BY ORDER OF THE SECRETARY OF THE AIR FORCE

AIR FORCE INSTRUCTION 91-110

18 MARCH 1994

Safety

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

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

OPR: HQ AFSA/SENA (Capt William V. Hoak)

Certified by: HQ USAF/SE (Brig Gen James L. Cole, Jr.)

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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 Agency (HQ AFSA/SENA, 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 is the first issuance of AFI 91-110. It updates, clarifies, and streamlines procedures formerly found in AFR 122-16.

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 Space*, December 14, 1977, and Department of Defense (DoD) Directive 3200.11, *Major Range and Test Facility Base*, September 29, 1980.

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

- 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.
- Any materials held under section 91b of the Atomic Energy Act of 1954, as amended.
- Air Force agencies that develop, test, or have operational responsibility for radioactive materials in space.
- Other agencies or organizations that plan to use an Air Force range to launch radioactive materials and do not have an 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* (formerly AFR 127-4) , 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*, if the radioactive material has a permit from the US Air Force Radioisotope Committee or a license issued by the NRC.

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 AFSA/SENA, 9700 Avenue G, Kirtland AFB NM 87117-5670.

Section B—General Responsibilities

4. HQ Air Force Safety Agency. HQ AFSA/SEN:

4.1. Performs Nuclear Safety Analysis and Review by:

- Evaluating safety analysis reports.
- Providing the DoD coordinator for the Interagency Nuclear Safety Review Panel (INSRP).
- Assigning members to the technical subpanels for INSRP.
- Providing technical help to organizations developing systems that incorporate significant amounts of radioactive material.

4.2. Grants or gets nuclear safety launch approval for launches, based on the threshold quantities defined in **Attachment 2**. HQ AFSA establishes the nuclear safety position for Air Force launches that require higher approval. When the radioactive material exceeds 1,000 times the threshold quantity, HQ AFSA requests nuclear safety launch approval from the Assistant to the Secretary of Defense for Atomic Energy (ATSD[AE]).

4.3. Performs Launch Forecast and Notification by sending ATSD(AE) a quarterly forecast of projected Air Force space or missile launches using radioactive material.

4.4. Performs Range Nuclear Safety Surveys that evaluate:

- Safety procedures for launching radioactive material.

- Safety measures to prevent radiological mishaps.
- Procedures and contingency plans for responding to a radiological mishap.

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 radioactive material must:

- Notify HQ AFSA/SEN of the potential use of radioactive material as early as possible in the development or acquisition phase of the program.
- Prepare a safety analysis summary (SAS), if required. See **Attachment 3** for an SAS format.
- Forecast and report all launches involving radioactive material to HQ AFSA/SEN. See **Attachment 4** for a report format.

5.2. The Air Force or INSRP nuclear safety 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.

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

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 AFSA/SEN	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 AFSA/SEN approval; as directed by HQ AFSA/SEN for higher approval.
3	HQ AFSA/SEN	evaluates safety analysis. If program needs higher approval establishes Air Force safety position and sends nuclear safety launch approval request	ATSD(AE)	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 AFSA/SEN	at least 5 calendar days before launch.
5		notifies of successful launch		within 5 calendar days after launch.

JAMES L. COLE, JR., Brig General, USAF
Chief of Safety

Attachment 1

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

Abbreviations and Acronyms

AFI—Air Force Instruction

AFPEO—Air Force Program Executive Office

AFR—Air Force Regulation

AFSA—Air Force Safety Agency

AFSA/SEN—AFSA, Directorate of Nuclear Surety

AFSA/SENA—AFSA/SEN, Nuclear Systems Engineering Division

AFSPACECOM—Air Force Space Command

ATSD(AE)—Assistant to the Secretary of Defense (Atomic Energy)

DoD—Department of Defense

HQ AFSA—Headquarters, AFSA

INSRP—Interagency Nuclear Safety Review Panel

MAJCOM—Major Command

NRC—Nuclear Regulatory Commission

OPR—Office of Primary Responsibility

SAS—Safety Analysis Summary

WSO—Weapon Safety Officer

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 AFSA/SEN may approve quantities that exceed the threshold. HQ AFSA/SEN determines the necessary level of safety review and approval for quantities that exceed 1,000 times the threshold and for reactors or other devices where the potential for criticality exists.

ELEMENT (Atomic Number)	ISOTOPE	QUANTITY (Curies)
Actinium (89)	Ac-225	2.70×10^{-4}
	Ac-227	5.41×10^{-7}
	Ac-228	1.08×10^{-2}
Aluminum (13)	Al-26	1.08×10^{-2}
Americium (95)	Am-241	5.41×10^{-6}
(See Note)	Am-242m	5.41×10^{-6}
	Am-243	5.41×10^{-6}
Antimony (51)	Sb-122	8.11×10^{-3}
	Sb-124	1.35×10^{-2}
	Sb-125	2.43×10^{-2}
	Sb-126	1.08×10^{-2}
Argon (18)	Ar-37	1.08
	Ar-39	0.541
	Ar-41	1.62×10^{-2}
	Ar-42	5.41×10^{-3}
Arsenic (33)	As-72	5.41×10^{-3}
	As-73	1.08
	As-74	1.35×10^{-2}
	As-76	5.41×10^{-3}

ELEMENT (Atomic Number)	ISOTOPE	QUANTITY (Curies)
	As-77	1.35×10^{-2}
Astatine (85)	At-211	5.41×10^{-2}
Barium (56)	Ba-131	5.40×10^{-2}
	Ba-133m	2.43×10^{-2}
	Ba-133	8.11×10^{-2}
	Ba-140	1.08×10^{-2}
Berkelium (97)	Bk-247	5.41×10^{-6}
	Bk-249	2.16×10^{-3}
Beryllium (4)	Be-7	0.540
	Be-10	1.35×10^{-2}
Bismuth (83)	Bi-205	1.62×10^{-2}
	Bi-206	8.11×10^{-3}
	Bi-207	1.89×10^{-2}
	Bi-210m	8.11×10^{-4}
	Bi-210	1.35×10^{-2}
	Bi-212	8.11×10^{-3}
Bromine (35)	Br-76	8.11×10^{-3}
	Br-77	8.11×10^{-2}
	Br-82	1.08×10^{-2}
Cadmium (48)	Cd-109	2.70×10^{-2}
	Cd-113m	2.43×10^{-3}
	Cd-115m	8.11×10^{-3}
	Cd-115	1.35×10^{-2}
Calcium (20)	Ca-41	1.08
	Ca-45	2.43×10^{-2}
	Ca-47	1.35×10^{-2}
Californium (98)	Cf-248	8.11×10^{-5}
(See Note)	Cf-249	5.41×10^{-6}

ELEMENT (Atomic Number)	ISOTOPE	QUANTITY (Curies)
	Cf-250	1.35×10^{-5}
	Cf-251	5.41×10^{-6}
	Cf-252	2.70×10^{-5}
	Cf-253	1.62×10^{-3}
	Cf-254	1.62×10^{-5}
Carbon (6)	C-11	1.35×10^{-2}
	C-14	5.40×10^{-2}
Cerium (58)	Ce-139	0.162
	Ce-141	1.35×10^{-2}
	Ce-143	1.35×10^{-2}
	Ce-144	5.41×10^{-3}
Cesium (55)	Cs-129	0.108
	Cs-131	1.08
	Cs-132	2.70×10^{-2}
	Cs-134m	0.243
	Cs-134	1.35×10^{-2}
	Cs-135	2.43×10^{-2}
	Cs-136	1.35×10^{-2}
	Cs-137	1.35×10^{-2}
Chlorine (17)	Cl-36	1.35×10^{-2}
	Cl-38	5.41×10^{-3}
Chromium (24)	Cr-51	0.811
Cobalt (27)	Co-55	1.35×10^{-2}
	Co-56	8.11×10^{-3}
	Co-57	0.216
	Co-58m	1.08
	Co-58	2.70×10^{-2}
	Co-60	1.08×10^{-2}
Copper (29)	Cu-64	2.43×10^{-2}

ELEMENT (Atomic Number)	ISOTOPE	QUANTITY (Curies)
	Cu-67	2.43×10^{-2}
Curium (96)	Cm-240	5.41×10^{-4}
(See Note)	Cm-241	2.43×10^{-2}
	Cm-242	2.70×10^{-4}
	Cm-243	8.11×10^{-6}
	Cm-244	1.08×10^{-5}
	Cm-245	5.41×10^{-6}
	Cm-246	5.41×10^{-6}
	Cm-247	5.41×10^{-6}
	Cm-248	1.35×10^{-6}
Dysprosium (66)	Dy-159	0.541
	Dy-165	1.35×10^{-2}
	Dy-166	8.11×10^{-3}
Erbium (68)	Er-169	2.43×10^{-2}
	Er-171	1.35×10^{-2}
Europium (63)	Eu-147	5.40×10^{-2}
	Eu-148	1.35×10^{-2}
	Eu-149	0.540
	Eu-150	1.89×10^{-2}
	Eu-152m	1.35×10^{-2}
	Eu-152	2.43×10^{-2}
	Eu-154	1.35×10^{-2}
	Eu-155	5.41×10^{-2}
	Eu-156	1.35×10^{-2}
Fluorine (9)	F-18	1.35×10^{-2}
Gadolinium (64)	Gd-146	1.08×10^{-2}
	Gd-148	8.11×10^{-6}

ELEMENT (Atomic Number)	ISOTOPE	QUANTITY (Curies)
	Gd-153	0.135
	Gd-159	1.35×10^{-2}
Gallium (31)	Ga-67	0.162
	Ga-68	8.11×10^{-3}
	Ga-72	1.08×10^{-2}
Germanium (32)	Ge-68	8.11×10^{-3}
	Ge-71	1.08
	Ge-77	8.11×10^{-3}
Gold (79)	Au-193	0.162
	Au-194	2.70×10^{-2}
	Au-195	0.270
	Au-196	5.41×10^{-2}
	Au-198	1.35×10^{-2}
	Au-199	2.43×10^{-2}
Hafnium (72)	Hf-172	8.11×10^{-3}
	Hf-175	8.11×10^{-2}
	Hf-181	2.43×10^{-2}
	Hf-182	8.11×10^{-4}
Holmium (67)	Ho-163	1.08
	Ho-166m	8.11×10^{-3}
	Ho-166	8.11×10^{-3}
Hydrogen (1)	H-3	1.08
Indium (49)	In-111	5.41×10^{-2}
	In-113m	0.108
	In-114m	8.11×10^{-3}
	In-115m	2.43×10^{-2}
Iodine (53)	I-123	0.162
	I-124	2.43×10^{-2}
	I-125	5.41×10^{-2}

ELEMENT (Atomic Number)	ISOTOPE	QUANTITY (Curies)
	I-126	2.43×10^{-2}
	I-129	1.08
	I-131	1.35×10^{-2}
	I-132	1.08×10^{-2}
	I-133	1.35×10^{-2}
	I-134	8.11×10^{-3}
	I-135	1.35×10^{-2}
Iridium (77)	Ir-189	0.270
	Ir-190	1.89×10^{-2}
	Ir-192	1.35×10^{-2}
	Ir-193m	0.270
	Ir-194	5.41×10^{-3}
Iron (26)	Fe-52	5.40×10^{-3}
	Fe-55	1.08
	Fe-59	2.16×10^{-2}
	Fe-60	5.41×10^{-3}
Krypton (36)	Kr-81	1.08
	Kr-85m	0.162
	Kr-85	0.270
	Kr-87	5.41×10^{-3}
Lanthanum (57)	La-137	5.41×10^{-2}
	La-140	1.08×10^{-2}
Lead (82)	Pb-201	2.70×10^{-2}
	Pb-202	5.41×10^{-2}
	Pb-203	8.11×10^{-2}
	Pb-205	1.08
	Pb-210	2.43×10^{-4}
	Pb-212	8.11×10^{-3}
Lutetium (71)	Lu-172	1.35×10^{-2}

ELEMENT (Atomic Number)	ISOTOPE	QUANTITY (Curies)
	Lu-173	0.216
	Lu-174m	0.216
	Lu-174	0.108
	Lu-177	2.43×10^{-2}
Magnesium (12)	Mg-28	5.41×10^{-3}
Manganese (25)	Mn-52	8.11×10^{-3}
	Mn-53	1.08
	Mn-54	2.70×10^{-2}
	Mn-56	5.41×10^{-3}
Mercury (80)	Hg-194	2.70×10^{-2}
	Hg-195m	0.135
	Hg-197m	2.43×10^{-2}
	Hg-197	0.270
	Hg-203	2.43×10^{-2}
Molybdenum (42)	Mo-93	0.189
	Mo-99	1.35×10^{-2}
Neodymium (60)	Nd-147	1.35×10^{-2}
	Nd-149	1.35×10^{-2}
Neptunium (93)	Np-235	1.08
(See Note)	Np-236	2.70×10^{-5}
	Np-237	5.41×10^{-6}
	Np-239	1.35×10^{-2}
Nickel (28)	Ni-59	1.08
	Ni-63	0.811
	Ni-65	8.11×10^{-3}
Niobium (41)	Nb-92m	1.89×10^{-2}
	Nb-93m	0.162
	Nb-94	1.62×10^{-2}
	Nb-95	2.70×10^{-2}

ELEMENT (Atomic Number)	ISOTOPE	QUANTITY (Curies)
	Nb-97	1.35×10^{-2}
Nitrogen (7)	N-13	1.35×10^{-2}
Osmium (76)	Os-185	2.70×10^{-2}
	Os-191m	1.08
	Os-191	2.43×10^{-2}
	Os-193	1.35×10^{-2}
	Os-194	5.41×10^{-3}
Palladium (46)	Pd-103	1.08
	Pd-107	1.08
	Pd-109	1.35×10^{-2}
Phosphorous (15)	P-32	8.11×10^{-3}
	P-33	2.43×10^{-2}
Platinum (78)	Pt-188	1.62×10^{-2}
	Pt-191	8.11×10^{-2}
	Pt-193m	0.243
	Pt-193	1.08
	Pt-195m	5.41×10^{-2}
	Pt-197m	2.43×10^{-2}
	Pt-197	1.35×10^{-2}
Plutonium (94)	Pu-236	1.89×10^{-5}
(See Note)	Pu-237	0.541
	Pu-238	5.41×10^{-6}
	Pu-239	5.41×10^{-6}
	Pu-240	5.41×10^{-6}
	Pu-241	2.70×10^{-4}
	Pu-242	5.41×10^{-6}
	Pu-244	5.41×10^{-6}
Polonium (84)	Po-208	5.41×10^{-4}

ELEMENT (Atomic Number)	ISOTOPE	QUANTITY (Curies)
	Po-209	5.41×10^{-4}
	Po-210	5.41×10^{-4}
Potassium (19)	K-42	5.41×10^{-3}
	K-43	1.35×10^{-2}
Praseodymium (59)	Pr-142	5.41×10^{-3}
	Pr-143	1.35×10^{-2}
Promethium (61)	Pm-143	8.11×10^{-2}
	Pm-144	1.62×10^{-2}
	Pm-145	0.189
	Pm-147	2.43×10^{-2}
	Pm-148m	1.35×10^{-2}
	Pm-149	1.35×10^{-2}
	Pm-151	1.35×10^{-2}
Protactinium (91)	Pa-230	2.70×10^{-3}
(See Note)	Pa-231	1.62×10^{-6}
	Pa-233	2.43×10^{-2}
Radium (88)	Ra-223	8.11×10^{-4}
	Ra-224	1.62×10^{-3}
	Ra-225	5.41×10^{-4}
	Ra-226	5.41×10^{-4}
	Ra-228	1.08×10^{-3}
Radon (86)	Rn-222	1.08×10^{-4}
Rhenium (75)	Re-183	0.135
	Re-184m	8.11×10^{-2}
	Re-184	2.70×10^{-2}
	Re-186	1.35×10^{-2}
	Re-187	1.08
	Re-188	5.41×10^{-3}

ELEMENT (Atomic Number)	ISOTOPE	QUANTITY (Curies)
	Re-189	$1.35x10^{-2}$
	Re_{nat}	1.08
Rhodium (45)	Rh-99	$5.41x10^{-2}$
	Rh-101	0.108
	Rh-102m	$2.43x10^{-2}$
	Rh-102	$1.35x10^{-2}$
	Rh-103m	1.08
	Rh-105	$2.43x10^{-2}$
Rubidium (37)	Rb-81	$2.43x10^{-2}$
	Rb-83	$5.41x10^{-2}$
	Rb-84	$2.43x10^{-2}$
	Rb-86	$8.11x10^{-3}$
	Rb-87	1.08
	Rb_{nat}	1.08
Ruthenium (44)	Ru-97	0.108
	Ru-103	$2.43x10^{-2}$
	Ru-105	$1.35x10^{-2}$
	Ru-106	$5.41x10^{-3}$
Samarium (62)	Sm-145	0.541
	Sm-147	0.023
	Sm-151	0.108
	Sm-153	$1.35x10^{-2}$
Scandium (21)	Sc-44	$1.35x10^{-2}$
	Sc-46	$1.35x10^{-2}$
	Sc-47	$2.43x10^{-2}$
	Sc-48	$8.11x10^{-3}$
Selenium (34)	Se-75	$8.11x10^{-2}$
	Se-79	$5.41x10^{-2}$
Silicon (14)	Si-31	$1.35x10^{-2}$

ELEMENT (Atomic Number)	ISOTOPE	QUANTITY (Curies)
	Si-32	5.41×10^{-3}
Silver (47)	Ag-105	5.41×10^{-2}
	Ag-108m	1.62×10^{-2}
	Ag-110m	1.08×10^{-2}
	Ag-111	1.35×10^{-2}
Sodium (11)	Na-22	1.35×10^{-2}
	Na-24	5.41×10^{-3}
Strontium (38)	Sr-82	5.41×10^{-3}
	Sr-85m	0.135
	Sr-85	5.41×10^{-2}
	Sr-87m	8.11×10^{-2}
	Sr-89	1.35×10^{-2}
	Sr-90	2.70×10^{-2}
	Sr-91	8.11×10^{-3}
	Sr-92	5.41×10^{-3}
Sulfur (16)	S-35	5.41×10^{-2}
Tantalum (73)	Ta-178	2.70×10^{-2}
	Ta-179	0.811
	Ta-182	1.35×10^{-2}
Technetium (43)	Tc-95m	5.41×10^{-2}
	Tc-96m	1.08×10^{-2}
	Tc-96	1.08×10^{-2}
	Tc-97m	1.08
	Tc-97	1.08
	Tc-98	1.89×10^{-2}
	Tc-99m	0.216
	Tc-99	2.43×10^{-2}
Tellurium (52)	Te-118	5.41×10^{-3}

ELEMENT (Atomic Number)	ISOTOPE	QUANTITY (Curies)
	Te-121m	0.135
	Te-121	5.41×10^{-2}
	Te-123m	0.189
	Te-125m	0.243
	Te-127m	1.35×10^{-2}
	Te-127	1.35×10^{-2}
	Te-129m	1.35×10^{-2}
	Te-129	1.35×10^{-2}
	Te-131m	1.35×10^{-2}
	Te-132	1.08×10^{-2}
Terbium (65)	Tb-157	0.270
	Tb-158	1.89×10^{-2}
	Tb-160	1.35×10^{-2}
Thallium (81)	Tl-200	2.16×10^{-2}
	Tl-201	0.270
	Tl-202	5.41×10^{-2}
	Tl-204	1.35×10^{-2}
Thorium (90)	Th-227	2.70×10^{-4}
(See Note)	Th-228	1.08×10^{-5}
	Th-229	8.11×10^{-7}
	Th-230	5.41×10^{-6}
	Th-231	2.43×10^{-2}
	Th-232	2.5×10^{-3}
	Th-234	5.41×10^{-3}
	Th_{nat}	2.5×10^{-3}
Thulium (69)	Tm-167	0.189
	Tm-168	2.16×10^{-2}
	Tm-170	1.35×10^{-2}
	Tm-171	0.270

ELEMENT (Atomic Number)	ISOTOPE	QUANTITY (Curies)
Tin (50)	Sn-113	0.108
	Sn-117m	5.41×10^{-2}
	Sn-119m	1.08
	Sn-121m	2.43×10^{-2}
	Sn-123	1.35×10^{-2}
	Sn-125	5.41×10^{-3}
	Sn-126	8.11×10^{-3}
Titanium (22)	Ti-44	5.41×10^{-3}
Tungsten (74)	W-178	2.70×10^{-2}
	W-181	0.811
	W-185	2.43×10^{-2}
	W-187	1.35×10^{-2}
	W-188	5.41×10^{-3}
Uranium (92)	U-230	2.70×10^{-4}
(See Note)	U-232	8.11×10^{-6}
	U-233	2.70×10^{-5}
	U-234	2.70×10^{-5}
	U-235	1.08
	U-236	2.70×10^{-5}
	U-238	1.08
	U_{nat}	1.08
	U_{enr}	
	<5%	1.08
	>5% See Mixtures	
	U_{dep}	1.08
Vanadium (23)	V-48	8.11×10^{-3}
	V-49	1.08
Xenon (54)	Xe-122	5.41×10^{-3}
	Xe-123	5.41×10^{-3}

ELEMENT (Atomic Number)	ISOTOPE	QUANTITY (Curies)
	Xe-127	0.108
	Xe-131m	1.08
	Xe-133	0.541
	Xe-135	0.108
Ytterbium (70)	Yb-169	8.11×10^{-2}
	Yb-175	2.43×10^{-2}
Yttrium (39)	Y-87	5.41×10^{-2}
	Y-88	1.08×10^{-2}
	Y-90	5.41×10^{-3}
	Y-91m	5.41×10^{-2}
	Y-91	8.11×10^{-3}
	Y-92	5.41×10^{-3}
	Y-93	5.41×10^{-3}
Zinc (30)	Zn-65	5.41×10^{-2}
	Zn-69m	1.35×10^{-2}
	Zn-69	1.35×10^{-2}
Zirconium (40)	Zr-88	8.11×10^{-2}
	Zr-93	5.41×10^{-3}
	Zr-95	2.43×10^{-2}
	Zr-97	8.11×10^{-3}

CONTENTS	THRESHOLD QUANTITY (Curies)
Only beta- or gamma- emitting nuclides known to be present	5×10^{-4}
Alpha-emitting nuclides known to be present or no relevant data are available	5.41×10^{-7}

A2.2. Mixture of Radionuclides:

A2.2.1. Treat a mixture of radionuclides resulting from the natural decay of a single-parent radionuclide as a single source of the parent.

A2.2.2. When using several isotopes or a mixture of isotopes, base the required nuclear safety review on the normalized total quantity of radioactive material present. Either:

- The normalized total is the sum of the ratios of the individual isotopes to their respective threshold quantity or:

Figure A2.1.

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

- Normalized totals exceeds 100 percent and require a safety analysis summary. HQ AFSA/SEN must complete a nuclear safety review and can grant launch approval. In the example below, each isotope alone would not require analysis because each is below its respective analysis threshold quantity. However, this example would require HQ AFSA/SEN review and launch approval since the normalized total exceeds 100 percent.

EXAMPLE:

0.324 Curies of Iron-55 is 0.324 Curies/1.08 Curies or 30 percent of the analysis threshold quantity limit for Iron-55.

0.0031 Curies of Iridium-192 is 0.0031 Curies/0.0135 Curies or 23 percent of the analysis threshold quantity limit for Iridium-192.

0.00057 Curies of Radium-223 is 0.00057 Curies/0.000811 Curies or 70 percent of the analysis threshold quantity limit for Radium-223.

Normalized total: 123 percent

Attachment 3

GUIDE FOR SAFETY ANALYSIS SUMMARY

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**attachment 2 or as specified by HQ AFSA/SEN. Prepare the SAS according to this attachment and send two copies to HQ AFSA/SENA.

A3.1. Mission Description. Include system, radioactive material, and mission profile descriptions.

A3.1.1. System Description:

- Program name.
- Launch vehicle description.
- Spacecraft and payload description.

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

- Radionuclides.
- Modes of decay and associated intensities.
- Activity (in curies).
- Radiation levels, with particular emphasis on areas accessible to personnel.
- Proposed use.
- Location on launch vehicle and payload.
- Manufacturer and source identification number.
- Nuclear Regulatory Commission or Agreement State sealed source and device registry number and the license or permit authorizing possession, if applicable.
- Source construction, including the chemical and physical form.
- Construction materials.
- Dimensions.
- Design criteria.
- Other information pertinent to assessing source integrity in normal and extreme operating conditions and potential accident environments.

A3.1.3. Mission Profile:

- Launch facility identification.
- Proposed launch date.
- Launch azimuth.
- Mission profile description, including orbital or flight parameters.
- Mission duration.
- Impact predictions, if applicable.

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

- Nuclear and radiation safety considerations throughout the mission, including handling from installation through flight and postflight.
- 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:

- All mission phases, including prelaunch, launch, ascent, orbital, reentry, impact, and post impact.
- Potential accident scenarios, environments, and contingency options.
- Mission failure evaluation, including launch vehicle, payload, and source failure mode analyses and associated probabilities.
- Source response to accidents and potential consequences to the public and the environment.
- Any additional information pertinent to the SAS.

Attachment 4

LAUNCH FORECAST REPORT FORMAT

A forecast of all scheduled launches involving radioactive materials or nuclear systems during the next quarter must reach HQ AFSA/SEN 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:

- Program name.
- Launch vehicle, site, and date.
- Impact area or orbital parameters.
- Specific radioisotopes and associated activities (in curies).
- Type of nuclear system or device, if applicable.