

Summation peaks and escape peaks of selected radionuclides in gamma spectrometry

γ -SPEKT/SUMESC

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As a supplement to the Sections 7 and 9.7 of the General Chapter γ -SPEKT/GRUNDL of this Procedures' Manual [1], Table 1 of this General Chapter compiles a selection of summation and escape peaks that are relevant to the monitoring of radioactive substances in the environment.

Summation peaks (SL) may occur in the case of radionuclides with cascade transitions, Table 1 only lists those summation peaks of a radionuclide that do not coincide with its individual peaks and are not generally found in regular nuclide databases, When evaluating the pulse height spectrum, these gamma peaks must be paid particular attention and be excluded from the activity calculation.

In the case of peaks with gamma energies that are considerably higher than 1 MeV, so-called single escape peaks (SE) and double escape peaks (DE) occur in the pulse height spectrum during the measurement due to the triplet effect.

If a gamma peak with a very large number of counts is found in the pulse height spectrum, another peak may occur approx. 10 keV to 12 keV below this peak; the former will, however, exhibit a smaller number of counts, This additional peak is a germanium X-ray escape peak [2]. Such a peak occurs when a secondary germanium X-ray quantum escapes from the detector crystal. When, for example, measurements take place over a long period of time, a slightly wider weak peak occurs at approx. 650 keV in addition to the Cs-137 peak at 661,7 keV, Similarly, such a peak may occur at approx. 1450 keV in the case of K-40 ($E_\gamma = 1460,8$ keV).

Besides the summation and escape peaks described in this section, additional peak-like structures may occur in the pulse height spectrum if a stronger activity of one radionuclide is present in the source to be measured, These structures may be backscattering peaks and Compton edges that are discussed in the General Chapter γ -SPEKT/ INTERF of this Procedures' Manual [3].

Note:

All nuclear data used in this General Chapter is as of June 2018. Up-to-date values can be found in the General Chapter KERNDATEN of this Procedures' Manual [4].

Tab. 1: Selection of relevant summation and escape peaks;

with: SE single escape peak
DE double escape peak
SL summation peaks of two or more individual peaks

Radionuclide/ radionuclide pair	Energy of the peak in keV	Code	Energy of the original gamma radiation in keV	
Na-22	1785,54	SL	511,00	1274,54
	763,54	SE	1274,54	
	252,54	DE	1274,54	
K-40	438,82	DE	1460,82	
	949,82	SE	1460,82	
Mn-56	1091,01	DE	2113,01	
	1602,01	SE	2113,01	
	1635,56	DE	2657,56	
	2146,56	SE	2657,56	
	2347,84	DE	3369,84	
	2858,84	SE	3369,84	
Co-56	2182,15	SL	846,77	1335,38
	2206,97	SL	846,77	1360,20
Co-58	1321,76	SL	511	810,76
Fe-59	2390,77	SL	1099,25	1291,59
	780,52	SE	1291,59	
Co-60	310,49	DE	1332,49	
	821,49	SE	1332,49	
	2505,72	SL	1173,23	1332,49
Se-75	187,17	SL	121,12	66,05
	202,05	SL	136,00	66,05
	319,73	SL	121,12	198,61
	334,61	SL	136,00	198,61
	385,78	SL	121,12	264,66
Y-88	814,07	DE	1836,07	
	1325,07	SE	1836,07	
	2734,11	SL	898,04	1836,07
Ru-106	1133,75	SL	511,85	621,90
Ag-108m	1156,85	SL	722,91	433,94
	1337,19	SL	722,91	614,28
	1771,13	SL	722,91	614,28 433,94
Ag-110m	1104,57	SL	446,81	657,76
	1153,67	SL	763,94	446,81
	1331,49	SL	446,81	884,68
	1364,44	SL	706,68	657,76
	1421,70	SL	763,94	657,76
	1450,95	SL	763,94	687,01

Radionuclide/ radionuclide pair	Energy of the peak	Code	Energy of the original gamma radiation	
	in keV		in keV	
Ag-110m (continued)	1450,96	SL	706,68	744,28
	1524,70	SL	706,68	818,02
	1581,96	SL	763,94	818,02
	1591,36	SL	706,68	884,68
	1595,25	SL	937,49	657,76
	1648,62	SL	763,94	884,68
	1822,17	SL	937,49	884,68
	2182,64	SL	706,68	1475,78
	2268,97	SL	1384,29	884,68
	2268,97	SL	763,94	1505,03
Te-123m	247,43	SL	88,46	158,97
Sb-124	668,97	DE	1690,97	
	1068,93	DE	2090,93	
	1179,97	SE	1690,97	
	1579,93	SE	2090,93	
	1248,58	SL	645,85	602,73
	1570,93	SL	968,20	602,73
	1647,86	SL	1045,13	602,73
	2293,71	SL	1690,97	602,73
	2693,66	SL	2090,93	602,73
Sb-126	988,20	SL	573,80	414,40
	1080,50	SL	414,40	666,10
	1109,40	SL	414,40	695,00
	1111,40	SL	697,00	414,40
	1134,70	SL	720,30	414,40
	1239,90	SL	573,80	666,10
	1259,10	SL	593,00	666,10
	1268,80	SL	573,80	695,00
	1288,00	SL	593,00	695,00
	1363,10	SL	697,00	666,10
	1386,40	SL	720,30	666,10
	1392,00	SL	697,00	695,00
	1415,30	SL	720,30	695,00
	1417,30	SL	697,00	720,30
	1522,80	SL	856,70	666,10
	1551,70	SL	856,70	695,00
	1553,70	SL	697,00	856,70
	1775,50	SL	414,40	695,00
	1777,50	SL	697,00	414,40
	1806,40	SL	697,00	414,40
	2058,10	SL	697,00	695,00
				666,10
				666,10
				695,00
				666,10

Radionuclide/ radionuclide pair	Energy of the peak in keV	Code	Energy of the original gamma radiation in keV		
Te-131m	483,99	SL	334,27	149,72	
	854,77	SL	81,10	773,67	
	874,85	SL	81,10	793,75	
	875,73	SL	102,06	773,67	
	933,31	SL	81,10	852,21	
	954,27	SL	102,06	852,21	
	1186,48	SL	334,27	852,21	
	1899,11	SL	1125,44	773,67	
	1980,32	SL	1206,65	773,67	
Te-132	166,06	SL	116,34	49,72	
	278,05	SL	228,33	49,72	
Ba-133	132,77	SL	53,16	79,61	
	134,16	SL	53,16	81,00	
	357,40	SL	276,40	81,00	
	437,01	SL	356,01	81,00	
	437,01	SL	53,16	383,85	
	437,01	SL	276,40	160,61	
Cs-134	1167,97	SL	563,25	604,72	
	1174,05	SL	604,72	569,33	
	1400,58	SL	604,72	795,86	
	1643,33	SL	604,72	1038,61	
	1772,69	SL	604,72	1167,97	
	1969,91	SL	604,72	1365,19	
Cs-136	230,80	SL	66,88	163,92	
	885,39	SL	66,88	818,51	
	904,87	SL	86,36	818,51	
	971,76	SL	153,25	818,51	
	995,11	SL	176,60	818,51	
	1092,16	SL	273,65	818,51	
	1114,95	SL	66,88	1048,07	
	1134,43	SL	86,36	1048,07	
	1159,06	SL	340,55	818,51	
	1201,32	SL	153,25	1048,07	
	1224,67	SL	176,60	1048,07	
	1302,24	SL	66,88	1235,36	
	1321,72	SL	273,65	1048,07	
	1321,72	SL	86,36	1235,36	
	1388,61	SL	153,25	1235,36	
	1388,62	SL	340,55	1048,07	
	1866,58	SL	1048,07	818,51	
	1933,46	SL	66,88	1048,07	818,51
	2019,83	SL	153,25	1048,07	818,51

Radionuclide/ radionuclide pair	Energy of the peak	Code	Energy of the original gamma radiation		
	in keV		in keV		
Cs-136 (continued)	2043,18	SL	176,60	1048,07	818,51
	2053,81	SL	1235,36	818,51	
	2207,13	SL	340,55	1048,07	818,51
Ba-140	567,22	SL	537,26	29,96	
La-140	574,20	DE	1596,20		
	1085,20	SE	1596,20		
	1836,85	SE	2347,85		
	2010,39	SE	2521,39		
	1924,96	SL	328,76	1596,20	
	2028,71	SL	432,51	1596,20	
	2083,22	SL	487,02	1596,20	
	2411,98	SL	328,76	487,02	1596,20
	2411,98	SL	815,78	1596,20	
Ce-144/Pr-144	185,51	SE	696,51		
	1674,66	SE	2185,65		
Eu-152	1123,18	SL	778,90	344,28	
	989,17	SL	867,38	121,78	
	1233,86	SL	1112,08	121,78	
	1529,79	SL	1408,01	121,78	
Eu-154	705,08	SL	582,01	123,07	
	839,69	SL	591,76	247,93	
	971,23	SL	723,30	247,93	
	1027,13	SL	904,06	123,07	
	1397,50	SL	1274,43	123,07	
	1719,55	SL	723,30	996,25	
Ta-182	1189,04	SL	67,75	1121,29	
	1289,15	SL	67,75	1221,40	
Tl-208	816,56	SL	233,37	583,19	
	2847,88	SL	233,37	2614,51	
	2891,88	SL	277,37	2614,51	
	3125,21	SL	510,74	2614,51	
	3197,70	SL	583,19	2614,51	
	3475,04	SL	860,53	2614,51	
	3708,40	SL	510,74	583,19	2614,51
Ra-226 series	742,49	DE	1764,49		
	1096,55	DE	2118,55		
	1182,21	DE	2204,21		
	1253,49	SE	1764,49		
	1271,40	DE	2293,40		
	1425,86	DE	2447,86		
	1607,55	SE	2118,55		

Radionuclide/ radionuclide pair	Energy of the peak	Code	Energy of the original gamma radiation	
	in keV		in keV	
Ra-226 series (continued)	1693,21	SE	2204,21	
	1782,40	SE	2293,40	
	1936,86	SE	2447,86	
Th-232 series	566,20	DE	1588,20	
	598,74	DE	1620,74	
	608,63	DE	1630,63	
	616,28	DE	1638,28	
	1077,20	SE	1588,20	
	1109,74	SE	1620,74	
	1119,63	SE	1630,63	
	1127,28	SE	1638,28	
	1592,51	DE	2614,51	
	2103,51	SE	2614,51	
Np-239	289,64	SL	61,46	228,18
	339,06	SL	61,46	277,60
	383,73	SL	106,13	277,60
	391,59	SL	106,13	285,46

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