BY ORDER OF THE
SECRETARY OF THE AIR FORCE

AIR FORCE INSTRUCTION 91-110

28 JUNE 2002

Safety

NUCLEAR SAFETY REVIEW AND LAUNCH APPROVAL FOR SPACE OR MISSILE USE OF RADIOACTIVE MATERIAL AND NUCLEAR SYSTEMS

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

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This instruction implements AFPD 91-1, *Nuclear Weapons and Systems Surety*. It defines the nuclear safety review and launch approval procedures for using radioactive materials in space or missiles. This instruction does not apply to the Air Force Reserve and Air National Guard. Send major command (MAJCOM) supplements to this instruction to the Air Force Safety Center (HQ AFSC/SEWE, 9700 Avenue G, Kirtland AFB NM 87117-5670) for coordination and to HQ USAF/SE, 1400 Air Force Pentagon, Washington DC 20330-1400, for approval before publication. **Attachment 1** lists abbreviations and acronyms used in this instruction.

SUMMARY OF REVISIONS

This document is substantially revised and must be completely reviewed.

Range Nuclear Safety Surveys are replaced by Range Nuclear Safety Inspections. The MAJCOM is assigned responsibility for performing these inspections. Range commanders are tasked with developing and exercising radiological safety and contingency plans for space and missile launches carrying radiological materials. They are also responsible for ensuring radiological issues have a more prominent place in launch readiness reviews. In addition, threshold quantities for radioactive materials have been increased to match threshold values for the safe transport of radioactive materials as outlined in the *International Atomic Energy Agency's, Safety Series 6, Regulations for the Safe Transport of Radioactive Material, 1996 (Revised).* These threshold values are now listed in Terabecquerels (TBQ) instead of Curies to conform with international standards.

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Section A—General Information

1. Defining Scope and Requirements. This instruction defines the nuclear safety review and launch approval process for using radioactive materials aboard a space or missile system. These requirements add to AFI 40-201, *Control of Radioactive Material* (formerly AFR 161-16), which allows Air Force installations to possess radioactive materials. This instruction implements Presidential Directive/National Security Council Memorandum-25, *Scientific or Technological Experiments with Possible Large-Scale Adverse Environmental Effects and Launch of Nuclear Systems Into Spac*e, December 14, 1977 (revised by letter, 8 May 1996), Department of Defense (DoD) Directive 3200.11, *Major Range and Test Facility Bas*e, January 26, 1998. and DoDD 3100.10, *DoD Space Policy,* September 14, 2000.

1.1. Nuclear safety review and launch approval procedures apply to:

1.1.1. Agencies that use any radioactive materials aboard a space or missile system (atmospheric, ballistic, orbital, or earth escape), including radioactive materials that the US Nuclear Regulatory Commission (NRC), Agreement States, or other Military Services exempt from licensing.

1.1.2. Any materials held under section 91b of the Atomic Energy Act of 1954, currently found in 42 USC 2121 (b).

1.1.3. Air Force agencies that develop, test, or have operational responsibility for radioactive materials in space.

1.1.4. Other agencies or organizations that plan to use an Air Force range to launch radioactive materials and have not completed a range-approved equivalent nuclear safety review..

1.2. These procedures do not apply to radioactive materials in gravity weapons or manned aircraft where they are used as structural material, instruments, or ballast.

2. Reporting Radiological Mishaps. Follow AFI 91-204, *Investigating and Reporting US Air Force Mishaps,* to report accidents involving radioactive material. If the radioactive material has a permit from

the US Air Force Radioisotope Committee or an NRC license, also follow AFI 40-201 and Title 10, Code of Federal Regulations, *Energy.*

3. Obtaining Exemptions or Waivers. The Air Force Chief of Safety (HQ USAF/SE) may approve requests for exemptions or waivers to this instruction. The Air Force Vice Chief of Staff or higher-level authority grants waivers for special access programs, which must be in writing. Send requests for exemptions and waivers to HQ AFSC/SEWE, 9700 Avenue G, Kirtland AFB NM 87117-5670.

Section B—General Responsibilities

4. HQ Air Force Safety Center. HQ AFSC/SEW:

4.1. Performs Nuclear Safety Analysis and Review by:

4.1.1. Evaluating safety analysis reports.

4.1.2. Providing the DoD coordinator for the Interagency Nuclear Safety Review Panel (INSRP).

4.1.3. Assigning members to the technical subpanels for INSRP.

4.1.4. Providing technical help to organizations developing systems that incorporate significant amounts of radioactive material.

4.2. Grants or obtains nuclear safety launch approval for launches, based on the threshold quantities defined in **Attachment 2**. HQ AFSC establishes the nuclear safety position for Air Force launches that require higher approval. When the radioactive material exceeds threshold quantity, HQ AFSC requests nuclear safety launch approval from the Office of the Assistant to the Secretary of Defense (Nuclear, Chemical and Biological Defense Programs (OATSD (NCB)).

4.3. Performs launch forecast and notification by sending OATSD (NCB) a quarterly forecast of projected Air Force space or missile launches using radioactive material.

5. Major Commands (MAJCOM) and Air Force Program Executive Offices (AFPEO):

5.1. MAJCOMs and AFPEOs that develop, test, or operate any programs or systems involving radio-active material must:

5.1.1. Notify HQ AFSC/SEW of the potential use of radioactive material as early as possible in the development or acquisition phase of the program.

5.1.2. Prepare a safety analysis summary (SAS), if required. An SAS must be prepared for any planned launch of radioactive material when the total quantity of radioactive material exceeds the analysis threshold quantity listed in **Attachment 2**. See **Attachment 3** for an SAS format.

5.1.2.1. If a Safety Evaluation Report (SER) is written by the INSRP, this report, along with its references Final Safety Analysis Report (FSAR) will be sufficient to meet this requirement.

5.1.3. Forecast and report all launches involving radioactive material to HQ AFSC/SEW. See **Attachment 4** for a report format.

5.1.4. Ensure coordination with higher authorities, per DoDI 3100.12, is accomplished.

5.2. The Air Force or INSRP reviews may require MAJCOMs to provide technical support.

5.3. Air Force Space Command (AFSPACECOM) must track systems with radioactive material throughout the system's life. AFSPACECOM can provide information on non-Air Force systems.

5.4. Perform Range Nuclear Safety Inspections that evaluate:

5.4.1. Safety procedures for launching radioactive material and contingency plans for responding to a radiological mishap.

5.4.2. Safety measures to prevent radiological mishaps.

5.4.3. These inspections may be performed in conjunction with other MAJCOM inspections.

5.4.4. MAJCOMS should report the results of these inspections to HQ AFSC/SEWE.

6. Range Commanders. Range commanders must ensure that all parties comply with **Table 1.** notification, reporting, and launch approval requirements.

6.1. Develop and exercise radiological safety and contingency plans for launch-related radiological mishaps.

6.2. Review radiological issues at launch readiness reviews for launches containing radioactive material.

6.2.1. This review should include:

6.2.1.1. Types and quantities of radiological materials on board the launch vehicle and payload.

6.2.1.2. Review of radiological safety plans and procedures in place.

6.2.1.3. Review of plans and operations in place, to include coordination with external agencies (Department of Energy, NASA, US Navy, etc.), regarding contingency, clean up, or recovery plans.

Table 1. Nuclear Safety Review, Approval, and Reporting Procedures.

STEP	A Who	B What	C To	D When
1	MAJCOM system program director, AFPEO, or project manager	initially notifies	HQ AFSC/SEW	as early as possible in the acquisition process.
2		prepares and sends a safety analysis (if required)		at least 180 calendar days before launch for HQ AFSC/SEW approval; as directed by HQ AFSC/SEW for higher approval.
3	HQ AFSC/SEW	evaluates safety analysis. If program needs higher approval establishes Air Force safety position and sends nuclear safety launch approval request	OATSD (NCB)	at least 150 calendar days before launch
4	Range commander	makes sure that the launch of radioactive materials or nuclear systems has required approvals. Provides type and quantity of radioactive material in prelaunch message	HQ AFSC/SEW	at least 5 calendar days before launch.
5		notifies of successful launch		within 5 calendar days after launch.

GREG ALSTON, Colonel, USAF
Acting Chief of Safety

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

DoDD 3200.11, *Major Range and Test Facility Bas*e

DoDD 3100.10, *DoD Space Policy,* September 14, 2000

AFI 40-201, *Control of Radioactive Material*

AFPD 91-1, *Nuclear Weapons and Systems Surety*

AFI 91-204, *Investigating and Reporting US Air Force Mishaps*

Presidential Directive/National Security Council Memorandum-25, *Scientific or Technological Experiments with Possible Large-Scale Adverse Environmental Effects and Launch of Nuclear Systems Into Spac*e

International Atomic Energy Agency's, Safety Series 6, Regulations for the Safe Transport of Radioactive Material, 1996 (Revised)

Abbreviations and Acronyms

AFI—Air Force Instruction

AFPEO—Air Force Program Executive Office

AFR—Air Force Regulation

AFSC—Air Force Safety Center

AFSC/SEW—AFSC, Weapons, Space and Nuclear Safety Division

AFSC/SEWE—AFSC/SEW, Space and Engineering Branch

AFSPACECOM—Air Force Space Command

OATSD (NCB)—Office of the Assistant to the Secretary of Defense (Nuclear, Chemical and Biological Defense Programs)

DoD—Department of Defense

HQ AFSC—Headquarters, Air Force Safety Center

INSRP—Interagency Nuclear Safety Review Panel

MAJCOM—Major Command

NRC—Nuclear Regulatory Commission

OPR—Office of Primary Responsibility

SAS—Safety Analysis Summary

Attachment 2

ANALYSIS THRESHOLD QUANTITIES FOR RADIOACTIVE MATERIALS

A2.1. The threshold quantity determines the level of launch approval and depth of analysis. Local range requirements guide launch approval of radioactive materials below the threshold quantity.

CAUTION: *Threshold quantities do not apply to reactors or other devices when a potential for criticality is present.* The end of this attachment shows the analysis threshold quantities for mixed fission or unlisted radionuclides and mixtures of radionuclides. HQ AFSC/SEW determines the necessary level of safety review and approval for quantities that exceed the threshold and for reactors or other devices where the potential for criticality exists. NOTE: 1 TBq ~ 27.03 Ci

Table A2.1. Allowable Limits for Radioisotopes.

ELEMENT	ISOTOPE	QUANTITY TBq
Actinium (89)	Ac-225 (a)	6×10^{-3}
	Ac-227 (a)	9×10^{-5}
	Ac-228	5×10^{-1}
Silver (47)	Ag-105	2×10^{0}
	Ag-108m (a)	7×10^{-1}
	Ag-110m (a)	4×10^{-1}
	Ag-111	6×10^{-1}
Aluminium (13)	Al-26	1×10^{-1}
Americium (95)	Am-241	1×10^{-3}
	Am-242m (a)	1×10^{-3}
	Am-243 (a)	1×10^{-3}
Argon (18)	Ar-37	4×10^{1}
	Ar-39	2×10^{1}
	Ar-41	3×10^{-1}

ELEMENT	ISOTOPE	QUANTITY TBq
Arsenic (33)	As-72	3×10^{-1}
	As-73	4×10^{1}
	As-74	9×10^{-1}
	As-76	3×10^{-1}
	As-77	7×10^{-1}
Astatine (85)	At-211 (a)	5×10^{-1}
Gold (79)	Au-193	2×10^{0}
	Au-195	6×10^{0}
	Au-198	6×10^{-1}
	Au-199	6×10^{-1}
Barium (56)	Ba-131 (a)	2×10^{0}
	Ba-133	3×10^{0}
	Ba-133m	6×10^{-1}
	Ba-140 (a)	3×10^{-1}
Beryllium (4)	Be-7	2×10^{1}
	Be-10	6×10^{-1}
Bismuth (83)	Bi-205	7×10^{-1}
	Bi-206	3×10^{-1}
	Bi-207	7×10^{-1}
	Bi-210	6×10^{-1}
	Bi-210m (a)	2×10^{-2}
	Bi-212 (a)	6×10^{-1}
Berkelium (97)		
	Bk-247	8×10^{-4}
	Bk-249 (a)	3×10^{-1}

ELEMENT	ISOTOPE	QUANTITY TBq
Bromine (35)	Br-76	4×10^{-1}
	Br-77	3×10^{0}
	Br-82	4×10^{-1}
Carbon (6)	C-11	6×10^{-1}
	C-14	3×10^{0}
Calcium (20)	Ca-41	Unlimited
	Ca-45	1×10^{0}
	Ca-47 (a)	3×10^{-1}
Cadmium (48)	Cd-109	2×10^{0}
	Cd-113m	5×10^{-1}
	Cd-115 (a)	4×10^{-1}
	Cd-115m	5×10^{-1}
Cerium (58)	Ce-139	2×10^{0}
	Ce-141	6×10^{-1}
	Ce-143	6×10^{-1}
	Ce-144 (a)	2×10^{-1}
Californium (98)	Cf-248	6×10^{-3}
	Cf-249	8×10^{-4}
	Cf-250	2×10^{-3}
	Cf-251	7×10^{-4}
	Cf-252	3×10^{-3}
	Cf-253 (a)	4×10^{-2}
	Cf-254	1×10^{-3}

ELEMENT	ISOTOPE	QUANTITY TBq
Chlorine (17)	Cl-36	6×10^{-1}
	Cl-38	2×10^{-1}
Curium (96)	Cm-240	2×10^{-2}
	Cm-241	1×10^{0}
	Cm-242	1×10^{-2}
	Cm-243	1×10^{-3}
	Cm-244	2×10^{-3}
	Cm-245	9×10^{-4}
	Cm-246	9×10^{-4}
	Cm-247 (a)	1×10^{-3}
	Cm-248	3×10^{-4}
Cobalt (27)	Co-55	5×10^{-1}
	Co-56	3×10^{-1}
	Co-57	1×10^{1}
	Co-58	1×10^{0}
	Co-58m	4×10^{1}
	Co-60	4×10^{-1}
Chromium (24)	Cr-51	3×10^{1}

ELEMENT	ISOTOPE	QUANTITY TBq
Caesium (55)	Cs-129	4×10^{0}
	Cs-131	3×10^{1}
	Cs-132	1×10^{0}
	Cs-134	7×10^{-1}
	Cs-134m	6×10^{-1}
	Cs-135	1×10^{0}
	Cs-136	5×10^{-1}
	Cs-137 (a)	6×10^{-1}
Copper (29)	Cu-64	1×10^{0}
	Cu-67	7×10^{-1}
Dysprosium (66)	Dy-159	2×10^{1}
	Dy-165	6×10^{-1}
	Dy-166 (a)	3×10^{-1}
Erbium (68)	Er-169	1×10^{0}
	Er-171	5×10^{-1}

ELEMENT	ISOTOPE	QUANTITY TBq
Europium (63)	Eu-147	2×10^{0}
	Eu-148	5×10^{-1}
	Eu-149	2×10^{1}
	Eu-150 (short lived)	7×10^{-1}
	Eu-150 (long lived)	7×10^{-1}
	Eu-152	1×10^{0}
	Eu-152m	8×10^{-1}
	Eu-154	6×10^{-1}
	Eu-155	3×10^{0}
	Eu-156	7×10^{-1}
Fluorine (9)	F-18	6×10^{-1}
Iron (26)	Fe-52 (a)	3×10^{-1}
	Fe-55	4×10^{1}
	Fe-59	9×10^{-1}
	Fe-60 (a)	2×10^{-1}
Gallium (31)	Ga-67	3×10^{0}
	Ga-68	5×10^{-1}
	Ga-72	4×10^{-1}
Gadolinium (64)	Gd-146 (a)	5×10^{-1}
	Gd-148	2×10^{-3}
	Gd-153	9×10^{0}
	Gd-159	6×10^{-1}

ELEMENT	ISOTOPE	QUANTITY TBq
Germanium (32)	Ge-68 (a)	5×10^{-1}
	Ge-71	4×10^{1}
	Ge-77	3×10^{-1}
Hafnium (72)	Hf-172 (a)	6×10^{-1}
	Hf-175	3×10^{0}
	Hf-181	5×10^{-1}
	Hf-182	Unlimited
Mercury (80)	Hg-194 (a)	1×10^{0}
	Hg-195m (a)	7×10^{-1}
	Hg-197	1×10^{1}
	Hg-197m	4×10^{-1}
	Hg-203	1×10^{0}
Holmium (67)	Ho-166	4×10^{-1}
	Ho-166m	5×10^{-1}
Iodine (53)	I-123	3×10^{0}
	I-124	1×10^{0}
	I-125	3×10^{0}
	I-126	1×10^{0}
	I-129	Unlimited
	I-131	7×10^{-1}
	I-132	4×10^{-1}
	I-133	6×10^{-1}
	I-134	3×10^{-1}
	I-135 (a)	6×10^{-1}

ELEMENT	ISOTOPE	QUANTITY TBq
Indium (49)	In-111	3×10^{0}
	In-113m	2×10^{0}
	In-114m (a)	5×10^{-1}
	In-115m	1×10^{0}
Iridium (77)	Ir-189 (a)	1×10^{1}
	Ir-190	7×10^{-1}
	Ir-192	6×10^{-1}
	Ir-194	3×10^{-1}
Potassium (19)	K-40	9×10^{-1}
	K-42	2×10^{-1}
	K-43	6×10^{-1}
Krypton (36)	Kr-81	4×10^{1}
	Kr-85	1×10^{1}
	Kr-85m	3×10^{0}
	Kr-87	2×10^{-1}
Lanthanum (57)	La-137	6×10^{0}
	La-140	4×10^{-1}
Lutetium (71)	Lu-172	6×10^{-1}
	Lu-173	8×10^{0}
	Lu-174	9×10^{0}
	Lu-174m	1×10^{1}
	Lu-177	7×10^{-1}
Magnesium (12)	Mg-28 (a)	3×10^{-1}

ELEMENT	ISOTOPE	QUANTITY TBq
Manganese (25)	Mn-52	3×10^{-1}
	Mn-53	Unlimited
	Mn-54	1×10^{0}
	Mn-56	3×10^{-1}
Molybdenum (42)	Mo-93	2×10^{1}
	Mo-99 (a)	6×10^{-1}
Nitrogen (7)	N-13	6×10^{-1}
Sodium (11)	Na-22	5×10^{-1}
	Na-24	2×10^{-1}
Niobium (41)	Nb-93m	3×10^{1}
	Nb-94	7×10^{-1}
	Nb-95	1×10^{0}
	Nb-97	6×10^{-1}
Neodymium (60)	Nd-147	6×10^{-1}
	Nd-149	5×10^{-1}
Nickel (28)	Ni-59	Unlimited
	Ni-63	3×10^{1}
	Ni-65	4×10^{-1}
Neptunium (93)	Np-235	4×10^{1}
	Np-236 (short lived)	2×10^{0}
	Np-236 (long lived)	2×10^{-2}
	Np-237	2×10^{-3}
	Np-239	4×10^{-1}

ELEMENT	ISOTOPE	QUANTITY TBq
Osmium (76)	Os-185	1×10^{0}
	Os-191	2×10^{0}
	Os-191m	3×10^{1}
	Os-193	6×10^{-1}
	Os-194 (a)	3×10^{-1}
Phosphorus (15)	P-32	5×10^{-1}
	P-33	1×10^{0}
Protactinium (91)	Pa-230 (a)	7×10^{-2}
	Pa-231	4×10^{-4}
	Pa-233	7×10^{-1}
Lead (82)	Pb-201	1×10^{0}
	Pb-202	2×10^{1}
	Pb-203	3×10^{0}
	Pb-205	Unlimited
	Pb-210 (a)	5×10^{-2}
	Pb-212 (a)	2×10^{-1}
Palladium (46)	Pd-103 (a)	4×10^{1}
	Pd-107	Unlimited
	Pd-109	5×10^{-1}
Promethium (61)	Pm-143	3×10^{0}
	Pm-144	7×10^{-1}
	Pm-145	1×10^{1}
	Pm-147	2×10^{0}
	Pm-148m (a)	7×10^{-1}
	Pm-149	6×10^{-1}
	Pm-151	6×10^{-1}

ELEMENT	ISOTOPE	QUANTITY TBq
Polonium (84)	Po-210	2×10^{-2}
Praseodymium (59)	Pr-142	4×10^{-1}
	Pr-143	6×10^{-1}
Platinum (78)	Pt-188 (a)	8×10^{-1}
	Pt-191	3×10^{0}
	Pt-193	4×10^{1}
	Pt-193m	5×10^{-1}
	Pt-195m	5×10^{-1}
	Pt-197	6×10^{-1}
	Pt-197m	6×10^{-1}
Plutonium (94)	Pu-236	3×10^{-3}
	Pu-237	2×10^{1}
	Pu-238	1×10^{-3}
	Pu-239	1×10^{-3}
	Pu-240	1×10^{-3}
	Pu-241 (a)	6×10^{-2}
	Pu-242	1×10^{-3}
	Pu-244 (a)	1×10^{-3}
Radium (88)		
	Ra-223 (a)	7×10^{-3}
	Ra-224 (a)	2×10^{-2}
	Ra-225 (a)	4×10^{-3}
	Ra-226 (a)	3×10^{-3}
	Ra-228 (a)	2×10^{-2}

ELEMENT	ISOTOPE	QUANTITY TBq
Rubidium (37)	Rb-81	8×10^{-1}
	Rb-83 (a)	2×10^{0}
	Rb-84	1×10^{0}
	Rb-86	5×10^{-1}
	Rb-87	Unlimited
	Rb (nat)	Unlimited
Rhenium (75)	Re-184	1×10^{0}
	Re-184m	1×10^{0}
	Re-186	6×10^{-1}
	Re-187	Unlimited
	Re-188	4×10^{-1}
	Re-189 (a)	6×10^{-1}
	Re (nat)	Unlimited
Rhodium (45)		
	Rh-99	2×10^{0}
	Rh-101	3×10^{0}
	Rh-102	5×10^{-1}
	Rh-102m	2×10^{0}
	Rh-103m	4×10^{1}
	Rh-105	8×10^{-1}
Radon (86)		
	Rn-222 (a)	4×10^{-3}
Ruthenium (44)	Ru-97	5×10^{0}
	Ru-103 (a)	2×10^{0}
	Ru-105	6×10^{-1}
	Ru-106 (a)	2×10^{-1}
Sulphur (16)	S-35	3×10^{0}

ELEMENT	ISOTOPE	QUANTITY TBq
Antimony (51)	Sb-122	4×10^{-1}
	Sb-124	6×10^{-1}
	Sb-125	1×10^{0}
	Sb-126	4×10^{-1}
Scandium (21)	Sc-44	5×10^{-1}
	Sc-46	5×10^{-1}
	Sc-47	7×10^{-1}
	Sc-48	3×10^{-1}
Selenium (34)	Se-75	3×10^{0}
	Se-79	2×10^{0}
Silicon (14)	Si-31	6×10^{-1}
	Si-32	5×10^{-1}
Samarium (62)	Sm-145	1×10^{1}
	Sm-147	Unlimited
	Sm-151	1×10^{1}
	Sm-153	6×10^{-1}
Tin (50)	Sn-113 (a)	2×10^{0}
	Sn-117m	4×10^{-1}
	Sn-119m	3×10^{1}
	Sn-121m (a)	9×10^{-1}
	Sn-123	6×10^{-1}
	Sn-125	4×10^{-1}
	Sn-126 (a)	4×10^{-1}

ELEMENT	ISOTOPE	QUANTITY TBq
Strontium (38)	Sr-82 (a)	2×10^{-1}
	Sr-85	2×10^{0}
	Sr-85m	5×10^{0}
	Sr-87m	3×10^{0}
	Sr-89	6×10^{-1}
	Sr-90 (a)	3×10^{-1}
	Sr-91 (a)	3×10^{-1}
	Sr-92 (a)	3×10^{-1}
Tritium (1)	T(H-3)	4×10^{1}
Tantalum (73)	Ta-178 (long lived)	8×10^{-1}
	Ta-179	3×10^{1}
	Ta-182	5×10^{-1}
Terbium (65)	Tb-157	4×10^{1}
	Tb-158	1×10^{0}
	Tb-160	6×10^{-1}
Technetium (43)	Tc-95m (a)	2×10^{0}
	Tc-96	4×10^{-1}
	Tc-96m (a)	4×10^{-1}
	Tc-97	Unlimited
	Tc-97m	1×10^{0}
	Tc-98	7×10^{-1}
	Tc-99	9×10^{-1}
	Tc-99m	4×10^{0}

ELEMENT	ISOTOPE	QUANTITY TBq
Tellurium (52)	Te-121	2×10^{0}
	Te-121m	3×10^{0}
	Te-123m	1×10^{0}
	Te-125m	9×10^{-1}
	Te-127	7×10^{-1}
	Te-127m (a)	5×10^{-1}
	Te-129	6×10^{-1}
	Te-129m (a)	4×10^{-1}
	Te-131m (a)	5×10^{-1}
	Te-132 (a)	4×10^{-1}
Thorium (90)	Th-227	5×10^{-3}
	Th-228 (a)	1×10^{-3}
	Th-229	5×10^{-4}
	Th-230	1×10^{-3}
	Th-231	2×10^{-2}
	Th-232	Unlimited
	Th-234 (a)	3×10^{-1}
	Th (nat)	Unlimited
Titanium (22)	Ti-44 (a)	4×10^{-1}
Thallium (81)	Tl-200	9×10^{-1}
	Tl-201	4×10^{0}
	Tl-202	2×10^{0}
	Tl-204	7×10^{-1}

ELEMENT	ISOTOPE	QUANTITY TBq
Thulium (69)	Tm-167	8×10^{-1}
	Tm-170	6×10^{-1}
	Tm-171	4×10^{1}
Uranium (92)		
	U-230 (fast lung absorption) (a) (c)	1×10^{-1}
	U-230 (medium lung absorption)(a) (d)	4×10^{-3}
	U-230 (slow lung absorption) (a) (e)	3×10^{-3}
	U-232 (fast lung absorption) (c)	1×10^{-2}
	U-232 (medium lung absorption) (d)	7×10^{-3}
	U-232 (slow lung absorption) (e)	1×10^{-3}
	U-233 (fast lung absorption) (c)	9×10^{-2}
	U-233 (medium lung absorption) (d)	2×10^{-2}
	U-233 (slow lung absorption) (e)	6×10^{-3}
	U-234 (fast lung absorption) (c)	9×10^{-2}
	U-234 (medium lung absorption) (d)	2×10^{-2}
	U-234 (slow lung absorption) (e)	6×10^{-3}
	U-235 (all lung absorption types)(a), (c), (d), (e)	Unlimited

ELEMENT	ISOTOPE	QUANTITY TBq
	U-236 (fast lung absorption) (c)	Unlimited
	U-236 (medium lung absorption) (d)	2×10^{-2}
	U-236 (slow lung absorption) (e)	6×10^{-3}
	U-238 (all lung absorption types) (c), (d), (e)	Unlimited
	U (nat)	Unlimited
	U (enriched to 20% or less) (f)	Unlimited
	U (dep)	Unlimited
Vanadium (23)	V-48	4×10^{-1}
	V-49	4×10^{1}
Tungsten (74)	W-178 (a)	5×10^{0}
	W-181	3×10^{1}
	W-185	8×10^{-1}
	W-187	6×10^{-1}
	W-188 (a)	3×10^{-1}
Xenon (54)	Xe-122 (a)	4×10^{-1}
	Xe-123	7×10^{-1}
	Xe-127	2×10^{0}
	Xe-131m	4×10^{1}
	Xe-133	1×10^{1}
	Xe-135	2×10^{0}

ELEMENT	ISOTOPE	QUANTITY TBq
Yttrium (39)	Y-87 (a)	1×10^{0}
	Y-88	4×10^{-1}
	Y-90	3×10^{-1}
	Y-91	6×10^{-1}
	Y-91m	2×10^{0}
	Y-92	2×10^{-1}
	Y-93	3×10^{-1}
Ytterbium (70)	Yb-169	1×10^{0}
	Yb-175	9×10^{-1}
Zinc (30)	Zn-65	2×10^{0}
	Zn-69	6×10^{-1}
	Zn-69m (a)	6×10^{-1}
Zirconium (40)		
	Zr-88	3×10^{0}
	Zr-93	Unlimited
	Zr-95 (a)	8×10^{-1}
	Zr-97 (a)	4×10^{-1}

(a) Values include contributions from daughter nuclides with half-lives less than 10 days.

(b) The quantity may be determined from a measurement of the rate of decay or a measurement of the radiation level at a prescribed distance from the source.

(c) These values apply only to compounds of uranium that take the chemical form of UF6 , UO2 F2 and UO2(NO3)2 in both normal and accident conditions of transport.

(d) These values apply only to compounds of uranium that take the chemical form of UO3 , UF4 , UCl4 and hexavalent compounds in both normal and accident conditions of transport.

(e) These values apply to all compounds of uranium other than those specified in (c) and (d) above.

(f) These values apply to *unirradiated uranium* only.

A2.1.1. Treat a mixture of radionuclides resulting from the natural decay of a single-parent radionuclide as a single source of the parent.

A2.1.2. When using several isotopes or a mixture of isotopes, base the required nuclear safety review on the normalized total quantity of radioactive material present. The normalized total is the sum of the ratios of the individual isotopes to their respective threshold quantities as shown in **Figure A2.1.**. If the normalized totals exceeds 1.00 a safety analysis summary is required. HQ AFSC/SEW must complete a nuclear safety review and obtain launch approval from OATSD(NCB).

Figure A2.1. Mixed Isotopes.

$$\frac{\text{Isotope A (TBq)}}{\text{Threshold A (TBq)}} + \frac{\text{Isotope B (TBq)}}{\text{Threshold B (TBq)}} + \frac{\text{Isotope C (TBq)}}{\text{Threshold C (TBq)}} + \ldots < 1.00$$

Example:

1.2×10^{-4} TBq of Pu-238 is 1.2×10^{-4}TBq/1.0×10^{-3} or 12 percent of the analysis threshold limit for Pu-238.

0.5 TBq of Nb-95 is 0.5Tbq/1.0Tbq, or 50 percent of the analysis threshold limit for Nb-95.

7.0 TBq of Be-7 is 7.0TBq/20 TBq, or 35 percent of the analysis threshold limit of BE-7.

Therefore, the normalized total is 97 percent and an SAS would not be required.

Attachment 3

GUIDE FOR SAFETY ANALYSIS SUMMARY (SAS)

A3.1. Safety Analysis Summary (SAS). You must prepare an SAS for any planned launch of radioactive material when the total quantity of radioactive material exceeds the analysis threshold quantity listed in **Attachment 2** or as specified by HQ AFSC/SEW. Prepare the SAS according to this attachment and send two copies to HQ AFSC/ SEWE.

A3.1.1. Mission Description. Include system, radioactive material, and mission profile descriptions.

A3.1.1.1. System Description:

A3.1.1.1.1. Program name.

A3.1.1.1.2. Launch vehicle description.

A3.1.1.1.3. Spacecraft or missile, and payload description.

A3.1.2. Describe each radionuclide separately, if applicable. Each radioactive material description consists of:

A3.1.2.1. Radionuclides.

A3.1.2.2. Modes of decay and associated intensities.

A3.1.2.3. Activity (in Terabecquerels).

A3.1.2.4. Radiation levels, with particular emphasis on areas accessible to personnel.

A3.1.2.5. Proposed use.

A3.1.2.6. Location on launch vehicle and payload.

A3.1.2.7. Manufacturer and source identification number.

A3.1.2.8. Nuclear Regulatory Commission or Agreement State sealed source and device registry number and the license or permit authorizing possession, if applicable.

A3.1.2.9. Source construction, including the chemical and physical form.

A3.1.2.10. Construction materials.

A3.1.2.11. Dimensions.

A3.1.2.12. Design criteria.

A3.1.2.13. Other information pertinent to assessing source integrity in normal and extreme operating conditions and potential accident environments.

A3.1.3. Mission Profile:

A3.1.3.1. Launch facility identification.

A3.1.3.2. Proposed launch date.

A3.1.3.3. Launch azimuth.

A3.1.3.4. Mission profile description, including orbital or flight parameters.

A3.1.3.5. Mission duration.

A3.1.3.6. Impact predictions, if applicable.

A3.2. Normal Mission Analysis. This analysis should address:

A3.2.1. Nuclear and radiation safety considerations throughout the mission, including handling from installation through flight and post-flight.

A3.2.2. Disposing of radioactive material. Identify the license or permit under which you will receive recovered materials, if applicable.

A3.3. Accident Evaluation. This evaluation should address:

A3.3.1. All mission phases, including prelaunch, launch, ascent, orbital, reentry, impact, and post impact.

A3.3.2. Potential accident scenarios, environments, and contingency options.

A3.3.3. Mission failure evaluation, including launch vehicle, payload, and source failure mode analyses and associated probabilities.

A3.3.4. Source response to accidents and potential consequences to the public and the environment.

A3.3.5. Any additional information pertinent to the SAS.

Attachment 4

LAUNCH FORECAST REPORT FORMAT

A4.1. A forecast of all scheduled launches involving radioactive materials or nuclear systems during the next quarter must reach HQ AFSC/SEW at least 15 calendar days before the start of each calendar-year quarter. This report is exempt from the requirements of AFI 37-124, *Management and Control of Information Report* (formerly AFR 4-38). The forecast should include:

A4.2. Program name.

A4.3. Launch vehicle, site, and date.

A4.4. Impact area or orbital parameters.

A4.5. Specific radioisotopes and associated activities (in Terabecquerels).

A4.6. Type of nuclear system or device, if applicable.