-possible safety. We therefore reject this temperature limit.

10.3 Dissenting opinion of Prof. Dr.-Ing. Wolfram Kudla

Dissenting opinions regarding the ‘Temperature criterion’ and the ‘scientific advisory council’ for the final report of the ‘Commission on the Storage of High-Level Radioactive Materials’

At its last meeting, the *‘Commission on the Storage of High-Level Radioactive Materials’* (Commission) discussed parts A and B of the final report on site selection. As a member of the Commission, the author provides the *following dissenting opinions on the ‘temperature criterion’ and the ‘scientific advisory committee’*.

1. Regarding the temperature criterion
A temperature criterion has already been mentioned in the final report of the AKEnd. Based on this temperature criterion, the Commission members Dr. Appel

and Mr. Wenzel (Minister of the Environment, Lower Saxony) provided a recommendation for a temperature criterion as a consideration criterion to the Commission (see K.-Drs. 209j of 11 June 2016). A central point of this recommendation was that,
for precautionary reasons, a temperature limit of 100°C in the host rock may not be exceeded. Such a demand is not a consideration criterion per se, but a design criterion that could be used as a basis for the dimensioning of the disposal facility in connection with the safety studies.
The author provided its own recommendation regarding the temperature criterion (cf. K.-Drs. 209 et seq. of 15 June 2016). This recommendation did not provide for a consideration criterion for temperature and instead stated that all questions regarding temperature should be handled in connection with the safety studies. In particular, the recommendation provided for consideration of all temperature questions in terms of specific host rock and did not define a temperature limit.
K.-Drs. 209 et seq. explains that defining a temperature limit of 100°C for all three host rocks (salt, claystone and crystalline rock) does not make sense, is not necessary and has not been called for by anyone yet. Stipulating a temperature limit would mean that particularly in rock salt, the optimisation potential could not be tapped by a higher temperature in the host rock. A higher temperature in the rock salt would not damage the rock salt, but cause it to creep faster and in turn isolate the waste materials faster. After the Commission failed to reach a consensus at the last meeting of the Commission on 27 June 2016, a '*small working group'* (consisting of 13 members from the Commission) was formed in the late hours of 27 June at the recommendation of the chairperson. This '*small working group'* was - as is customary at larger conferences and when dealing with controversial topics in political circles - to offer a solution for such controversial topics behind closed doors and excluding the public

- **c)** Criterion for temperature compatibility
- **d)** Criterion for the overburden
- **e)** Legal redress

Following prolonged discussions, the '*small working group'* agreed by a majority to the following formulation regarding temperature and, as a result, the temperature limit, which was then approved by the Commission:
'The temperature resistance of the host rock (and/or buffer) with respect to the temperature occurring on the outer surface of the waste container must be evaluated and substantiated. A safety margin must be established between the temperature occurring and the temperature at which critical states (e.g. harmful mineral metamorphoses, long-term damage etc.) can occur. The research activities relating to the maximum physically possible temperatures on the outer surface of the storage container with respect to the host rock (e.g. buffer) must be intensified. The permissible maximum temperature must be derived from the maximum physically possible temperature in compliance with a safety margin. At the same time, the recommendations regarding future research provided in the expert opinion of the GRS on heat generation/temperature resistance of rock from May 2016 must be considered. The questions must be clarified by the project delivery organisation by the end of phase 1. Until then, the Commission recommends, for precautionary reasons, assuming a temperature limit on the outer surface of the container of 100°C as long as the maximum physically possible temperatures in the respective host rocks have not been reliably stipulated on the basis of the research work.'

The majority of the members of the 'small working group' chose this wording as a concession to the representative of the Land of Lower Saxony so that he is able to consent to the final report. The stipulation of a uniform (provisional!) temperature limit of 100°C is a purely political stipulation for the sake of compromise. It has nothing to do with any scientific findings. The expert opinion regarding '*Heat generation /temperature resistance of the rock'* prepared by the GRS on May 2016 (see K-MAT 64) contains no such demand, nor can such requirement be drawn from any scientific publication. For the sake of compromise, the author agreed to the compromise of adopting the aforementioned temperature limit in the final report as a provisional temperature limit for precautionary reasons and proposed in the small working group to also include in the report **that this stipulation is a purely political stipulation for the sake of compromise and cannot, however, be justified scientifically**. Unfortunately, the '*small working group*' did not agree to this recommendation. This led to this dissenting opinion. As a scientist, the author believes it is important that the criteria can be derived scientifically. Not one of the eight scientists on the Commission called for a uniform temperature limit of 100°C for all three host rocks. The solution to the controversial question of 'Temperature resistance' was therefore a 'political' one in connection with the solution to the whole set of disputed questions regarding temperature resistance, overburden and legal redress.

Furthermore, it must be stated that the text currently formulated in section 6.5.6.3.2. as 'Requirement 8' does not represent a criterion for a comparison of sites, but rather a preliminary temperature limit has been specified in this section for the interpretation. It would have been better to include the text in section 6.5.2 'Methodology for preliminary safety studies', which was no longer possible for reasons of time.

2. Scientific advisory council

The entire site selection process is to be overseen through all phases by a 'National Societal Commission' (see section '7.4.1 National Societal Commission'). The National Societal Commission **can** appoint a scientific advisory council or also obtain scientific expertise through hearings or the commissioning of expert opinions on questions arising spontaneously (see '7.4.1.4 Academic support'). The author believes it is **imperative** that a scientific advisory council be appointed by the National Societal Commission and that it oversees the entire site selection procedure. This is imperative in order to clarify scientific questions and above all, to ensure that the right questions are asked. The 'merited personalities', who will be assigned to the National Societal Commission, will not be capable of doing so on their own. Only the scientific advisory council can ensure that the site with the best possible safety is also selected in consideration of scientific aspects and that this process is not undermined and caused to fail in connection with political stipulations / individual interests / the reconciliation of interests. Otherwise there is the hazard that defining a site or prior stipulation of the sites, which are to undergo surface and underground exploration, is in the end also prematurely fixed in 'small working groups' (see above) in a non-transparent manner and then recommended by the National Societal Commission. **The author therefore believes that it is imperative that a scientific advisory council of**

sufficient size be appointed. Unfortunately, this did not gain the support of the majority within the Commission.

10.4 Dissenting opinion of State Minister Ulrike Scharf (Bavaria)

Statement regarding the report of the Commission on the Storage of High-Level Radioactive Materials (in accordance with Section 3 (5) sentence 5 Site Selection Act)

Dear Ms Heinen-Esser, dear Mr Müller,
In approving the Site Selection Act in the summer of 2013, the German Federation and Länder have agreed to a new start to the search for a disposal site, in particular for heat-generating radioactive waste. In doing so, Bavaria also announced its support of an unbiased, transparent search according to principle of the 'blank map' and on the basis of scientific criteria. To prepare the site selection procedure, the Commission on the Storage of High-Level Radioactive Materials should first clarify the fundamental questions pertaining to the disposal of radioactive waste and, in particular, provide recommendations for exclusion criteria, minimum requirements and consideration criteria for the site selection process as well as requirements for the selection process.
The report, which is now in place, is an important, significant step towards reaching a forward-looking consensus in order to, in the ensuing site selection procedure, find a safe disposal site, in particular for heat-generating radioactive waste. Bavaria generally supports this consensus. The following points are, however, decisive.
The geoscientific criteria compiled by the Commission are based on the disposal concept of the isolating rock zone (isolating rock zone concept). However, the Commission generally does not also exclude any disposal concepts where the long-term safe containment of the radioactive waste is based on technical barriers (hereinafter referred to as 'container concept') or a combination of an isolating rock zone and container concept (section 'Provision of evidence about the safe isolation of the radioactive waste materials'). In the view of the Free State of Bavaria, only the disposal concept of the isolating rock zone can lead to a disposal facility with the best possible safety. The AkEnd had already developed the isolating rock zone as a safe disposal concept. A disposal facility whose safety for 1 million years is to be based on technical barriers cannot offer the best possible safety.
With respect to the other disposal concepts, it has not been sufficiently shown that the proof of long-term safety based on the buffer and geotechnical barriers leads to an equivalent and equally robust conclusion regarding safety as a proof of long-term safety based on the isolating rock zone concept. As a result, various disposal concepts with the corresponding safety requirements must be drawn up for the new site selection procedure in an initial step.
On one hand, the defined exclusion criteria, minimum requirements and consideration criteria are to remain valid for all three phases of the selection process as well as for all three host rocks (section 'Geoscientific criteria') while, on the other hand, deficiencies of the geological barriers can be offset by technical and geotechnical precautions. This is inconsistent and goes against the

defined geoscientific criteria. Particularly with respect to the criterion of ‘Thickness of the isolating rock zone’, the minimum requirement of a homogenous 100 metre thick isolating rock zone without chasms equally applies to all three host rock formations.
Furthermore, the complexity and scope of the resources required for the search and consequently the duration of the search for potentially suitable regions increases significantly if the container concept and the respective ‘offsetting’ of geological barriers with technical barriers are permitted. Bavaria therefore rejects such an approach.
The concept of the isolating rock zone concept must provide the basis for the criteria and the entire selection procedure. Through the sole application of the isolating rock zone concept in the site selection procedure, both the Site Selection Act can be accounted for in that the possible host rocks salt, claystone and crystalline are included in the search and also the responsibility of not leaving future generations with the task of finding a solution to the disposal issue.
The container concept prolongs and complicates the search for a disposal site. Also with respect to evacuation of the on-site storage facilities, a prompt search for a disposal site should be endeavoured and reflect their intention. Allowing on-site interim storage facilities to gradually develop into de facto disposal facilities is unacceptable.

Kind regards
Ulrike Scharf, Member of the Landtag
State Minister

10.5 Dissenting opinion of State Minister Thomas Schmidt (Saxony)

Statement of State Minister Mr Thomas Schmidt regarding the report of the Commission on the Storage of High-Level Radioactive Materials in accordance with Section 3 (5) sentence 5 Site Selection Act

1. Rejection of the attenuation of the minimum requirement concerning the thickness of the isolating rock zone only for crystalline rock

In its principles (preamble, section 1), the Commission emphasised the primacy of safety with respect to the selection of a disposal site, emphasising that not an adequate level of safety, but the best possible safety must be achieved.
As a result, the Free State of Saxony rejects the attenuation of the minimum requirement ‘Thickness of the isolating rock zone’ designated solely for crystalline rock. Though such attenuation may increase the probability of finding crystalline rock sites that are suitable for exploration, curtailments to safety-oriented minimum requirements with the described motivation are not acceptable. Exclusion criteria and minimum requirements must apply to the same degree to all potential host rocks without concessions. The attenuation of requirements is not consistent with the primacy of safety of a disposal site and would endanger the acceptance of the site selection procedure.

2. Precedence of a disposal concept based on an isolating rock zone

In section B 5.5.4, the Commission presents the possible disposal concepts to provide evidence of long-term safety. In addition to the concept based on an isolating rock zone, a concept based on technical and geotechnical barriers as well as a combination of the two are described. The Commission does not

explicitly give precedence to any of these concepts. As a result, they are all on equal footing with one another.
In the view of the Free State of Saxony, a geological barrier for the isolation of radioactivity for geological periods offers more promise than technical and/or geotechnical barriers. Such barriers can only serve as supplementary measures to increase long-term safety. As a result, the concept based on the isolating rock zone must be given unreserved precedence in the site selection procedure. The Commission has also only defined selection criteria for this concept. If, contrary to expectations, no site is found in Germany where a concept based on an isolating rock zone can be implemented with the defined minimum requirements, supplementary measures in the form of technical and/or geotechnical measures are plausible providing long-term safety can still be demonstrated.
It is important to the Free State of Saxony that these stipulations apply equally without reservation to the host rocks salt, clay stone and crystalline rock.

10.6 Dissenting opinion of Hubertus Zdebel, member of the Bundestag (The Left/DIE LINKE.)

Statement in accordance with Section 3 (5) of the Site Selection Act of 27 March 2013

Hubertus Zdebel, member of the Bundestag and member of the Commission on the Storage of High-Level Radioactive Materials, rapporteur of The Left parliamentary group in the Bundestag on the final report ‘Responsibility for the future – a fair, transparent procedure for the selection of a national disposal site’ of the Commission on the Storage of High-Level Radioactive Materials in accordance with Section 3 Site Selection Act

I. Site Selection Act and Commission - initial position
II. Boundary conditions (evaluation)
a. Economical (KFK)
b. Political (NAPro)
III. Commission function (evaluation)
IV. Reasons for rejection (evaluation)
c. Nuclear waste and storage requirements
d. Public participation and rights of action
V. Consequences

I. The Left parliamentary group rejected the Site Selection Act in the Bundestag in 2013

With the motion for a resolution of 26 June 2013 (Printed Paper 17/14213), The Left was the only parliamentary group in the German Bundestag to reject the draft for a Site Selection Act (StandAG) and substantiated its criticism before the Commission on the Storage of High-Level Radioactive Waste began work in April 2014 with the request Printed Paper 18/1069

- because the law had been passed without a societal clarification process bypassing important actors in the matter to date[1315],

[1315] On 8 April 2014 in the Bundestag, the motion ‘Atommüll-Endlagersuche vom Kopf auf die Füße stellen’ Printed Paper 18/1069, the Left parliamentary group demanded that a consensus be reached with

- because it fails to address the existing problems relating to all radioactive waste and excludes, in particular, the acute problems,
- because it is not based on systematic, politically or technically methodical review of the matter over the last 50 years and therefore does not fulfil the requirements of an actual new start,
- because clinging to the geologically unsuitable and politically charged Gorleben site would place a burden on the entire procedure,
- because it limits the rights of participation and rights of action through the introduction of the instrument of legal planning (decisions of the Bundestag) and cuts federal as well as other rights in establishing a 'supreme authority'.

Despite its criticism, The Left parliamentary group took part in the work of the Commission. The task was firstly to determine whether the Commission uses the possibilities for a fundamental review provided for in the Site Selection Act and secondly whether it would be capable of charting a feasible course despite the problematic boundary conditions.

II. Indeed, the Commission showed itself to be a public figurehead
with respect to the phasing-out of the use of nuclear energy, which was administered under vague circumstances, where once again the economic interests of large corporations and political interests were given precedence at the expense of the population as was the case when they were implemented 50 years ago.
a) **Profiteers get off easy, the state takes responsibility and passes the waste and costs on to the citizens.** This is the outcome of the Commission on Evaluating the Financing of the Phasing-Out of Nuclear Energy (KFK) [1316], which was residing at the Ministry for Economic Affairs and Energy, whose meetings were not open to the public and to whose results the public was not heard although they were to bear the burden. As a result, the actions of the government, as with the introduction of nuclear energy in the Federal Republic of Germany, are oriented more towards the interests of private business rather than those of the public and not towards the required minimisation of public hazards. In the end, the nuclear waste is to become a public good and its storage is to be for the common good. This corresponds with the political strategy, driven by the discussions around nuclear energy, of steering the energy revolution, primarily developed by small and medium-sized businesses, into the hands of large corporations (preference given to offshore versus onshore, tendering procedures etc.).

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environmental organisations and anti-nuclear groups before the Commission began work and that legal regulations only be implemented once this has occurred: 'Environmental organisations in particular are, however, able to significantly contribute towards bringing about the best possible solution when it comes to questions of the safest possible storage of radioactive waste and reaching a broad societal consensus. The environmental organisations and the movement against anti-nuclear power plants have uncovered the hazards associated with nuclear plants and their resistance has led to the higher safety standards in Germany. A procedure to find a disposal site whose outcome has to be trustworthy must involve the environmental organisations and citizens' initiatives on equal footing.' The majority of the Bundestag rejected this.

[1316] The Left parliamentary group was not involved in the Commission on the Financing of the Phasing-Out of Nuclear Energy (KFK) appointed by the Ministry for Economic Affairs and Energy on the basis of the cabinet resolution of 14 October 2015. Final report of 25 May 2016.
https://www.bmwi.de/BMWi/Redaktion/PDF/B/bericht-der-expertenkommission-kernenergie,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf

b) **In the National Nuclear Waste Programme (NAPro), the Federal Environment Ministry has ignored far-reaching radiation hazards instead of solving problems in a transparent manner**[1317]:

- The following should apply to the **leftover uranium from Wismut** (Thuringia / Saxony): 'The radioactive materials therefore do no concern radioactive waste in the sense of the Atomic Energy Act. Allowances and clearance levels of the Radiation Protection Ordinance are not to be applied.' [1318] – **no problem!**
- **Large quantities of slightly contaminated waste** are 'cleared' in accordance with the Radiation Protection Ordinance and returned to the material cycle – **no problem!**[1319]
- The **problems relating to the interim storage facilities**, which became apparent in connection with the cancellation of the license for the CASTOR interim storage facility at the nuclear power plant in Brunsbüttel by the Higher Administrative Court Schleswig in June 2013 [1320], are ignored: The Federal Government simply knows best and therefore puts itself above the court. Although no deep geological repository is foreseeable until the end of the operating licences for the interim storage facilities and containers, the Federal Government, contrary to all experience, decides that there will be a site in 2031 and, in 2040, that a so-called 'receiving storage facility' for 500 containers with high-level radioactive nuclear waste will be built .[1321] So in this case as well: by definition, **no problem!**
- In order to enable the 'export' of **problematic** high-level radioactive **waste from the AVR Jülich and the THTR Hamm** to the USA, power reactors are simply reclassified as research reactors in the customary fashion. **No problem!**
- As for **so-called weak and medium-level nuclear waste**, the KONRAD mine that was planned according to the mindset and methodology of the 1970s takes care of all concerns. Even though KONRAD continues to be controversial and is far from being operational: **No problem!**

III. It was neither the **role nor the function of the Commission** to define path to a disposal facility let alone bring about handling of nuclear waste that is reasonable for the long term, but instead to include as many multipliers from

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[1317] See the motion of The Left parliamentary group in the Bundestag: 'Umgang mit Atommüll – Defizite des Entwurfs des Nationalen Entsorgungsprogramms beheben und Konsequenzen aus dem Atommülldesaster ziehen', Printed Paper Motion 18/5228, information on the topic of nuclear waste report including a statement regarding the NaPro: www.atommuellreport.de.www.atommuellreport.de.

[1318] Cited from the response of the Federal Government (Printed Paper 18/243) of 27 December 2013 to the small inquiry 'Permanent storage of radioactive waste in the waste dumps and settling basins of Wismut GmbH' (Drucksache 18/58) of the member of the Bundestag Ralph Lenkert, Caren Lay, Eva Bulling-Schröter, other delegates and The Left parliamentary group in the Bundestag.

[1319] In this case, refer to the study of BUND 'Stellungnahme zu Defiziten der Regelung von Freigaben radioaktiver Stoffe in der Bundesrepublik Deutschland', Dipl.-Phys. Wolfgang Neumann, INTAC Hanover, October 2013; http://www.bund.net/index.php?id=20036

[1320] For the decision of the Upper Administrative Court of Schleswig, cf.: http://www.ovgsh.de/ovg_sh/Entscheidungen/OVG/2013/4%20KS%203-08/.http://www.ovgsh.de/ovg_sh/Entscheidungen/OVG/2013/4%20KS%203-08/. The decision from 2013 took effect after the Federal Administrative Court had dismissed the claims of the operator Vattenfall and the licensing authority, the Federal Office for Radiation Protection in early 2015. Since then, the on-site interim storage facility no longer holds a licence under nuclear law. All on-site interim storage facilities either have the same construction and licence as the Brunsbüttel facility or are even less secured (Southern German on-site storage facilities). A process against the on-site storage facility at the Unterweser nuclear power plant before the Upper Administrative Court of Lüneburg has not yet been decided on.

[1321] For this, cf.: Atommüll-Desaster und Nationales Entsorgungsprogramm – So geht das nicht!, http://www.hubertus-zdebel.de/?p=1517. At the receiving storage facility, the containers with high-level radioactive waste would be kept in interim storage in large quantities at the surface for decades.

different areas in a process, which virtually arbitrary administrative activities can resort to later on.

If 1. representatives from E.ON and RWE, while lodging a complaint against the Site Selection Act, are to negotiate with 2. representatives from the field of science, who took responsibility in the past and will also do so in the future, and 3. representatives of participating administrative bodies in a public, but also corporatist manner as to what will be done in the future, then this is in the end poorly suited for correcting the errors and healing the wounds, which these very actors have inflicted in the last decades. The strategic involvement of important societal groups, which were involved in the debate so far more on the periphery, such as the churches and unions will not be sufficient to overcome the societal divides.

The end result will not be a conclusive concept, but the ‘good feeling’ of having struggled to reach a ‘consensus’. Otherwise, it would hardly be possible to justify the time spent by the Commission vis-à-vis its audience and those carrying its costs.

The Commission developed its own dynamic, which led its members to spend their well compensated (work) time, under considerable time pressure and against all reason, in discourse with another. In the process, actual problems were not discussed, but texts[1322] that were so fragmented and which had ended up on the Commission’s table so late that it is hardly likely any member of the Commission had read them in context before a final decision was taken. Commission considered success to be jointly editing a text under increasing time pressure, but not that this text describes a societally feasible, reasonable path for the future.

The Commission and its members were in no way suited to supporting a new start to the search for a site. In any town council, parties with business interests such as the representatives of nuclear power companies would be considered biased and would not be allowed to take part in votes. This simple rule was not observed in the Commission[1323].

Against this background, claiming a societal consensus as an objective while excluding the very actors from the anti-nuclear movement through the use of terms and stipulations and in so doing, perpetuating the conflict instead of overcoming it may be consistent, but in no way helpful.

IV. Reasons for refusal

The finding in the submitted report is sobering: The Commission failed to cover any substantial ground and took the wrong approach.

a) Nuclear waste and requirements for its storage

[1322] ‘It’s not about reality, it’s about how to deal with this text’. Prof. Dr. Armin Grunwald on 04 May 2016 at the 23rd meeting of working group 3, discussion regarding the time required for the site selection procedure. The verbatim record of the meeting was not yet available at the time these statements had been formulated, cited based on an audio recording at 6:09:57

[1323] The Commission members appointed by the Bundestag and Bundesrat included not only persons who had played an active role with respect to a disposal facility in Gorleben in the past, but also, in the case of two representatives, the nuclear power companies E.on and RWE directly, who were in turn able to directly represent their economic interests. Early on when the Commission had begun work, their claims for compensation due to the decommissioning of their nuclear power plants after Fukushima placed a burden on the ‘working environment’ from the beginning of the Commission’s work on. The companies again clarified that there is no doubt that Gorleben site was a suitable ‘disposal site’. Only a few weeks after the Commission had begun work, the companies also lodged a complaint against the Site Selection Act. The nuclear energy representatives are doing what would be virtually impossible to do in a community council: Although they are directly affected by this matter, which in turn establishes their partiality, they do not forego the right to vote. At the same time, they also negotiated with the Federal Government e.g. regarding the financing of the disposal of nuclear waste.

- **Marginalisation of acute problems:** The Commission still failed to take advantage of the possibility of issuing a comprehensive statement, which the Site Selection Act very much provided for, even after this logical step arose in the course of its work. As a result, the representative of the Catholic Church, for example, rightly observed at the meeting of the Commission on 13 May 2016 that the problems in connection with the interim storage of high-level radioactive waste are significantly more urgent – considering that the procedure to find a site for a geological disposal facility is postponed by decades.[1324] However, no recommendation was provided to the Federal Government to immediately take effective, transparent action. It is therefore feared that the rightful safety interests of the interim storage facility sites contradict the rightful interests of possible sites for a geological storage facility following in-depth, safety-oriented clarification or are even used against them.
- **Collective storage of high-level radioactive and other waste:** The unique aspects of non high-level, chemo-toxic radioactive waste (e.g. from ASSE and Gronau[1325]) were dismissed with reference to the priority of the high-level radioactive waste: If a site offering sufficient space is found, waste could indeed be stored there. This is an unreasonable demand for any of the potential sites considering the type of waste to be stored there has not been clearly defined!
- **Gorleben panic:** Parts of the Commission were consumed by panic as soon as the Gorleben question was brought up[1326]. Attempts to conduct a factual, professional discussion were met with personal attacks. Ourselves and many of the critics believe that this indicates that numerous actors expect to return to Gorleben after a cooling-off period and a short legitimating search process has run its course. This would be a serious setback, which would again rekindle all justified reservations.
- **Forgoing a systematic new start in favour of selectively resorting to the Committee on a Selection Procedure for Repository Sites (AKEnd).** The Commission did not take advantage of the possibility, in divergence to the procedure so far, of defining a model for storage in deep geological formations. Instead, the working group 3 used the old results of the AKEnd (2000-2002) as a starting point and arbitrarily adopted parts thereof, particularly the model of the 'isolating rock zone' (ewG) and geological criteria. The considerable importance the AKEnd placed on socio-scientific criteria was abandoned. To this extent, the report even falls behind the level achieved by the AKEnd.

[1324] Cf. the verbatim record of the 27th meeting of the Commission dated 13 May 2016 and the statements of Georg Milbradt, page 63. The Brunsbüttel decision is also significant (see foot note 6). Since 2011, upgrades have been performed at all interim storage facilities for the purpose of hazard prevention to 'protect against disruptive actions or other third-party intervention' (SEWD). As anti-terrorism protection, these measures are subject to confidentiality, cf: http://www.bmub.bund.de/themen/atomenergie-strahlenschutz/nukleare-sicherheit/zwischenlagerung/sicherung-der-zwischenlager-und-hintergruende-der-erforderlichen-nachruestung/#.http://www.bmub.bund.de/themen/atomenergie-strahlenschutz/nukleare-sicherheit/zwischenlagerung/sicherung-der-zwischenlager-und-hintergruende-der-erforderlichen-nachruestung/#.

[1325] The uranium facilities in Gronau and Lingen have open-ended operating licences. The Left parliamentary group therefore demanded that the Federal Government include these facilities in the phasing-out of nuclear energy and decommission them.

[1326] Cf. in particular, the Commission Printed Paper submitted in April 2016/AG4-27. Following a comparative review regarding the report section 'National experiences' with respect to Gorleben, it is stated in closing: 'Considering the site's history, such a project could not be implemented on a political level.' This sparked considerable controversy. Even after it was agreed to adopt two separate points of view regarding the experience with Gorleben in the report, the initiative of BUND failed to have this sentence adopted, even in part. Cf. the verbatim record of the meeting of 27 June 2016, which is not yet present.

- **‘Isolating rock zone’ replaces ‘disposal facility’.** The search for an ‘isolating rock zone’ is the basis of the geological criteria. This isolating rock zone is not a natural limit, but refers to a relationship between the nuclear waste and the surrounding rock to be projected solely on the basis of calculations. Calculation-based proof that the nuclear waste to be emplaced will presumably remain contained in a certain zone for a long period of time doesn’t make it a storage location: The respective installation must also be able to be built, operated and sealed. It should be monitored and the retrievability during operation as well as the recoverability 500 years later must be possible. And last, but not least: What happens if the assumptions made about the isolating rock zone turn out to be misguided? Are there any other different, redundant geological barriers? All this was described at length in the report of the Commission, but the hard criteria do not take this into account and instead adopt the isolating rock zone as their mantra. This is unsettling not lastly due to the fact that interested actors never doubted that they would consider an isolating rock zone to be proven for Gorleben and that the isolating rock zone would in turn be: Gorleben.
- **Retrievability and recoverability:** The report of the Commission defines the chosen course of storage including retrievability and recoverability as having no alternative . This is surprising on one hand because many participants have rejected retrievability and recoverability for decades and have continued to do so until recently and, on the other hand, because no hard criteria have been defined in this respect. With respect to the experiences with ASSE II, retrievability and recoverability appear to be the next logical step, but this concerns an entirely different type of container (200l barrels versus Castor-like containers) as well as a disproportionately high amount of resources required for safety-relevant interventions. This does not represent a vote against retrievability and recoverability, but one favouring a serious consideration process, which the Commission has failed to conduct. This therefore suggests that this is a populistic statement that is not the product of professional consideration.
- **Criteria, safety studies and other assessment criteria.** The ‘hard’ criteria resolved by the Commission refer solely to the search for an ‘isolating rock zone’ in salt domes. But even the best ‘isolating rock zone’ is merely a possibility that must first be explored. Determining whether and how it works will be left to significantly less conclusive safety studies during the search for a site and the licensing procedure. It was particularly important to the representative from the energy industry that the safety requirements for operation be stipulated as late as possible in the procedure.
- **Salt bias:** Since the 1960s, the approach of storing nuclear waste in salt has been taken in Germany. The starting point for this was the requirement that exhausted mines which had not been sealed were to be used for reasons of cost. Although the approach of subsequent use was abandoned beginning in the early 1980s, research, the development of concepts and lobby interests settled on a manifest bias towards salt. This could only be compensated if research, concept development and exploration with respect to other host rocks are adequately pushed forward. Asse, Morsleben and current developments in the USA cast serious doubt on the salt approach, which the Commission has failed to adequately follow up on.
- **Tip-toeing around crystalline rock:** The inclusion of crystalline rock (granite) has led to a lot of tip toeing on the part of geologists. Instead of considering a thorough revision of the 15-year old AKEnd concept, it was first

considered that, with respect to crystalline rock, the containers are to ensure safe containment. However, the idea that the containers alone are to guarantee safety for 1,000,000 years is rather absurd. It also goes against the idea of guaranteeing safety by means of geological barriers in particular, and, as a result, a container concept could also be imagined in salt and claystone. Up to the last meeting of the Commission, the attempt was therefore made to skew and stretch the criteria so that they could somehow also be applied to crystalline rock. In the end, the question as to whether and how long-term containment in crystalline rock is possible is still and will continue to be open throughout the entire procedure[1327]

- **Bias towards geological data:** Contrary to the statements of the Federal Institute for Geosciences and Natural Resources (BGR) that there were sufficient geological data
to determine the best possible site, a survey of the State Geological Services of the Länder, which was initiated by the Land of Mecklenburg Western-Pomerania, determined that the practitioners on location see this differently. The current level of data has been shaped by history and is particularly based on the economically motivated search for raw materials. Making it the sole basis is neither fair for the Länder which have been explored extensively, nor appropriate when it comes to finding the best possible location. In particular, a serious analysis of crystalline rock appears only to be possible in connection with strategic exploration. Otherwise, an irreversible lack of fairness will remain.
- **Timeframe:** It became clear in the Commission that the timeframe defined in the Site Selection Act for the selection procedure up to the site decision (approx. 2031) and commissioning of a nuclear waste storage facility for final disposal (approx. 2050) is not realistic and is oriented more towards the time limits on the licences for the interim storage facilities. As a result, these dates have in turn been politically stipulated in the existing Site Selection Act. On the other hand, a realistic discussion regarding the amendment of the concepts for the interim storage of the high-level radioactive waste due to the long procedures for the search for a disposal site, which are expected to take decades, failed to take place.[1328]
- **No new approaches in research:** The working group 3 had already rejected the request of the Land of Lower Saxony to conduct a generally critical review of the research to date as well as of its actors. Considering the members of the working group 3, this may come as no surprise. Though many tasks are correctly described in part in the research section B 6.9, it is up to the discretion of the ‘involved institutions and funding providers’ as to how the substantial research funding is to be used and, if applicable, established lobby interests are to be served.
- **Socio-scientific criteria:** With reference to the primacy of safety for 1,000,000 years, the Commission has shifted the geological criteria of the AKEnd into focus and significantly detracted from the importance of the socio-scientific criteria. This fails to consider that there is a vital interest in safety during the construction and operating period at the applicable sites, which may amount to more than 100 years overall.
- Overall, the Commission would have been better advised, with respect to the brevity of the available timeframe, to only submit an **interim report** as proposed

[1327] Bavaria announced its dissenting opinion effectively describing the granite deposits there as unsuitable. Cf. also ‘Endlager-Kommission kommt beim Kristallingestein ins Stolpern’, www.endlagerdialog.de
[1328] Cf.: ‘Commission abandons time frame’, http://www.bundestag.de/mobil/kw22-endlagerkommission/424744.

by myself and other members of the Commission. This would have provided the possibility of making it clear which questions cannot be consolidated based on experience and reporting further research requirements. Furthermore, this would have made it possible to put the debate back in the hands of society where it belongs.

b. Public participation and legal aspects

- A new start with respect to the search for a permanent nuclear waste storage facility requires that **the mistakes and injustice of the past are corrected**. This is the only way to create a basis for moving forward to ensure that these errors are avoided in the future. The Commission has failed to complete the important task of working through conflicts as a basis for the endeavoured consensus. [1329]
- **Public involvement in the work of the Commission has failed:** The Commission has not only failed to achieve the required objective of fostering a broad public debate and involving the public, which it set for itself, it has also failed to make any serious attempt to do so.[1330] It even failed to come close to achieving the defined objective of having the entire report critically evaluated on the basis of public discussion prior to the conclusion of the Commission's work and addressing the findings in the report. Even the current postponement of involvement that has been provided for to September, after the summer break, via the Bundestag (environmental committee) and the BfE (event) is incapable of resolving this shortcoming.
- Instead, the Commission has defined **target groups** (representatives from the regions, youth, professional community) and developed corresponding formats. With respect to the individual events, participation managers tasked (and paid) by the Commission posed questions to an interested, but for the most part ill prepared audience, which was to answer them. This laboratory exercise differs greatly from any situation where those involved represent their own interests and opinions. The willingness of the professional community to take part in the professional event at the end of January 2016 (K-Drs. 143) in the end did not reflect genuine involvement as the Commission was unable to submit any documents that could be discussed. Two nationwide events in Berlin at the start and end were virtually insignificant because the critical members of the audience, who could have contributed their own opinion stayed away based on past experiences. Instead of a for the most part complete draft of the report, the participants at the 'consultation' on 29 April (K-Drs. 205) were only able to discuss 'core messages'. A report on the evaluation of involvement during the Commission's work tasked by the

[1329] Cf. the statement of the conflict advisors or mediators in a letter to the Commission, K-Drs. 73 of 23 May 2016. 'Remarks on the work of the Commission on the Storage of High-Level Radioactive Materials'. Published by: Joint group of experts of the Förderverein Mediation im öffentlichen Bereich e.V. and the Federal Association fundamental rights 2016 p. 31 et seq. The MEDIATION e.V.: 'Without such a review, the Gorleben site has shown itself, as expected, to be an 'elephant on the Commission's table': As advisors in conflicts, we know that taboo issues must be explicitly addressed as they implicitly take away from one another and block the process as is currently the case in the Commission's work e.g. with respect to the specification of suitability criteria.' Furthermore: Ulrike Donat (2016) in Müller-Heidelberg et al (publisher.) Report on attorney and mediator Ulrike Donat was, at the beginning of the Commission's work, a guest member of working group one on public involvement and resigned in February 2015. Her reasons are documented in K-Drs. 88a.

[1330] See the resolution proposal Printed Matter 18/1068: For this reason, the German Bundestag affirms the objective defined with the establishment of the Commission and in the Site Selection Act... 'to increase the probability of reaching a societal consensus with respect to the search for a disposal site through the broad participation of societally relevant groups in the Commission...' (page 2). A total of more than 20 million people in the Federal Republic of Germany would be affected by the pending search procedure in the first phase according to the Commission paper of Prof. Dr. - Ing. Wolfram Kudla with the cooperation of Dipl.-Ing. Jörg Weißbach, Drs. 83a, working group 3 and Drs. 63a, working group one.

Commission contained rather critical remarks and as a result, was met with little appreciation on the part of the Commission. [1331]

- **The public and their involvement during the course of the procedure:** The Commission recommended a series of highly regulated formats and instruments to involve the public during the course of the selection procedure. They do not allow for any participative collaboration, on equal footing, of the affected citizens, groups critical of nuclear energy or citizens' initiatives capable of influencing outcomes and tended more to place twice the burden on local politicians to rally acceptance. Participation is more than information and top-down consultation, it must be able to influence the procedure and results, allow for paradox interventions, allow for potential setbacks and dispose of its own financial resources. Above all, the basic requirement that a discussion involving the whole of society including the correction of errors must be fulfilled before the search for a new site begins.
- The Left welcomes the **transfer of the Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe mbH (DBE) to a state-owned operating company.** It is, however, probable that this will only be resolved once a concrete handling proposal is in place. The rights, which the Federal Government transferred to private third parties, such as property and expertise from research centres and research assignments must be transferred back at no charge. In consideration of the financial exemption of the nuclear energy companies by the KfK and the corresponding implementation of the Federal Government in the coming legislative process, taxpayers may not be asked yet again to pay for the nationalisation of the DBE.
- **Federal control mechanisms removed:** With the principle of legal planning and the establishment of the Federal Office for the Regulation of Nuclear Waste Management (BfE), federal control mechanisms have been removed on all levels of the separation of powers and centralistic decision-making structures have been introduced without being replaced by other adequate 'checks and balances'. At the same time, the federally-owned Gesellschaft für Endlagerung (BGE) gains central importance as the project delivery organisation – as with the BfE under the umbrella of the Federal Environment Ministry.
- **Structure of Authorities:** Though the BfE, as the regulatory and licensing authority, must hear other authorities, regions, communities and affected parties in the search procedure in the future, it can, however, override their statements. There is no guarantee that the BfE evaluates all concerns and, if applicable, changes its plans; there is also no guarantee that the Bundestag adopts the plans of the BfE without any changes. No joint discussions have been provided for. The Commission did not find any viable solutions for the resulting gaps in the procedure and the critical relationship between executive planning and a legal decision by the Bundestag. The population in the affected regions does not have sufficient rights of co-determination. The designated one-time re-examination right of the regions is not sufficient in order to gain equal footing with respect to such centralisation and counteract undesirable developments.
- **Legal redress is also not sufficient after the evaluation.** Though the Site Selection Act has now been improved in compliance with European law and the possibilities for legal action have been ameliorated, however, this is not yet sufficient as possibilities for legal redress are not provided for in each phase of

[1331] See K-Drs. 230. Evaluation report on the participation procedure by the Commission on the Storage of High-Level Radioactive Materials, 22 February 2016.

the site selection procedure although any act can infringe on rights and other effective control possibilities no longer exist due to the centralisation on the part of the Federal Government and without participative citizen involvement.[1332]

- **WAA return transports to the on-site interim storage facilities without public participation.** In connection with the Site Selection Act, a compromise for the consent of the Federal State of Lower Saxony has been provided for that vitrified radioactive waste will no longer be transported to the Gorleben interim storage facility, but to an on-site interim storage facility. After prolonged negotiations, the on-site storage facilities in Brokdorf, Biblis, Philippsburg and Isar/Ohu are to accept this waste. New licenses are required for this because currently only the spent fuel elements produced on site may be brought to these on-site storage facilities in Castor containers. The new start and public participation are subjected to a litmus test: With respect to the corresponding licensing procedures ahead, for which the nuclear power plant operators have not submitted any applications to date, the public will not be involved although a 'significant change' as defined by nuclear law is to be assumed due to the unique nature of (vitrified) nuclear waste and the containers.[1333]

Export ban: In addition to the existing export ban on high-level radioactive waste from power reactors, the Commission called for such a ban on fuel elements from research reactors in October 2015. In so doing, it directly responded to the aforementioned attempts to relocate nuclear waste to the USA by reclassifying nuclear waste as research waste from Jülich. The Federal Government has yet to issue a clear statement prohibiting such export plans and at last putting an end to the corresponding cost-incurring plans.[1334]

Phasing-out of nuclear energy in the German Basic Law: As an important consequence from the history of the use of nuclear energy and the massive conflicts associated with it, the anchoring of the phasing-out of nuclear energy in Basic Law is a significant consequence not only in the eyes of The Left parliamentary group in order to build the required trust for a new start. Two expert opinions tasked by the Commission have shown that this is generally possible. However, the Commission refrained from taking a position of its own and has passed this debate on to the Bundestag.[1335] In the view of The Left

[1332] With the 2013 Site Selection Act, the control system was completely changed with respect to the search for a site: Legal redress was significantly reduced through the reassignment of the official decision at the Länder-level (old law) to Bundestag decisions (legally planning). Legal planning only provides for the path to the Federal Constitutional Court. This limits the legal redress to violations of fundamental rights. In the Site Selection Act, legal action directly before the Federal Administrative Court as the sole authority was only provided for under Section 17 (selection for underground exploration). The Commission is now proposing an additional possibility for legal action in Section 19 (Conclusive Comparison of Sites and Site Proposal) on the basis of the requirements of European law.

[1333] When queried at the Commission meeting of 18 December 2015, the head of the nuclear department of the Federal Environmental Ministry, Wolfgang Cloosters, in the presence of the Federal Minister of the Environment explained that such public involvement had not been provided for, cf. the verbatim record of the 18th meeting, p. 16 et seq. For the new safety requirements, refer to the letter of Hubertus Zdebel to the Commission, K-Drs. 109.

[1334] Recently, the Federal Minister of the Environment Hendricks, when asked, explained that the Federal Government still hasn't reached a consensus on this question. Cf: http://www.hubertus-zdebel.de/?p=4364

[1335] The current phasing-out of nuclear energy can be amended by way of a basic majority in the Bundestag. A constitutional provision would significantly increase the hurdles for a new start. The lack of trust is, among other things, so great that though the directors of the nuclear energy companies agreed to the 'nuclear consensus' in early 2000/2 and signed it, they set up a campaign to extend the term a short time later and found the support of the CDU/CSU and FDP for this. This extension of the term led to the largest protests in recent history of anti-nuclear protests and was initially ignored by the CDU-FDP government for the benefit of the companies. Only the manifold Fukishima disaster prompted German Chancellor Angela Merkel to parliamentary group, this important requirement of the Commission for a serious attempt at a new start is as good as buried.

V. Consequences
The Left parliamentary group in the Bundestag rejects this report.
However, it supported the early establishment of a National Advisory Committee and will also do everything with respect to the revision of the Site Selection Act to implement a fair, public procedure oriented solely towards minimising the radiation exposure of people and the environment.
The people in Gorleben are well advised to beware. Sites that could be affected by a potential site search would do well to form their own opinion in due time. Regardless whether the approach of a site search is pursued further (which we support) or not, the sites where the interim storage facilities are located bear the full burden as well as the growing risk of nuclear remains for a prolonged, undefined period of time. Failure to intervene in this matter is not only irresponsible on the part of the Commission, but also a serious shortcoming on its part.

With respect to the enormous risks and the enormous responsibility vis-à-vis future generations, The Left pleads in favour of a new start to how the storage of all types of radioactive waste is handled on the basis of a broad societal process that provides for comprehensive rights on the part of the citizens. With this in mind, the German Bundestag and Bundesrat as well as the Federal Government must evaluate the report of the Commission, correct the errors and other shortcomings of the report, and implement them in the described manner.

turn things around. This is why this topic is so important to critics. The two expert opinions tasked by the Commission on the topic of the phasing-out of nuclear energy in the German Basic Law are available here online: Alexander Roßnagel, K-MAT 62 and Klaus F. Gärditz, K-MAT-61