Package Contents Specification
for Safkeg-HS
Package Design No 3977A

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1 Specification of contents

1.1 General nature of contents

The Safkeg-HS 3977A package is designed as a Type B(U) general purpose package for radioactive material.

The package is designed for radioactive material that emits neutron, alpha, beta or gamma radiation.

The contents may be in solid, liquid or gaseous form and carried in various inserts as specified in the Table 1 below.

Table 1 Contents Types

Contents Type Designation	Material Form	Shielding Insert	General Requirements for each Contents Type (1)	Activity Limits for each Contents Type
CT-1	Solid	HS-12x95-Tu Design No 3982	See Table 1-3-1	See Table 4-1
CT-2	Solid	HS-31x114-Tu Design No 3985	See Table 1-3-2	See Table 4-2
CT-3	Gas	HS-31x114-Tu Design No 3985	See Table 1-3-3	See Table 4-3
CT-4	Liquid (I-131)	HS-55x128-SS Design No 3987 with Titanium liner	See Table 1-3-4	See Table 4-4
CT-5	Liquid (Mo-99)	HS-50x85-SS Design No 4081 in tungsten liner with Split Lid CV	See Table 1-3-5	See Table 4-5
CT-6	Solid (thorium metal)	HS-55x113-SS– Design No 4109 with Split Lid CV	See Table 1-3-6	See Table 4-6

1 These tables are in the SARP [1].

1.2 Shielding inserts

The shielding inserts specified in Section 1 of the SARP for Safkeg-HS 3977A [1] and listed in Table 1 above are required for all contents.

Under NCT and HAC, the shielding inserts, together with the user defined product containers, provide confinement of the solid or liquid radioactive material.

1.3 Radionuclides included

See Tables 4-x.

1.4 Quantity

The maximum mass (and volume for gases) of each radionuclide carried in Type B quantities is detailed in Table 2 and Tables 4-x for specific Contents Types.

1.5 Activity limit

The package activity limits for individual nuclides, according to the insert used, are given in Tables 4-x. The activity limit is determined in accordance with the methodology in Section 2 below except for CT-6 for which typical contents are given in Table 4-6.

1.6 Other limiting factors

Various restrictions and limits of quantity of radionuclides apply according to the insert used and for the form of the radioactive material (solid, liquid or gas). These restrictions and contents limits are detailed in Section 1 of the SARP for Safkeg-HS 3977A in Section 1.2.2 in the tables for specific Contents Types.

2 Calculation of allowable contents

The package activity limit in Tables 4-x is the least of the limits determined based on heat output, mass limit and shielding limit and, for gas contents, the limit based on allowable leakage under NCT or HAC.

2.1 Heat limits

The heat limit for solid contents is 30 W and for liquid contents the heat limit is 5 W.

2.2 Mass limit

The upper limit on the mass is different for each insert - as specified in section 1.4 above.

The maximum mass of the radionuclides is set at nominally 50% the mass of a steel cylinder that would fill the cavity of the insert (see Table 2).

Table 2 Maximum mass of the radionuclides

Shielding Insert	Mass of a steel cylinder that would fill the cavity of the insert (g)	Maximum mass of the radionuclides (g)
HS-12x95-Tu Design No 3982	90	45
HS-31x114-Tu Design No 3985	690	345
HS-55x128-SS Design No 3987 with titanium liner	1,810	905
HS-50x85-SS Design No 4081 with tungsten liner	1,615	808
HS-55x113-SS Design No 4109	2,100	<100 *

* Arbitrary limit

2.3 Shielding limit

The package design is such that the surface dose rate, as opposed to the TI, is the limiting factor under HAC. The shielding limits in Tables 4-x for each radionuclide are based on the assessments listed in Table 3.

Table 3 Shielding Limit of the radionuclides

Contents Type	Assessment
CT-1, CT-2 (solids) And CT-3 (gases)	Report CTR 2011/01 [2] provides the maximum activity to give the maximum allowable package surface dose rate (for β, γ and n emitters) of 2mSv/h (200 mrem/h). These calculations are based on the worst case assumption of the radioactive material being a point source at the centre of the base of the insert (neglecting spacing due to use of product containers). This location has been shown to produce the highest package surface dose rate in report AMEC/SF6652/001 [3]. This shielding limit has been further adjusted to take into account some shielding calculation uncertainties as discussed in Croft report CTR 2013/09 [7].
CT-4 (I-131 in liquid)	The package surface dose rate has been determined in report AMEC/CRM37327/TN_001 [8]. These are the package limits to meet user requirements.

Contents Type	Assessment
CT-5 (Mo-99 in liquid)	The package surface dose rate has been determined in report AMEC/CRM42622/TN_001. These are the package limits to meet user requirements.
CT-6 (thorium metal)	The surface dose is given in Table 4-6 for a typ;ical activated thorium target. The dose data is taken from Atkins Report 5163778-HS-REP-001-001 which gives the dose rate per Ci for the radionuclides arising from a thorium metal target activated by proton bombardment.

2.4 Leakage limit

For solid and liquid contents, the contents are completely contained as the O-ring seal of the CV meets the requirement of Leaktight as defined in ANSI N 14.5 [4].

2.5 Criticality Limits

There are no fissile material in the contents for this package.

3 References

[1] CTR 2008/11, SARP for Safkeg-HS 3977A, Docket No. 71-9337
[2] Croft, CTR 2011/01, Issue D, SAFKEG LS 3977A, Package Activity Limits Based on Shielding
[3] AMEC/SF6652/001, Issue 2, Monte Carlo Modelling of Safkeg HS Container
[4] ANSI N14.5, American National Standard for Radioactive Materials - Leakage Test on Packages for Shipment, American National Standards Institute, Inc., 1997
[5] 10CFR PART 71, Packaging And Transportation Of Radioactive Material, U.S. Nuclear Regulatory Commission
[6] CS 2012/05, Issue A, SAFKEG-HS 3977A - Gas contents limit for leaktight condition
[7] CTR 2013/09, Issue C, Uncertainties Associated with the Proposed Shielding Calculation Method for the SAFKEG-HS 3977A Package
[8] AMEC/CRM37327/TN-001, Issue 1, HS Container Shielding Assessment with I-131
[9] AMEC/CRM42622/TN-001, Issue 1, HS Container Shielding Assessment with Mo-99
[10] Atkins 5183326 -HS-REP-001, Shielding Assessment of the 3977A SAFKEG Transport Package Type B(U) with Thorium Target Source

Table 4-1 Activity Limits for Contents Type 1 - CT-1 - Solid in heavy tungsten insert – Design No 3982

										Contents heat limit			Contents mass limit		Shielding limit	Package limit			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Nuclide	Max Activity		A2	# A2s	Spec Ac	Mass	Heat gen	Heat output	Package Type	Heat output	Activity		Mass	Act	Act	Act	Code		
	TBq	Ci	TBq		TBq/g	g	W/Ci	W	A or B	W	Ci	Bq	g	Bq	Bq	Bq	H	M	S
Ac-225	2.51E+00	6.78E+01	6.00E-03	417.95	2.10E+03	1.19E-03	3.46E-02	2.34E+00	B	30.00	8.68E+02	3.2105E+13	45	9.45E+16	2.51E+12	2.51E+12			S
Ac-227	7.24E-01	1.96E+01	9.00E-05	8049.19	2.70E+00	2.68E-01	4.72E-04	9.24E-03	B	30.00	6.35E+04	2.3513E+15	45	1.22E+14	7.24E+11	7.24E+11			S
Ac-228	4.28E-01	1.16E+01	5.00E-01	0.86	8.40E+04	5.09E-06	8.04E-03	9.30E-02	A	30.00	3.73E+03	1.3807E+14	45	3.78E+18	4.28E+11	4.28E+11			S
Am-241	3.58E+00	9.68E+01	1.00E-03	3581.11	1.30E-01	2.75E+01	3.28E-02	3.18E+00	B	30.00	9.14E+02	3.3828E+13	45	5.85E+12	3.58E+12	3.58E+12			S
As-77	7.90E+02	2.13E+04	7.00E-01	1128.38	3.90E+04	2.03E-02	1.41E-03	3.00E+01	B	30.00	2.13E+04	7.8987E+14	45	1.76E+18	9.43E+19	7.90E+14	H		
Au-198	2.56E+02	6.92E+03	6.00E-01	426.50	9.00E+03	2.84E-02	4.34E-03	3.00E+01	B	30.00	6.92E+03	2.5590E+14	45	4.05E+17	6.99E+14	2.56E+14	H		
Ba-131	1.88E+02	5.08E+03	2.00E+00	94.05	3.10E+03	6.07E-02	3.06E-03	1.55E+01	B	30.00	9.82E+03	3.6334E+14	45	1.40E+17	1.88E+14	1.88E+14			S
C-14	7.20E+00	1.95E+02	3.00E+00	2.40	1.60E-01	4.50E+01	2.93E-04	5.71E-02	B	30.00	1.02E+05	3.7850E+15	45	7.20E+12	6.92E+27	7.20E+12		M	
Co-60	2.38E-01	6.44E+00	4.00E-01	0.60	4.20E+01	5.68E-03	1.54E-02	9.94E-02	A	30.00	1.95E+03	7.1970E+13	45	1.89E+15	2.38E+11	2.38E+11			S
Cs-131	6.71E+03	1.81E+05	3.00E+01	223.73	3.80E+03	1.77E+00	1.65E-04	3.00E+01	B	30.00	1.81E+05	6.7118E+15	45	1.71E+17	8.39E+35	6.71E+15	H		
Cs-134	7.05E+00	1.90E+02	7.00E-01	10.07	4.80E+01	1.47E-01	1.02E-02	1.94E+00	B	30.00	2.95E+03	1.0905E+14	45	2.16E+15	7.05E+12	7.05E+12			S
Cs-137	1.44E+02	3.89E+03	6.00E-01	240.00	3.20E+00	4.50E+01	1.01E-03	3.94E+00	B	30.00	2.96E+04	1.0966E+15	45	1.44E+14	1.58E+15	1.44E+14		M	
Cu-67	6.91E+02	1.87E+04	7.00E-01	986.75	2.80E+04	2.47E-02	1.61E-03	3.00E+01	B	30.00	1.87E+04	6.9073E+14	45	1.26E+18	6.50E+25	6.91E+14	H		
Hg-203	3.57E+01	9.66E+02	1.00E+00	35.75	5.10E+02	7.01E-02	1.99E-03	1.92E+00	B	30.00	1.51E+04	5.5787E+14	45	2.30E+16	3.57E+13	3.57E+13			S
Ho-166	2.04E+00	5.52E+01	4.00E-01	5.10	2.60E+04	7.85E-05	4.29E-03	2.37E-01	B	30.00	6.99E+03	2.5852E+14	45	1.17E+18	2.04E+12	2.04E+12			S
I-125	3.19E+03	8.61E+04	3.00E+00	1062.52	6.40E+02	4.98E+00	3.48E-04	3.00E+01	B	30.00	8.61E+04	3.1875E+15	45	2.88E+16	4.49E+35	3.19E+15	H		
I-129	2.93E-04	7.91E-03	< 1	< 1	6.50E-06	4.50E+01	4.68E-04	3.70E-06	B	30.00	6.41E+04	2.3720E+15	45	2.93E+08	3.31E+26	2.93E+08		M	
I-131	3.28E+02	8.85E+03	7.00E-01	468.01	4.60E+03	7.12E-02	3.39E-03	3.00E+01	B	30.00	8.85E+03	3.2761E+14	45	2.07E+17	4.11E+15	3.28E+14	H		
In-111	4.27E+02	1.15E+04	3.00E+00	142.34	1.50E+04	2.85E-02	2.60E-03	3.00E+01	B	30.00	1.15E+04	4.2702E+14	45	6.75E+17	1.45E+28	4.27E+14	H		
Ir-192	1.81E+02	4.90E+03	6.00E-01	302.02	3.40E+02	5.33E-01	6.13E-03	3.00E+01	B	30.00	4.90E+03	1.8121E+14	45	1.53E+16	2.71E+15	1.81E+14	H		
Ir-194	3.87E+01	1.04E+03	3.00E-01	128.87	3.10E+04	1.25E-03	5.35E-03	5.59E+00	B	30.00	5.61E+03	2.0766E+14	45	1.40E+18	3.87E+13	3.87E+13			S
Lu-177	1.03E+03	2.78E+04	7.00E-01	1470.30	4.10E+03	2.51E-01	1.08E-03	3.00E+01	B	30.00	2.78E+04	1.0292E+15	45	1.85E+17	1.56E+24	1.03E+15	H		
Mo-99	5.27E+01	1.42E+03	6.00E-01	87.87	1.80E+04	2.93E-03	3.27E-03	4.66E+00	B	30.00	9.18E+03	3.3972E+14	45	8.10E+17	5.27E+13	5.27E+13			S
Na-24	2.63E-02	7.12E-01	2.00E-01	0.13	3.20E+05	8.23E-08	2.77E-02	1.97E-02	A	30.00	1.08E+03	4.0053E+13	45	1.44E+19	2.63E+10	2.63E+10			S
Np-237	1.17E-03	3.16E-02	2.00E-03	0.59	2.60E-05	4.50E+01	2.88E-02	9.10E-04	A	30.00	1.04E+03	3.8570E+13	45	1.17E+09	3.58E+12	1.17E+09		M	
P-32	5.58E+00	1.51E+02	5.00E-01	11.15	1.10E+04	5.07E-04	4.12E-03	6.21E-01	B	30.00	7.28E+03	2.6946E+14	45	4.95E+17	5.58E+12	5.58E+12			S
P-33	2.44E+03	6.61E+04	1.00E+00	2444.45	5.80E+03	4.21E-01	4.54E-04	3.00E+01	B	30.00	6.61E+04	2.4444E+15	45	2.61E+17	5.10E+37	2.44E+15	H		
Pb-203	5.20E+02	1.40E+04	3.00E+00	173.28	1.10E+04	4.73E-02	2.14E-03	3.00E+01	B	30.00	1.40E+04	5.1983E+14	45	4.95E+17	1.18E+17	5.20E+14	H		
Pb-210	8.04E+00	2.17E+02	5.00E-02	160.79	2.80E+00	2.87E+00	2.31E-04	5.01E-02	B	30.00	1.30E+05	4.8135E+15	45	1.26E+14	8.04E+12	8.04E+12			S
Pd-109	2.96E+02	7.99E+03	5.00E-01	591.05	7.90E+04	3.74E-03	2.14E-03	1.71E+01	B	30.00	1.40E+04	5.1809E+14	45	3.56E+18	2.96E+14	2.96E+14			S
Ra-223	1.02E+01	2.75E+02	7.00E-03	1451.55	1.90E+03	5.35E-03	3.50E-02	9.60E+00	B	30.00	8.58E+02	3.1739E+13	45	8.55E+16	1.02E+13	1.02E+13			S
Ra-224	8.86E-02	2.40E+00	2.00E-02	4.43	5.90E+03	1.50E-05	3.37E-02	8.08E-02	B	30.00	8.90E+02	3.2924E+13	45	2.66E+17	8.86E+10	8.86E+10			S
Ra-226	1.02E-01	2.75E+00	3.00E-03	33.89	3.70E-02	2.75E+00	2.84E-02	7.80E-02	B	30.00	1.06E+03	3.9093E+13	45	1.67E+12	1.02E+11	1.02E+11			S
Re-186	1.56E+02	4.23E+03	6.00E-01	260.64	6.90E+03	2.27E-02	2.14E-03	9.04E+00	B	30.00	1.40E+04	5.1910E+14	45	3.11E+17	1.56E+14	1.56E+14			S
Re-188	1.22E+00	3.31E+01	4.00E-01	3.06	3.60E+04	3.40E-05	4.97E-03	1.64E-01	B	30.00	6.04E+03	2.2355E+14	45	1.62E+18	1.22E+12	1.22E+12			S
Rh-105	8.12E+02	2.19E+04	8.00E-01	1014.40	3.10E+04	2.62E-02	1.37E-03	3.00E+01	B	30.00	2.19E+04	8.1152E+14	45	1.40E+18	1.05E+31	8.12E+14	H		
Se-75	4.61E+02	1.25E+04	3.00E+00	153.81	5.40E+02	8.55E-01	2.41E-03	3.00E+01	B	30.00	1.25E+04	4.6144E+14	45	2.43E+16	8.89E+18	4.61E+14	H		
Sm-153	6.12E-01	1.65E+01	6.00E-01	1.02	1.60E+04	3.82E-05	1.94E-03	3.21E-02	B	30.00	1.54E+04	5.7134E+14	45	7.20E+17	6.12E+11	6.12E+11			S
Sr-89	1.22E+01	3.30E+02	6.00E-01	20.34	1.10E+03	1.11E-02	3.46E-03	1.14E+00	B	30.00	8.68E+03	3.2113E+14	45	4.95E+16	1.22E+13	1.22E+13			S
Sr-90	1.73E+00	4.67E+01	3.00E-01	5.76	5.10E+00	3.39E-01	3.46E-03	1.61E-01	B	30.00	8.68E+03	3.2113E+14	45	2.30E+14	1.73E+12	1.73E+12			S
Tb-161	1.61E+01	4.36E+02	2.00E-02	806.28	4.35E+03	3.71E-03	1.16E-03	5.06E-01	B	30.00	2.59E+04	9.5690E+14	45	1.96E+17	1.61E+13	1.61E+13			S
Th-227	1.01E+01	2.73E+02	5.00E-03	2020.21	1.10E+03	9.18E-03	3.59E-02	9.79E+00	B	30.00	8.36E+02	3.0947E+13	45	4.95E+16	1.01E+13	1.01E+13			S
Th-228	6.79E-02	1.84E+00	1.00E-03	67.95	3.00E+01	2.26E-03	3.21E-02	5.90E-02	B	30.00	9.33E+02	3.4537E+13	45	1.35E+15	6.79E+10	6.79E+10			S
Tl-201	1.45E+03	3.92E+04	4.00E+00	362.71	7.90E+03	1.84E-01	7.65E-04	3.00E+01	B	30.00	3.92E+04	1.4508E+15	45	3.56E+17	1.59E+22	1.45E+15	H		
W-187	2.24E+01	6.06E+02	6.00E-01	37.36	2.60E+04	8.62E-04	4.54E-03	2.75E+00	B	30.00	6.61E+03	2.4460E+14	45	1.17E+18	2.24E+13	2.24E+13			S
W-188	1.23E+00	3.31E+01	3.00E-01	4.08	3.70E+02	3.31E-03	5.98E-04	1.98E-02	B	30.00	5.02E+04	1.8558E+15	45	1.67E+16	1.23E+12	1.23E+12			S
Y-90	1.73E+00	4.67E+01	3.00E-01	5.76	2.00E+04	8.63E-05	5.54E-03	2.59E-01	B	30.00	5.41E+03	2.0032E+14	45	9.00E+17	1.73E+12	1.73E+12			S

										Contents heat limit			Contents mass limit		Shielding limit	Package limit			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Nuclide	Max Activity		A2	# A2s	Spec Ac	Mass	Heat gen	Heat output	Package Type	Heat output	Activity		Mass	Act	Act	Act	Code		
	TBq	Ci	TBq		TBq/g	g	W/Ci	W	A or B	W	Ci	Bq	g	Bq	Bq	Bq	H	M	S
Yb-169	4.42E+02	1.19E+04	1.00E+00	442.11	8.90E+02	4.97E-01	2.51E-03	3.00E+01	B	30.00	1.19E+04	4.4211E+14	45	4.01E+16	1.88E+19	4.42E+14	H		
Yb-175	1.11E+03	2.99E+04	9.00E-01	1228.91	6.60E+03	1.68E-01	1.00E-03	3.00E+01	B	30.00	2.99E+04	1.1060E+15	45	2.97E+17	6.04E+23	1.11E+15	H		
Max	6.71E+03	1.81E+05		8.05E+03		4.50E+01		3.00E+01											

Column

1	Identifies nuclide
2	Package activity limit for this Contents Type - from Col 17
3	Calculated from Bq amount in Col 2
4	A2 from 10CFR71
5	# of A2's of nuclide at package activity limit
6	Specific activity from 10CFR71
7	Mass of nuclide at package activity limit
8	Heat generation rate of nuclide - from Microshield.
9	Heat output of nuclide at package activity limit
10	Package Type [A or B] based on individual nuclide limit
11	Mass limit of nuclide based on package heat limit
12	Calculated from limit in Col 11
13	Calculated from Bq amount in Col 12
14	Mass limit of nuclide based on capacity of insert
15	Calculated from Bq amount in Col 14
16	Package shielding limit from CTR2011/01
17	Package limit = least of heat, mass and shielding limits in Cols 13, 15 & 16
18	H shown where package limit is Heat limit
19	M shown where package limit is Mass limit
20	S shown where package limit is Shielding limit

Colour codes

- Radionuclides
- Package limit
- Physics data
- Contents limit based on heat, mass or shielding

Table 4-2 Activity Limits for Contents Type 2 - CT-2 - Solid in light tungsten insert – Design No 3985

										Contents heat limit			Contents mass limit		Shielding limit	Package limit			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Nuclide	Max Activity		A2	# A2s	Spec Ac	Mass	Heat gen	Heat output	Package Type	Heat output	Act		Mass	Act	Act	Act	Code		
	TBq	Ci	TBq		TBq/g	g	W/Ci	W	A or B	W	Ci	Bq	g	Bq	Bq	Bq	H	M	S
Ac-225	1.09E+00	2.96E+01	6.00E-03	182.45	2.10E+03	5.21E-04	3.46E-02	1.02E+00	B	30.00	8.68E+02	3.2105E+13	345	7.25E+17	1.09E+12	1.09E+12			S
Ac-227	3.26E-01	8.81E+00	9.00E-05	3622.61	2.70E+00	1.21E-01	4.72E-04	4.16E-03	B	30.00	6.35E+04	2.3513E+15	345	9.32E+14	3.26E+11	3.26E+11			S
Ac-228	1.86E-01	5.03E+00	5.00E-01	0.37	8.40E+04	2.21E-06	8.04E-03	4.04E-02	A	30.00	3.73E+03	1.3807E+14	345	2.90E+19	1.86E+11	1.86E+11			S
Am-241	1.58E+00	4.28E+01	1.00E-03	1584.58	1.30E-01	1.22E+01	3.28E-02	1.41E+00	B	30.00	9.14E+02	3.3828E+13	345	4.49E+13	1.58E+12	1.58E+12			S
As-77	7.90E+02	2.13E+04	7.00E-01	1128.38	3.90E+04	2.03E-02	1.41E-03	3.00E+01	B	30.00	2.13E+04	7.8987E+14	345	1.35E+19	1.14E+19	7.90E+14	H		
Au-198	2.43E+02	6.57E+03	6.00E-01	405.30	9.00E+03	2.70E-02	4.34E-03	2.85E+01	B	30.00	6.92E+03	2.5590E+14	345	3.11E+18	2.43E+14	2.43E+14			S
Ba-131	6.12E+01	1.65E+03	2.00E+00	30.60	3.10E+03	1.97E-02	3.06E-03	5.05E+00	B	30.00	9.82E+03	3.6334E+14	345	1.07E+18	6.12E+13	6.12E+13			S
C-14	5.52E+01	1.49E+03	3.00E+00	18.40	1.60E-01	3.45E+02	2.93E-04	4.38E-01	B	30.00	1.02E+05	3.7850E+15	345	5.52E+13	6.13E+27	5.52E+13		M	
Co-60	9.37E-02	2.53E+00	4.00E-01	0.23	4.20E+01	2.23E-03	1.54E-02	3.91E-02	A	30.00	1.95E+03	7.1970E+13	345	1.45E+16	9.37E+10	9.37E+10			S
Cs-131	6.71E+03	1.81E+05	3.00E+01	223.73	3.80E+03	1.77E+00	1.65E-04	3.00E+01	B	30.00	1.81E+05	6.7118E+15	345	1.31E+18	7.43E+35	6.71E+15	H		
Cs-134	2.63E+00	7.11E+01	7.00E-01	3.76	4.80E+01	5.48E-02	1.02E-02	7.24E-01	B	30.00	2.95E+03	1.0905E+14	345	1.66E+16	2.63E+12	2.63E+12			S
Cs-137	3.16E+02	8.55E+03	6.00E-01	527.06	3.20E+00	9.88E+01	1.01E-03	8.65E+00	B	30.00	2.96E+04	1.0966E+15	345	1.10E+15	3.16E+14	3.16E+14			S
Cu-67	6.91E+02	1.87E+04	7.00E-01	986.75	2.80E+04	2.47E-02	1.61E-03	3.00E+01	B	30.00	1.87E+04	6.9073E+14	345	9.66E+18	2.84E+24	6.91E+14	H		
Hg-203	5.58E+02	1.51E+04	1.00E+00	557.87	5.10E+02	1.09E+00	1.99E-03	3.00E+01	B	30.00	1.51E+04	5.5787E+14	345	1.76E+17	5.32E+34	5.58E+14	H		
Ho-166	9.20E-01	2.49E+01	4.00E-01	2.30	2.60E+04	3.54E-05	4.29E-03	1.07E-01	B	30.00	6.99E+03	2.5852E+14	345	8.97E+18	9.20E+11	9.20E+11			S
I-125	3.19E+03	8.61E+04	3.00E+00	1062.52	6.40E+02	4.98E+00	3.48E-04	3.00E+01	B	30.00	8.61E+04	3.1875E+15	345	2.21E+17	3.98E+35	3.19E+15	H		
I-129	2.24E-03	6.06E-02	< 1	< 1	6.50E-06	3.45E+02	4.68E-04	2.84E-05	B	30.00	6.41E+04	2.3720E+15	345	2.24E+09	2.93E+26	2.24E+09		M	
I-131	3.28E+02	8.85E+03	7.00E-01	468.01	4.60E+03	7.12E-02	3.39E-03	3.00E+01	B	30.00	8.85E+03	3.2761E+14	345	1.59E+18	9.94E+14	3.28E+14	H		
In-111	4.27E+02	1.15E+04	3.00E+00	142.34	1.50E+04	2.85E-02	2.60E-03	3.00E+01	B	30.00	1.15E+04	4.2702E+14	345	5.18E+18	1.29E+28	4.27E+14	H		
Ir-192	1.81E+02	4.90E+03	6.00E-01	302.02	3.40E+02	5.33E-01	6.13E-03	3.00E+01	B	30.00	4.90E+03	1.8121E+14	345	1.17E+17	7.19E+14	1.81E+14	H		
Ir-194	1.47E+01	3.96E+02	3.00E-01	48.84	3.10E+04	4.73E-04	5.35E-03	2.12E+00	B	30.00	5.61E+03	2.0766E+14	345	1.07E+19	1.47E+13	1.47E+13			S
Lu-177	1.03E+03	2.78E+04	7.00E-01	1470.30	4.10E+03	2.51E-01	1.08E-03	3.00E+01	B	30.00	2.78E+04	1.0292E+15	345	1.41E+18	1.38E+24	1.03E+15	H		
Mo-99	1.91E+01	5.17E+02	6.00E-01	31.85	1.80E+04	1.06E-03	3.27E-03	1.69E+00	B	30.00	9.18E+03	3.3972E+14	345	6.21E+18	1.91E+13	1.91E+13			S
Na-24	1.28E-02	3.45E-01	2.00E-01	0.06	3.20E+05	3.99E-08	2.77E-02	9.55E-03	A	30.00	1.08E+03	4.0053E+13	345	1.10E+20	1.28E+10	1.28E+10			S
Np-237	8.97E-03	2.42E-01	2.00E-03	4.49	2.60E-05	3.45E+02	2.88E-02	6.98E-03	B	30.00	1.04E+03	3.8570E+13	345	8.97E+09	1.58E+12	8.97E+09		M	
P-32	2.49E+00	6.73E+01	5.00E-01	4.98	1.10E+04	2.26E-04	4.12E-03	2.77E-01	B	30.00	7.28E+03	2.6946E+14	345	3.80E+18	2.49E+12	2.49E+12			S
P-33	2.44E+03	6.61E+04	1.00E+00	2444.45	5.80E+03	4.21E-01	4.54E-04	3.00E+01	B	30.00	6.61E+04	2.4444E+15	345	2.00E+18	3.61E+37	2.44E+15	H		
Pb-203	5.20E+02	1.40E+04	3.00E+00	173.28	1.10E+04	4.73E-02	2.14E-03	3.00E+01	B	30.00	1.40E+04	5.1983E+14	345	3.80E+18	2.45E+16	5.20E+14	H		
Pb-210	3.31E+00	8.96E+01	5.00E-02	66.28	2.80E+00	1.18E+00	2.31E-04	2.07E-02	B	30.00	1.30E+05	4.8135E+15	345	9.66E+14	3.31E+12	3.31E+12			S
Pd-109	9.61E+01	2.60E+03	5.00E-01	192.26	7.90E+04	1.22E-03	2.14E-03	5.57E+00	B	30.00	1.40E+04	5.1809E+14	345	2.73E+19	9.61E+13	9.61E+13			S
Ra-223	4.14E+00	1.12E+02	7.00E-03	591.20	1.90E+03	2.18E-03	3.50E-02	3.91E+00	B	30.00	8.58E+02	3.1739E+13	345	6.56E+17	4.14E+12	4.14E+12			S
Ra-224	4.37E-02	1.18E+00	2.00E-02	2.18	5.90E+03	7.40E-06	3.37E-02	3.98E-02	B	30.00	8.90E+02	3.2924E+13	345	2.04E+18	4.37E+10	4.37E+10			S
Ra-226	4.80E-02	1.30E+00	3.00E-03	16.00	3.70E-02	1.30E+00	2.84E-02	3.68E-02	B	30.00	1.06E+03	3.9093E+13	345	1.28E+13	4.80E+10	4.80E+10			S
Re-186	5.31E+01	1.43E+03	6.00E-01	88.45	6.90E+03	7.69E-03	2.14E-03	3.07E+00	B	30.00	1.40E+04	5.1910E+14	345	2.38E+18	5.31E+13	5.31E+13			S
Re-188	5.67E-01	1.53E+01	4.00E-01	1.42	3.60E+04	1.57E-05	4.97E-03	7.60E-02	B	30.00	6.04E+03	2.2355E+14	345	1.24E+19	5.67E+11	5.67E+11			S
Rh-105	8.12E+02	2.19E+04	8.00E-01	1014.40	3.10E+04	2.62E-02	1.37E-03	3.00E+01	B	30.00	2.19E+04	8.1152E+14	345	1.07E+19	1.17E+29	8.12E+14	H		
Se-75	4.61E+02	1.25E+04	3.00E+00	153.81	5.40E+02	8.55E-01	2.41E-03	3.00E+01	B	30.00	1.25E+04	4.6144E+14	345	1.86E+17	7.87E+18	4.61E+14	H		
Sm-153	5.71E+02	1.54E+04	6.00E-01	952.23	1.60E+04	3.57E-02	1.94E-03	3.00E+01	B	30.00	1.54E+04	5.7134E+14	345	5.52E+18	1.91E+15	5.71E+14	H		
Sr-89	5.17E+00	1.40E+02	6.00E-01	8.62	1.10E+03	4.70E-03	3.46E-03	4.83E-01	B	30.00	8.68E+03	3.2113E+14	345	3.80E+17	5.17E+12	5.17E+12			S
Sr-90	8.30E-01	2.24E+01	3.00E-01	2.77	5.10E+00	1.63E-01	3.46E-03	7.75E-02	B	30.00	8.68E+03	3.2113E+14	345	1.76E+15	8.30E+11	8.30E+11			S
Tb-161	7.39E+00	2.00E+02	2.00E-02	369.26	4.35E+03	1.70E-03	1.16E-03	2.32E-01	B	30.00	2.59E+04	9.5690E+14	345	1.50E+18	7.39E+12	7.39E+12			S
Th-227	4.17E+00	1.13E+02	5.00E-03	834.00	1.10E+03	3.79E-03	3.59E-02	4.04E+00	B	30.00	8.36E+02	3.0947E+13	345	3.80E+17	4.17E+12	4.17E+12			S
Th-228	3.35E-02	9.07E-01	1.00E-03	33.54	3.00E+01	1.12E-03	3.21E-02	2.91E-02	B	30.00	9.33E+02	3.4537E+13	345	1.04E+16	3.35E+10	3.35E+10			S
Tl-201	1.45E+03	3.92E+04	4.00E+00	362.71	7.90E+03	1.84E-01	7.65E-04	3.00E+01	B	30.00	3.92E+04	1.4508E+15	345	2.73E+18	1.41E+22	1.45E+15	H		
W-187	8.56E+00	2.31E+02	6.00E-01	14.26	2.60E+04	3.29E-04	4.54E-03	1.05E+00	B	30.00	6.61E+03	2.4460E+14	345	8.97E+18	8.56E+12	8.56E+12			S
W-188	5.68E-01	1.53E+01	3.00E-01	1.89	3.70E+02	1.53E-03	5.98E-04	9.18E-03	B	30.00	5.02E+04	1.8558E+15	345	1.28E+17	5.68E+11	5.68E+11			S
Y-90	8.30E-01	2.24E+01	3.00E-01	2.77	2.00E+04	4.15E-05	5.54E-03	1.24E-01	B	30.00	5.41E+03	2.0032E+14	345	6.90E+18	8.30E+11	8.30E+11			S
Yb-169	4.42E+02	1.19E+04	1.00E+00	442.11	8.90E+02	4.97E-01	2.51E-03	3.00E+01	B	30.00	1.19E+04	4.4211E+14	345	3.07E+17	1.66E+19	4.42E+14	H		
Yb-175	1.11E+03	2.99E+04	9.00E-01	1228.91	6.60E+03	1.68E-01	1.00E-03	3.00E+01	B	30.00	2.99E+04	1.1060E+15	345	2.28E+18	6.09E+22	1.11E+15	H		

										Contents heat limit			Contents mass limit		Shielding limit	Package limit			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Nuclide	Max Activity		A2	# A2s	Spec Ac	Mass	Heat gen	Heat output	Package Type	Heat output	Act		Mass	Act	Act	Act	Code		
	TBq	Ci	TBq		TBq/g	g	W/Ci	W	A or B	W	Ci	Bq	g	Bq	Bq	Bq	H	M	S
Max	6.71E+03	1.81E+05		3.62E+03		3.45E+02		3.00E+01											

Column	
1	Identifies nuclide
2	Package activity limit for this Contents Type - from Col 17
3	Calculated from Bq amount in Col 2
4	A2 from 10CFR71
5	# of A2's of nuclide at package activity limit
6	Specific activity from 10CFR71
7	Mass of nuclide at package activity limit
8	Heat generation rate of nuclide - from Microshield.
9	Heat output of nuclide at package activity limit
10	Package Type [A or B] based on individual nuclide limit
11	Mass limit of nuclide based on package heat limit
12	Calculated from limit in Col 11
13	Calculated from Bq amount in Col 12
14	Mass limit of nuclide based on capacity of insert
15	Calculated from Bq amount in Col 14
16	Package shielding limit from CTR2011/01
17	Package limit = least of heat, mass and shielding limits in Cols 13, 15 & 16
18	H shown where package limit is Heat limit
19	M shown where package limit is Mass limit
20	S shown where package limit is Shielding limit

Colour codes

- Radionuclides
- Package limit
- Physics data
- Contents limit based on heat, mass or shielding

Table 4-3 Activity Limits for Contents Type 3 - CT-3 - Gas in light tungsten insert – Design No 3985

										Contents heat limit			Contents mass limit		Shielding limit	Gas limit	Package limit				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	16a	17	18	19	19a	20
Nuclide	Max	Activity	A2	# A2s	Spec Ac	Mass	Heat gen	Heat output	Package Type	Heat output	Act	Act	Mass	Act	Act	Act	Act	Code			
	TBq	Ci	TBq		TBq/g	g	W/Ci	W	A or B	W	Ci	Bq	g	Bq	Bq	Bq	Bq	H	M	L	S
Kr-79	2.30E+01	6.21E+02	2.00E+00	11.49	9.24E+04	2.49E-04	1.67E-03	1.04E+00	B	30.00	1.80E+04	6.6467E+14	345	3.19E+19	2.30E+13	3.07E+14	2.30E+13				S
Xe-133	1.04E+03	2.80E+04	1.00E+01	103.74	6.90E+03	1.50E-01	1.07E-03	3.00E+01	B	30.00	2.80E+04	1.0374E+15	345	2.38E+18	1.99E+33	6.97E+15	1.04E+15	H			

Notes

Column	
1	Identifies nuclide
2	Package activity limit for this Contents Type - from Col 17
3	Calculated from Bq amount in Col 2
4	A2 from 10CFR71
5	# of A2's of nuclide at package activity limit
6	Specific activity from 10CFR71
7	Mass of nuclide at package activity limit
8	Heat generation rate of nuclide - from Microshield.
9	Heat output of nuclide at package activity limit
10	Package Type [A or B] based on individual nuclide limit
11	Mass limit of nuclide based on package heat limit
12	Calculated from limit in Col 11
13	Calculated from Bq amount in Col 12
14	Mass limit of nuclide based on capacity of insert
15	Calculated from Bq amount in Col 14
16	Package shielding limit from CTR2011/01
16a	Gas Limit from CTR 2012/05
17	Package limit = least of heat, mass and shielding limits in Cols 13, 15 & 16
18	H shown where package limit is Heat limit
19	M shown where package limit is Mass limit
19a	L Shown where package limit is gas leakage rate
20	S shown where package limit is Shielding limit

Colour codes

- Radionuclides
- Package limit
- Physics data
- Contents limit based on heat, mass or shielding

Table 4-4 Activity Limits for Contents Type 4 - CT-4 - Liquid in steel insert – Design No 3987

										Contents heat limit			Contents mass limit		Shielding limit	Package limit			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Nuclide	Max	Activity	A2	# A2s	Spec Ac	Mass	Heat gen	Heat output	PackageType	Heat output	Act	Act	Mass	Act	Act	Act	Code		
	TBq	Ci	TBq		TBq/g	g	W/Ci	W	A or B	W	Ci	Bq	g	Bq	Bq	Bq	H	M	S
I-131	7.40E+00	2.00E+02	7.00E-01	10.57	4.60E+03	1.61E-03	3.41E-03	6.82E-01	B	5.00	1.47E+03	5.4252E+13	905	4.16E+18	7.40E+12	7.40E+12			S

Column

1 Identifies nuclide
2 Package activity limit for this Contents Type - from Col 17
3 Calculated from Bq amount in Col 2
4 A2 from 10CFR71
5 # of A2's of nuclide at package activity limit
6 Specific activity from 10CFR71
7 Mass of nuclide at package activity limit
8 Heat generation rate of nuclide - from Microshield.
9 Heat output of nuclide at package activity limit
10 Package Type [A or B] based on individual nuclide limit
11 Mass limit of nuclide based on package heat limit
12 Calculated from limit in Col 11
13 Calculated from Bq amount in Col 12
14 Mass limit of nuclide based on capacity of insert
15 Calculated from Bq amount in Col 14
16 Package shielding limit from CTR2011/01
17 Package limit = least of heat, mass and shielding limits in Cols 13, 15 & 16
18 H shown where package limit is Heat limit
19 M shown where package limit is Mass limit
20 S shown where package limit is Shielding limit

Colour codes

Radionuclides
Package limit
Physics data
Contents limit based on heat, mass or shielding

Table 4-5 Activity Limits for Contents Type 5 - CT-5 - Liquid Mo-99 in a steel insert – Design No 4081

										Contents heat limit			Contents mass limit		Shielding limit	Package limit			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Nuclide	Max	Activity	A2	# A2s	Spec Ac	Mass	Heat gen	Heat output	Package Type	Heat output	Act	Act	Mass	Act	Act	Act	Code		
	TBq	Ci	TBq		TBq/g	g	W/Ci	W	A or B	W	Ci	Bq	g	Bq	Bq	Bq	H	M	S
Mo-99	3.70E+01	1.00E+03	3.00E-01	123.33	3.10E+04	1.19E-03	3.43E-03	3.43E+00	B	5.00	1.46E+03	5.3901E+13	905	2.81E+19	3.70E+13	3.70E+13			S

Column

1	Identifies nuclide
2	Package activity limit for this Contents Type - from Col 17
3	Calculated from Bq amount in Col 2
4	A2 from 10CFR71
5	# of A2's of nuclide at package activity limit
6	Specific activity from 10CFR71
7	Mass of nuclide at package activity limit
8	Heat generation rate of nuclide - from Microshield.
9	Heat output of nuclide at package activity limit
10	Package Type [A or B] based on individual nuclide limit
11	Mass limit of nuclide based on package heat limit
12	Calculated from limit in Col 11
13	Calculated from Bq amount in Col 12
14	Mass limit of nuclide based on capacity of insert
15	Calculated from Bq amount in Col 14
16	Package shielding limit from CTR2011/01
17	Package limit = least of heat, mass and shielding limits in Cols 13, 15 & 16
18	H shown where package limit is Heat limit
19	M shown where package limit is Mass limit
20	S shown where package limit is Shielding limit

Colour codes

	Radionuclides
	Package limit
	Physics data
	Contents limit based on heat, mass or shielding

Table 4-6 Typical Activity for Contents Type 6 - CT-6 – Thorium Target in CV fitted with Insert Design No 4109

1	2	3	4	5	6	7	8	9
Nuclide	Max Activity		A2	# A2s	Spec Ac	Mass	Heat gen	Heat output
	TBq	Ci	TBq		TBq/g	g	W/Ci	W
Ac-225	7.46E-03	2.01E-01	6.00E-03	1.24	2.15E+03	3.48E-06	3.46E-02	6.97E-03
Ag-112	3.01E-02	8.15E-01	4.00E-01	0.08	2.10E+04	1.44E-06	1.21E-02	9.86E-03
Withheld per 10 CFR 2.390								
I-132	3.94E-03	1.06E-01	4.00E-01	0.01	3.80E+05	1.04E-08	1.63E-02	1.73E-03
Withheld per 10 CFR 2.390								
Nb-96	4.13E-03	1.12E-01	2.00E-02	0.21			1.61E-02	1.80E-03
Withheld per 10 CFR 2.390								
Sr-91	4.75E-03	1.28E-01	3.00E-01	0.02	1.30E+05	3.65E-08	8.07E-03	1.04E-03
Zr-97	9.40E-03	2.54E-01	4.00E-01	0.02	7.10E+04	1.32E-07	9.49E-03	2.41E-03
Max	9.20E-02	2.49E+00		2.50E+00		7.71E-06		3.58E-02