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Safety

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

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This Department of the Air Force Manual (DAFMAN) implements Air Force Policy Directive (AFPD) 91-1, *Nuclear Weapons and Systems Surety*, and establishes the nuclear safety review and launch approval procedures for radioactive materials intended for space or missiles use. This DAFMAN is consistent with the policy established in National Security Presidential Memorandum #20 (NSPM-20), *Launch of Spacecraft Containing Space Nuclear Systems*; Space Policy Directive-6 (SPD-6), *Memorandum on the National Strategy for Space Nuclear Power and Propulsion*; Department of Defense Directive (DoDD) 3200.11, *Major Range and Test Facility Base*; Department of Defense Instruction (DoDI) 3100.12, *Space Support*; DoDD 3100.10 *Space Policy*. In addition, this DAFMAN invokes the applicable guidance and procedures found in Air Force Manual (AFMAN) 48-148, *Ionizing Radiation Protection*, and AFMAN 40-201, *Radioactive Materials (RAM) Management*. This manual applies to all Regular Air Force, United States Space Force, Air Force Reserve, Air National Guard, Department of the Air Force civilian personnel, and contractors, if included in the applicable contract units that design, develop, modify, evaluate, test, and/or operate existing and future Department of the Air Force (DAF) space systems (operational, test, and experimental), DAF space support systems, and to organizations who use or operate DAF launch facilities or ranges. Compliance with Attachments **2** and **3** is mandatory. Compliance with Attachments **4** and **5** is not mandatory. Ensure all records generated as a result of processes prescribed in this publication adhere to Air Force Instruction (AFI) 33-322, *Records Management and Information Governance Program*, and are disposed in accordance with the Air Force Records Disposition Schedule, which is located in the Air Force Records Information

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SUMMARY OF CHANGES

This document is substantially revised and must be completely reviewed. Major changes include the thresholds for mission requirements, launch authority requirements, and safety review requirements.

Chapter 1

OVERVIEW

1.1. Defining Scope. This manual defines the nuclear safety review and launch approval process for using radioactive materials aboard a space or missile system. This manual also ensures a rigorous, risk informed safety analysis, and launch authorization process to protect the public, the environment, and national assets and to ensure the safe operation of launch vehicles or spacecraft containing radioactive material and ensure that mission planners, designers, managers, operators, and launch authorization authorities seek to ensure that safety guidelines are followed. The Department of the Air Force (DAF) ensures that radioactive material receives special attention and consideration because of the potential long-term health, environment, and operational consequences of a mishap and the public perception of such.

1.2. Applicability.

1.2.1. DAF nuclear safety review and launch approval procedures apply to:

1.2.1.1. Any DAF organizations that use any radioactive material (RAM), space nuclear system (SNS) or nuclear fission device aboard a space system or missile system.

1.2.1.2. Any Department of Defense (DoD) or U.S. Government organization that uses any radioactive material aboard a space system or missile system at a DAF range or using DAF assets.

1.2.1.3. Any DAF agencies that develop, test, or have operational responsibility for radioactive materials in space.

1.2.1.4. Any agency or organization (government or commercial) that plans to use a DAF facility, range, or other physical asset to launch a space or missile system that contains radioactive materials.

1.2.2. This manual does not address specific procedures, requirements, or licensing details for using, storing, shipping, or handling radioactive materials on a DAF range prior to integration into a launch vehicle or missile (see **paragraph 3.3**). This manual also does not address specific contingency requirements or procedures given a mishap (see **paragraph 3.24**).

Chapter 2

ROLES AND RESPONSIBILITIES

2.1. United States Air Force, Chief of Safety (AF/SE). AF/SE will review and advise waiver approval authorities on waiver requests for requirements in this manual.

2.2. Department of the Air Force Safety Center, Space Safety Division (AFSEC/SES). AFSEC/SES will (see **Table 2.1**):

2.2.1. Develop guidance to support the safe launch of systems containing radioactive material. **(T-3)**.

2.2.2. Develop and maintain Accepted Launch Safety Analyses list (see **paragraph 3.19**). **(T-3)**

2.2.3. Provide technical and regulatory assistance to DAF organizations planning missions or developing space systems that incorporate radioactive material. **(T-3)**

2.2.4. Conduct Nuclear Safety Review (NSR) of Tier I Safety Analysis Reports (SAR). **(T-1)**

2.2.5. Assist Range Safety Offices in conducting an NSR when requested (see **paragraph 3.12**). **(T-3)**

2.2.6. Produce safety assessment when requested by the Secretary of Defense (SECDEF) (or his/her designee) or military component heads per DoDI 3100.12, Sec. 5.5.4 and 6.5.1 (see **paragraph 3.13**). **(T-1)**

2.2.7. Ensure access to, and necessary resources for technical experts, subpanels, and working groups necessary to conduct credible NSRs and safety evaluations. **(T-1)**

2.2.8. Provide the technically qualified Department of Defense (DoD) member of the Interagency Nuclear Safety Review Board (INSRB) and participate in INSRB per NSPM-20. **(T-0)** This person will:

2.2.8.1. Facilitate INSRB review of DoD sponsored SARs. **(T-0)**

2.2.8.1.1. Facilitate early INSRB engagement in the safety analysis process after the conceptual design of the mission is generated, in order to identify gaps in time for mission planners to address them without creating unnecessary delays in the launch timeline. **(T-0)**

2.2.8.1.2. Facilitate restricting INSRB participation for classified DoD missions per NSPM-20. **(T-0)**. NSPM-20 Sec.5(c) states: “When necessary to protect national security, the head of the sponsoring agency, in consultation with the Assistant to the President for National Security Affairs (APNSA), may restrict INSRB member participation in any mission review.”

2.2.8.2. Provide Annual Report to Office of Science and Technology Policy (OSTP) (see **paragraph 3.7**). **(T-0)**

2.2.8.3. Ensure Annual Briefings to OSTP, National Science and Technology Council (NSTC) and APNSA are conducted (see **paragraph 3.8**). **(T-0)**

2.2.8.4. Advise SECDEF (or his/her designee) before completion of SARs for DoD missions. **(T-0)**

2.2.9. Determine DoD mission tiers in consultation with the DoD range users (see **paragraph 3.15**). **(T-1)**

2.2.10. Facilitate launch authorization for DAF sponsored missions using RAM and DoD missions using RAM on DAF ranges (see **paragraph 3.17**). **(T-1)**

Table 2.1. DAF Safety Products and Reporting Requirements Quick Reference.

Who	What	To	When
DAF Range User or DAF Mission Sponsor (Program Office)	Initial Notification	MAJCOM / FLDCOM and AFSEC/SES	Early, after the conceptual design of mission
	INSRB/SER Request	AFSEC/SES & INSRB	Early in the acquisition phase of mission, normally 3 to 5 years prior to launch
	Annual Report	MAJCOM / FLDCOM or AFSEC/SES	After Initial Notice annually until launch, prior to February 1st
	Annual Briefing	As coordinated by AFSEC/SES	After initial notice annually until launch
	Tier II & III Preliminary, Draft, and Final SARs	INSRB	Per INSRB's mission specific review plan
	Tier I Draft SAR	Range Safety Office & AFSEC/SES	NLT 18 months prior to launch
	Tier I Final SAR	Range Safety Office & AFSEC/SES	NLT 12 months prior to launch
	Safety Analysis Summary (SAS)	Range Safety Office	NLT 6 months prior to launch
	Risk Constraint	Range Safety Office	In SAS or SAR or NLT 6 months prior to launch
	Contingency Plans	Range Safety Office	Per range requirements
	Technical Support	Range Safety Office, AFSEC/SES & INSRB	As requested
	Tier Recommendation	AFSEC/SES	After completion of SAR & SER, before launch authorization request
	Launch Authorization Request	Launch Authorization Authority (LAA)	- Non-Tiered: per Program Office's internal requirements - Tiered: NLT 6 months prior to launch
	Launch Authorization letter from LAA	Range Safety Office & AFSEC/SES	NLT 10 days prior to launch
Range Safety Office	Initial Notification	MAJCOM / FLDCOM	Forward upon receipt
	Annual Report	MAJCOM / FLDCOM	Annually prior to February 1st
	Radiological Risk Review	DEL/CC	Prior to Launch
DEL/CC	Conduct Radiological Risk Review	With Range Safety Office	Prior to Launch
	Launch Authorization	Range User	Prior to Launch
MAJCOM / FLDCOM	Initial Notification	AFSEC/SES	Forward upon receipt
	Annual Report	AFSEC/SES	Annually prior to February 1st
AFSEC/SES	Annual Report	OSTP & APNSA	Annually
	Annual Briefings	OSTP, NSTC & APNSA	Annually
	Tier Determination	Range User & SECDEF	Before Launch Authorization Request
	Safety Assessment	Secretaries of Military Departments or SECDEF if requested	With Launch Authorization Request

2.3. Major Command (MAJCOM), Field Command (FLDCOM), or Direct Reporting Unit (DRU). FLDCOM, MAJCOM, or DRU Safety Offices will (see **Table 2.1**):

2.3.1. Forward Initial Notifications from Program Offices or Range Safety Offices to AFSEC/SES (see **paragraph 3.6**). **(T-1)**

2.3.2. Compile Annual Reports from Program Offices and Range Safety Offices and forward to AFSEC/SES (see **paragraph 3.7**). **(T-1)**

2.3.3. Perform Nuclear Safety Inspections every three years on ranges launching systems containing radioactive material and Program Offices sponsoring space and missile systems containing radioactive material. **(T-1)** These inspections must evaluate as appropriate:

2.3.3.1. Procedures for initiating, receiving, and forwarding Initial Notifications and Annual Reports (see paragraphs **3.6** and **3.7**). **(T-1)**

2.3.3.2. Range procedures for conducting or supporting NSRs (see **paragraph 3.12**). **(T-1)**

2.3.3.3. Range procedures for conducting Radiological Risk Reviews (see **paragraph 3.20**). **(T-1)**

2.3.3.4. Program Office procedures for managing radiological risk per AFI 91-202, *The Us Air Force Mishap Prevention Program*. **(T-1)**

2.3.3.5. Safety procedures for launching systems containing radioactive material and radiological contingency plans for responding to a space launch radiological mishap (see **paragraph 3.24**). **(T-1)**

2.4. Space Launch Delta Commander (DEL/CC). DEL/CC or equivalent will (see **Table 2.1**):

2.4.1. Conduct Radiological Risk Reviews (see **paragraph 3.20**). **(T-3)**

2.4.2. Ensure launches containing radioactive materials have the appropriate safety review and launch authorization or license (see **paragraph 3.17**). **(T-1)**

2.4.3. Assess launch radiological risk to people, the environment, operations, and assets on the range and provide the final approval to launch after all required approvals are obtained and launch requirements are met (see **paragraph 3.17.1.3**). **(T-1)**

2.4.4. Develop range radiological safety and contingency plan for radiological mishaps and ensure range participation in range user's radiological safety and contingency planning for launch related radiological mishaps (see **paragraph 3.24**). **(T-1)**

2.5. Range Safety Office. Range Safety Office will (see **Table 2.1**):

2.5.1. Receive Initial Notification from non-DAF range users and forward to FLDCOM safety office and the range's Radiation Safety Officer (RSO) (see **paragraph 3.6**). **(T-2)**

2.5.2. Compile Annual Report of non-DAF missions using the range and send to FLDCOM safety office (see **paragraph 3.7**). **(T-2)**

2.5.3. Conduct Nuclear Safety Reviews (NSR) as required (see **paragraph 3.12**). **(T-1)**

2.5.4. Support Commander's Radiological Risk Review (see **paragraph 3.20**). **(T-3)**

2.5.5. Produce Contamination Impact Statement (see **paragraph 3.21.3**). **(T-3)**

2.5.6. Support range users producing safety analysis documents. **(T-3)**

2.5.7. Provide support to the DoD INSRB member as subject matter experts as requested and agreed with AFSEC/SES. **(T-1)**

2.5.8. Determine non-tiered mission requirements in consultation with range user (see **paragraph 3.5**). **(T-2)**

2.5.9. Consult with the range RSO on Nuclear Safety Reviews and non-tiered mission requirements. **(T-3)**

2.5.10. Participate in the range user's radiological contingency planning as necessary (see **paragraph 3.24**). **(T-3)**

2.6. Department of the Air Force System Program Offices. DAF Program Offices or DRUs who plan to use radioactive material in space or who plan to develop a Space Nuclear System (SNS) will (see **Table 2.1**):

2.6.1. Notify MAJCOM / FLDCOM safety office who will forward notification to AFSEC/SES immediately, after the conceptual design of a SNS or plans to use RAM in space (see **paragraph 3.6**). **(T-1)**

2.6.2. If a System-Specific SAR is developed, provide an initial copy to AFSEC/SES and an updated copy after each annual review (see **paragraph 3.11**). **(T-1)**

2.6.3. Manage radiological risk during program development in accordance with AFI 91-202 or the sponsor's applicable regulations (see **paragraph 3.16**). **(T-1)**

2.6.4. Provide technical support to AFSEC/SES if requested (see **paragraph 3.25**). **(T-1)**

2.7. Range Radiation Safety Officer (RSO). The RSO will:

2.7.1. Notify Range Safety Office upon receipt of Initial Notification of the planned use of radioactive material on launch vehicles or missile systems that will be launched from the range (see **paragraph 3.6**). **(T-1)**

2.7.2. Advise Range Safety Office on:

2.7.2.1. Conducting an NSR (see **paragraph 3.12**). **(T-3)**

2.7.2.2. Determining non-tiered mission requirements (see **paragraph 3.5**). **(T-3)**

2.7.3. Participate in Radiological Risk Review when requested (see **paragraph 3.20**). **(T-3)**

2.7.4. Participate in the range user's radiological contingency planning as necessary (see **paragraph 3.24**). **(T-3)**

2.7.5. Advise range user of appropriate RAM and SNS handling procedures on the DAF range (see **paragraph 3.3**). **(T-3)** The Range Radiation Safety Officer will determine controls (posting, area surveys, mission-specific training/communication, and dosimetry) for the RAM or SNS intended for space use are in place from arrival on the range to launch. **(T-3)**. Designated controls are to be consistent with radiation protection requirements imposed by the regulatory authority for similar materials. **(T-3)**

2.8. Range Users. The range user is the organization that sponsors or owns a mission and holds primary responsibility for radiological safety of the mission per Memorandum on the National Strategy for Space Nuclear Power and Propulsion (SPD-6). DAF range users can be the Program Office or System Program Office (SPO) sponsoring the mission. If multiple organizations are

involved in the mission, these organizations must determine who will act as the range user in meeting the requirements of this manual, and inform the range. The range user will ensure the safe operation of launch vehicles or spacecraft containing radioactive material and ensure that Safety Guidelines are followed per NSPM-20 and this manual (see **paragraph 3.22**). **(T-0)**

Table 2.2. Non-DAF Range Users Safety Products & Reporting Requirements Quick Reference.

Who	What	To	When
DoD Range User	Initial Notification	AFSEC/SES or Range Safety Office & RSO	Early, after the conceptual design or when launch complex is selected
	INSRB/SER Request	AFSEC/SES & INSRB	Early in the acquisition phase of mission, normally 3 to 5 years prior to launch
	Annual Report	Range Safety Office	After Initial Notice annually until launch, prior to February 1st
	Annual Briefing	As coordinated by AFSEC/SES	After Initial Notice annually until launch
	Tier II & III Preliminary, Draft, Final SARs	INSRB	Per INSRB's mission specific review plan
	Tier I Draft SAR	Range Safety Office & AFSEC/SES	NLT 18 months prior to launch
	Tier I Final SAR	Range Safety Office & AFSEC/SES	NLT 12 months prior to launch
	SAS	Range Safety Office	NLT 6 months prior to launch
	Risk Constraint	Range Safety Office	In SAS or SAR or NLT 6 months prior to launch
	Contingency Plans	Range Safety Office	Per range requirements
	Technical Support	Range Safety Office, AFSEC/SES & INSRB	As requested
	Tier Recommendation	AFSEC/SES	After completion of SAR & SER, before launch request
	Launch Authorization Request	Launch Authorization Authority (LAA)	- Non-Tiered: per Program Office's internal requirements - Tiered: NLT 6 months prior to launch
	Launch Authorization letter from LAA	Range Safety Office	NLT 10 days prior to launch
NASA or Other Government Range User	Initial Notification	Range Safety Office & RSO	When DAF range is selected
	Tier II & III Preliminary, Draft, and Final SARs	INSRB	Per INSRB's mission review plan
	Tier I Draft SAR	Range Safety Office & AFSEC/SES	NLT 18 months prior to launch
	Tier I Final SAR	Range Safety Office & AFSEC/SES	NLT 12 months prior to launch
	SAS	Range Safety Office	NLT 6 months prior to launch
	Risk Constraint	Range Safety Office	In SAS or SAR or NLT 6 months prior to launch
	Contingency Plans	Range Safety Office	Per range requirements
	Technical Support	Range Safety Office, AFSEC/SES & INSRB	As requested
	Tier Determination	Range Safety Office & AFSEC/SES	NLT 10 days prior to launch
	Launch Authorization	Range Safety Office	NLT 10 days prior to launch
Commercial Range User	Initial Notification	Range Safety Office & RSO	When DAF range is selected
	Safety Analysis (EIS, SAR, SER)	Range Safety Office	Sufficient time for review, prior to launch
	Contingency Plans	Range Safety Office	Per range requirements
	FAA License	Range Safety Office	NLT 10 days prior to launch
	Technical Support	Range Safety Office, AFSEC/SES & INSRB	As requested

2.8.1. For programs involving multiple agencies, the terms of cooperation shall designate a lead agency with primary responsibility for radiological safety in each stage of development and use. **(T-0)**

2.8.2. Range users will comply with Title 42 United States Code Sections 4321-4347, *National Environmental Policy Act*, commonly referred to as NEPA. **(T-0)**

2.8.3. Range Users will develop mission radiological safety and contingency plans for launch-related radiological mishaps that are commensurate with the radiological risk (see **paragraph 3.24**). **(T-1)**

2.8.4. Range users must follow normal handling requirements in accordance with the range RSO's guidance (see **paragraph 3.3**). **(T-1)**

2.8.5. Range users (or Program Office) that launch, develop, test, or operate any programs or systems that use radioactive material in space or missile systems will also comply with the following paragraphs as applicable (see Tables **2.1, 2.2, and 3.2**). **(T-1)**

2.8.6. DAF Range Users (or Program Office), regardless of what range used will:

2.8.6.1. Provide Initial Notification to MAJCOM / FLDCOM immediately after the conceptual design of the mission is generated (see **paragraph 3.6**). **(T-1)**

2.8.6.2. Request an INSRB evaluation if required, coordinating a mission specific review plan and establishing the cost and milestones of the evaluation with the INSRB (see **paragraph 3.14**). **(T-0)**

2.8.6.3. Provide Annual report to AFSEC/SES if required (see **paragraph 3.7**). **(T-0)**

2.8.6.4. Provide Annual Briefing if required (see **paragraph 3.8**). **(T-0)**

2.8.6.5. Manage radiological risk during program development in accordance with AFI 91-202 (see **paragraph 3.16**). **(T-1)**

2.8.6.6. Measure mission risk against Risk Constraint (see **paragraph 3.21**) and Safety Guidelines if required (see **paragraph 3.23**). **(T-1)**

2.8.6.7. Provide input to the Contamination Impact Statement if required (see **paragraph 3.21.3**). **(T-3)**

2.8.6.8. Produce Safety Analysis Summary (SAS) if required (see **paragraph 3.9**). **(T-1)**

2.8.6.9. Produce Safety Analysis Report (SAR) if required (see **paragraph 3.10**). **(T-0)**

2.8.6.10. Use Tier definitions in this manual (see **paragraph 3.4**). **(T-0)**

2.8.6.11. Provide a Tier recommendation to AFSEC/SES if required (see **paragraph 3.15**). **(T-1)**

2.8.6.12. Request launch authorization in accordance with the process in this manual (see paragraph **3.17** and **3.18**). **(T-0)**

2.8.6.13. Provide a launch authorization letter from the appropriate Launch Authorization Authority to the Range Safety Office and AFSEC/SES in accordance with this manual (see **paragraph 3.18**). **(T-0)**

2.8.6.14. Provide technical support to the INSRB, AFSEC/SES and Range Safety Office (see **paragraph 3.25**). **(T-1)**

2.8.7. Other DoD Range Users of DAF Ranges will:

2.8.7.1. Provide Initial Notification to the Range Safety Office and RSO immediately after a DAF range is selected for launch (see **paragraph 3.6**). **(T-1)**

2.8.7.2. Request an INSRB evaluation, coordinate a mission specific review plan and establish the cost and milestones of the evaluation with the INSRB if required (see **paragraph 3.14**). **(T-0)**

2.8.7.3. Manage radiological risk during program development in accordance with the sponsor's applicable regulations (see **paragraph 3.16**). **(T-1)**

2.8.7.4. Measure mission risk against Risk Constraint (see **paragraph 3.21**) and Safety Guidelines if required (see **paragraph 3.22**). **(T-1)**

2.8.7.5. Provide inputs to Contamination Impact Statement if required (see **paragraph 3.21.3**). **(T-3)**

2.8.7.6. Produce SAS if required (see **paragraph 3.9**). **(T-1)**

2.8.7.7. Produce SAR if required (see **paragraph 3.10**). **(T-0)**

2.8.7.8. Use Tier definitions in this manual (see **paragraph 3.4**). **(T-0)**

2.8.7.9. Provide a Tier recommendation to AFSEC/SES if required (see **paragraph 3.15**). **(T-1)**

2.8.7.10. Request launch authorization in accordance with the process in this manual (see paragraph **3.17** and **3.18**). **(T-0)**

2.8.7.11. Provide a launch authorization letter from the appropriate Launch Authorization Authority to the Range Safety Office in accordance with this manual (see **paragraph 3.18**). **(T-0)**

2.8.7.12. Provide technical support to the INSRB, AFSEC/SES and Range Safety Office (see **paragraph 3.25**). **(T-1)**

2.8.8. NASA and Other Government (non-DoD) Range Users of DAF Ranges will:

2.8.8.1. Provide Initial Notification to the Range Safety Office and RSO immediately after a DAF range is selected for launch (see **paragraph 3.6**). **(T-1)**

2.8.8.2. Manage radiological risk during program development in accordance with the sponsoring agencies applicable regulations (see **paragraph 3.16**). **(T-1)**

2.8.8.3. Measure mission risk against Risk Constraint (see **paragraph 3.21**) and Safety Guidelines if required (see **paragraph 3.22**). **(T-1)**

2.8.8.4. Provide inputs to Contamination Impact Statement if required (see **paragraph 3.21.3**). **(T-3)**

2.8.8.5. Produce SAS if required (see **paragraph 3.9**). **(T-1)**

2.8.8.6. Produce SAR if required (see **paragraph 3.10**). **(T-0)**

2.8.8.7. Use Tier definitions of sponsoring agency (see **paragraph 3.4**). **(T-3)**

2.8.8.8. Provide sponsoring agency's tier determination letter to the Range Safety Office and AFSEC/SES (see **paragraph 3.15**). **(T-3)**

2.8.8.9. Provide launch authorization letter from the designated Launch Authorization Authority to the Range Safety Office (see **paragraph 3.18**). **(T-0)**

2.8.8.10. Provide technical support to the INSRB, AFSEC/SES, and Range Safety Office as requested (see **paragraph 3.25**). **(T-1)**

2.8.9. Commercial Range Users of DAF Ranges will:

2.8.9.1. Provide Initial Notification to the Range Safety Office and RSO as early as possible after a DAF range is selected for launch or at the time the mission is placed on the range's launch schedule (see **paragraph 3.6**). **(T-3)**

2.8.9.2. Provide safety analysis to Range Safety Office with sufficient time for review, prior to launch. **(T-3)**. FAA works with the DAF range on space nuclear systems safety analysis as it does with flight safety analysis associated with the license to launch. The FAA and DAF collaboration should occur early in the licensing process.

2.8.9.3. Provide required License to Launch a Space Nuclear System to Range Safety Office (see **paragraph 3.17**). **(T-0)**

2.8.9.4. Provide technical support to the Range Safety Office and AFSEC/SES if requested (see **paragraph 3.25**). **(T-1)**

Chapter 3

NUCLEAR SAFETY REVIEW AND LAUNCH APPROVAL INSTRUCTIONS

3.1. A2 Value. The A2 value refers to the maximum quantity of radioactive material in nominal form to be transported in a Type A container as established by the International Atomic Energy Agency (IAEA) (*IAEA Regulations for the Safe Transport of Radioactive Material*, SSR-6, Section IV "Activity Limits and Classifications," Table 2 "Basic Radionuclide Values," p. 25). A2 values are determined based on methodology established in Specific Safety Guide No. SSG-26, *Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material*, and are generally associated with those quantities that upon release could result in a total effective dose of 50 milli Sievert (mSv) or 5 roentgen equivalent man (rem). The A2 values are used by NSPM-20 as the basis to set Tier thresholds. In addition to the Tier thresholds, this manual uses the A2 values to set requirement thresholds. The most current IAEA A2 values will be used except when in conflict with NSPM-20 or OSTP direction. **(T-1)**

3.2. Determining a Mission's A2 Value. To determine the A2 value of the radioactive material used on a given mission, see **Attachment 2**. If multiple programs are using a single launch vehicle, the range user will need to consider the impact of the other payloads, including all radioactive materials on their safety analysis. **(T-1)** The combined total of radioactive material on a launch vehicle will determine the A2 value of that launch mission and the risk measured against the Safety Guideline and Risk Constraint. **(T-1)**

3.3. Handling Procedures. Radioactive Material or Space Nuclear Systems brought on to a DAF range will be handled as directed by the Radiation Safety Officer (RSO) in accordance with DAF regulatory guidance and procedures, which may include AFMAN 48-148, *Ionizing Radiation Protection*, and AFMAN 40-201, *Radioactive Materials (RAM) Management.* (T-1) RSO will ensure range users, processing a space or missile system utilizing radioactive material on a DAF range, handle, use, and have required possession authorization in accordance with any Federal and/or DoD regulations governing their material. (T-0)

3.4. Tiers. See **Table 3.1** below.

Table 3.1. Tiered and Non-Tiered Thresholds.

Tiers		Thresholds
Non-Tiered Missions	≥ A2×0.001 < A2	- Quantity of radioactive material is ≥ A2×0.001 < A2
	≥ A2 < A2×500	- Quantity of radioactive material is ≥ A2 < A2×500
	≥ A2×500 < A2×1,000	- Quantity of radioactive material is ≥ A2×500 < A2×1,000
Tiered Missions	Tier I	- Quantity of radioactive material is ≥ A2×1,000 ≤ A2×100,000
	Tier II	- Quantity of radioactive material is > A2×100,000 - Probability of exposure of 5 rem to 25 rem to any member of the public is ≥ 1 in 1,000,000 - Nuclear fission systems using low-enriched uranium
	Tier III	- Probability of exposure of > 25 rem to any member of the public is ≥ 1 in 1,000,000 - Nuclear fission systems using other than low-enriched uranium

3.4.1. DAF sponsored missions using any range will use the tier definitions in this section. **(T-1)** DoD (non-DAF) range users use the tier definitions in this section. NASA or other government (Non-DoD) range users use the sponsoring agencies tier definitions. DAF ranges will accept the tier determination of NASA or other government (non-DoD) agency sponsoring the mission. **(T-0)** Commercial missions follow Federal Aviation Administration (FAA) licensing tier definitions. DAF ranges will accept the tier determination of the FAA License to Launch a Space Nuclear System. **(T-0)**

3.4.2. Non-tiered applies to the following.

3.4.2.1. Launch vehicles (including spacecraft) containing a total of radioactive material quantities equaling more than and including 0.001 times the A2 value and up to less than 1,000 times the A2 value. **(T-1)**

3.4.3. Tier I applies to the following.

3.4.3.1. Launch vehicles (including spacecraft) containing a total of radioactive material quantities equaling more than and including 1,000 times the A2 value and up to and including 100,000 times the A2 value. **(T-0)**

3.4.4. Tier II applies to the following.

3.4.4.1. Launches of spacecraft containing radioactive material in excess of 100,000 times the A2 value. **(T-0)**

3.4.4.2. Any Tier I launches where the associated safety analyses determine that the probability of a mishap during launch or subsequent operation resulting in an exposure in the range of 5 rem to 25 rem total effective dose (TED) to any member of the public is equal to or greater than 1 in 1,000,000. **(T-0)**

3.4.4.3. Any launches of spacecraft containing nuclear fission systems and other devices with a potential for criticality (defined as the condition in which a nuclear fission chain reaction becomes self-sustaining), when such systems utilize low-enriched uranium (less than 20 percent uranium-235 enrichment). **(T-0)**

3.4.5. Tier III applies to the following.

3.4.5.1. Launches of any spacecraft containing a space nuclear system for which the associated safety analyses determine that the probability of a mishap during launch or subsequent operation resulting in an exposure in excess of 25 rem TED to any member of the public is equal to or greater than 1 in 1,000,000. **(T-0)**

3.4.5.2. Due to potential national security considerations associated with nuclear nonproliferation, Tier III shall also apply to launches of spacecraft containing nuclear fission systems and other devices with a potential for criticality when such systems utilize any nuclear fuel other than low-enriched uranium. **(T-0)**

3.5. Mission Requirements. See **Table 3.2** below and **paragraph 2.8**.

Table 3.2. DAF Range User Requirements Quick Reference.

Requirements	Non-Tiered Missions				Tiered Missions		
	< A2×0.001	≥ A2×0.001	≥ A2	≥ A2×500	Tier I	Tier II	Tier III
Reports							
NEPA	✓	✓	✓	✓	✓	✓	✓
Initial Notice		✓	✓	✓	✓	✓	✓
Annual Report to AFSEC				✓	✓	✓	✓
Annual Briefing						✓	✓
Safety Analysis							
SAS				✓			
SAR					✓	✓	✓
Safety Review							
NSR			✓	✓	✓		
INSRB/SER						✓	✓
Authorization							
LAA Launch Authorization		✓	✓	✓	✓	✓	✓
DEL/CC Launch Authorization		✓	✓	✓	✓	✓	✓
Protection Practice							
Risk Constraint			✓	✓	✓	✓	✓
Safety Guidelines	✓	✓	✓	✓	✓	✓	✓
Contingency Plans		✓	✓	✓	✓	✓	✓
Other							
Technical Support		✓	✓	✓	✓	✓	✓

3.5.1. General mission requirements.

3.5.1.1. All missions using radioactive material at a DAF range must follow normal handling requirements in accordance with the range RSO's guidance (see **paragraph 3.3**). **(T-1)**

3.5.1.2. All DAF missions or missions using DAF ranges must meet Safety Guidelines and Risk Constraint requirements in paragraphs **3.22** and **3.21** of this manual. **(T-1)**

3.5.1.3. DAF sponsored missions using any range will meet the tiered and non-tiered requirements in paragraphs **3.5.2** and **3.5.3**. **(T-1)**

3.5.1.4. DoD sponsored missions using a DAF range will meet the tiered and non-tiered requirements in paragraphs **3.5.2** and **3.5.3**. **(T-1)**

3.5.1.5. NASA sponsored missions using DAF ranges meet the tiered and non-tiered requirements established in paragraphs **3.5.2** and **3.5.3** However, NASA conducts Annual Reports and Briefings outside DAF channels and NASA determines Launch Authorization Authorities for their sponsored non-tiered missions. NASA will keep the Range Safety Office informed of the progress of a mission's safety and launch authorization process after a DAF launch site is selected. **(T-1)** If NASA's safety analysis and launch authorization

timeline conflicts with the deliverable deadline requirements of this DAFMAN, NASA will coordinate with the Range Safety Office or AFSEC/SES as appropriate to agree on a timeline. **(T-3)**

3.5.1.6. Other government (Non-DoD) sponsored missions using DAF ranges meet the tiered and non-tiered requirements established in paragraphs **3.5.2** and **3.5.3** However, the non-DoD government sponsor of a mission conducts Annual Reports and Briefings outside DAF channels and determines Launch Authorization Authorities for their sponsored non-tiered missions. The non-DoD government sponsor will keep the Range Safety Office informed of the progress of a mission's safety and launch authorization process after a DAF launch site is selected. **(T-1)** If a non-DoD government range user's safety analysis and launch authorization timeline conflicts with the deliverable deadline requirements of this DAFMAN, the sponsor will coordinate with the Range Safety Office or AFSEC/SES as appropriate to agree on a timeline. **(T-3)**

3.5.1.7. Commercial missions will meet FAA licensing requirements to launch from DAF ranges. **(T-0)** Commercial missions will also meet the requirements set out in **paragraph 2.8.9**. **(T-1)**

3.5.2. Tiered Mission Requirements.

3.5.2.1. Tier I requires Initial Notification and an Annual Report. **(T-1)** Tier I also requires a Safety Analysis Report (SAR) which will be reviewed by the Range Safety Office and AFSEC/SES. **(T-1)** Tier I missions also require authorization from the Launch Authorization Authority. **(T-1)**

3.5.2.2. Tier II and Tier III requires Initial Notification, an Annual Report, and an Annual Briefing. **(T-1)** Tiers II and III also require a Safety Analysis Report which will be reviewed by the Range Safety Office, AFSEC/SES, and evaluated by the INSRB. **(T-1)** Tier II and III missions also require authorization from the Launch Authorization Authority. **(T-1)**

3.5.3. Non-Tiered Mission Requirements.

3.5.3.1. Missions carrying a quantity of radioactive material equal to or more than A2 × 0.001 require Initial Notification and authorization from the Launch Authorization Authority. **(T-1)**

3.5.3.2. Missions carrying a quantity of radioactive material equal to or more than A2 requires Initial Notification, an Annual Report, a Nuclear Safety Review, and authorization from the Launch Authorization Authority. **(T-1)**

3.5.3.3. Missions carrying a quantity of radioactive material equal to or more than A2 × 500 but less than A2 × 1000 require Initial Notification, an Annual Report, a Safety Analysis Summary (SAS), Nuclear Safety Review, and authorization from the Launch Authorization Authority. **(T-1)**

3.6. Initial Notification. Initial Notification provides the range and AFSEC/SES early awareness of missions that plan to use radioactive material. This helps the Range Safety Office and AFSEC/SES to provide timely support to the range user ensuring that safety requirements are met early in the program development to avoid mission delays. Initial Notification is required for any mission that plans to use a reactor or will have radioactive materials in quantities greater than A2 × 0.001. **(T-1)**

3.6.1. The DAF Program Office or range user or equivalents will make Initial Notification immediately, after the conceptual design of the mission is generated, to MAJCOM / FLDCOM safety offices who will provide the Initial Notification to AFSEC/SES, regardless of what range the mission plans to use. **(T-1)** During program introduction of the specific mission to the range intended to support the launch operation, the DAF range user will also notify the Range Safety Office and Radiation Safety Officer (RSO) of their intent to use radioactive material on the mission. **(T-1)**

3.6.2. DAF Direct Reporting Units (DRUs) will make initial notifications directly to AFSEC/SES. **(T-1)**

3.6.3. NASA, DoD (Non-DAF), or other government and commercial range users will provide Initial Notification to the Range Safety Office and RSO as early as possible after the selection of the range or during program introduction of the specific mission to the range intended to support the launch operation. **(T-1)**

3.6.4. The Program Office or range user will include within the Initial Notification, the program name and as much basic information about the radioactive material as is known at the time of the notification, including the quantity, and A2 value of the materials. **(T-1)**

3.6.5. The Range Safety Office will forward Initial Notifications from non-DAF mission sponsors to their MAJCOM / FLDCOM safety office and make sure that their MAJCOM / FLDCOM safety office is aware of DAF missions using RAM at the range. **(T-1)**

3.6.6. MAJCOM / FLDCOM safety offices will forward Initial Notification received from their Program Offices or from ranges that received Initial Notification for non-DAF missions to AFSEC/SES as early as possible. **(T-1)**

3.7. Annual Reports. Annual Reports keep AFSEC/SES, Office of Science and Technology Policy (OSTP), and other organizations aware of a mission's ongoing safety and launch authorization process. Each year DAF FLDCOMs, MAJCOMs, DRUs, or equivalents will report all missions they sponsor to AFSEC/SES that are tiered or have total radioactive quantities greater than the A2 value scheduled for launch in the coming 18 months. **(T-0)** The report will also include all missions that were launched from DAF ranges in the past calendar year. **(T-0)** MAJCOM / FLDCOM safety offices will report all non-DAF missions scheduled to launch or that have launched from DAF ranges that have radioactive quantities greater than the A2 value during the same time period. **(T-1)** AFSEC/SES must receive the report prior to the first of February of each year. **(T-1)**

3.7.1. The Annual report will include:

3.7.1.1. Program name. **(T-1)**

3.7.1.2. Program sponsor (Program Office or range user). **(T-1)**

3.7.1.3. Launch vehicle, site, and date. **(T-1)**

3.7.1.4. Impact area or orbital parameters. **(T-1)**

3.7.1.5. Specific radioisotopes and associated activities measured in Terabecquerels (TBq) or if a reactor, the fuel composition, and power output. **(T-1)**

3.7.1.6. Type of nuclear system or device, if applicable. **(T-1)**

3.7.1.7. A launch authorization Tier projection, if applicable. **(T-1)** A change in the tier projection as the design progresses should be highlighted.

3.7.2. AFSEC/SES will compile Annual Reports and provide them to SECDEF (or his/her designee), OSTP, and APNSA, in accordance with NSPM-20. **(T-0)**

3.8. Annual Briefing. Missions in Tiers II and III require an annual briefing to the OSTP and NSTC on the status of safety analysis per NSPM-20. **(T-0)** The annual briefing may also include APNSA. AFSEC/SES will ensure these briefings are accomplished for any DoD sponsored missions. **(T-1)**

3.9. Safety Analysis Summary (SAS). If a SAR is created, a SAS is not required. A Safety Analysis Summary is typically not a probabilistic risk assessment, but rather an analysis resulting in a conservatively-biased assessment of the radiological risk of launching radioactive material. The level of detail (including the degree of realism sought through validation of the physical models used) of the SAS will be coordinated with the Range Safety Office and should be commensurate with the anticipated radiological risk based upon relevant past radiological analyses. **(T-1)**

3.9.1. DoD Program Office or DAF range users will prepare a SAS when a mission will use quantities of radioactive material that total more than or equal to A2 × 500 but less than A2 × 1000. **(T-1)** A SAS will include risk estimates from the time the radioactive material is mated to or integrated into the launch vehicle or missile at the launch site until the radioactive material is recovered, no longer poses a risk to the biosphere, or, in the case of a suborbital launch system, at the end of the mission. **(T-1)**

3.9.2. Any test information, validated models used, references, data, and any other information, or programs used to support SAS findings must be made available to the Range Safety Office and AFSEC/SES if requested. **(T-1)** The SAS will be delivered to the Range Safety Office no later than six months prior to launch. **(T-3)** The Range Safety Office will review the SAS against the Risk Constraints and Safety Guidelines. **(T-1)** The Range Safety Office may request assistance in reviewing a SAS from AFSEC/SES.

3.9.3. The SAS will contain at a minimum the following, unless coordinated with the Range Safety Office.

3.9.3.1. Brief Description. **(T-1)**:

3.9.3.1.1. Mission, schedule, launch vehicle, spacecraft, trajectory, orbit, device or system containing the radioactive materials. **(T-1)**

3.9.3.1.2. All radioactive materials, their physical state/chemical form, A2 multiple, and quantities. **(T-1)**

3.9.3.1.3. Safety and radiation protection methods used in the design of mission. **(T-1)**

3.9.3.2. Analysis **(T-1)**:

3.9.3.2.1. Potential mishap scenarios and environments information. **(T-1)** Scenario description and resulting consequences of launch and in-flight mishaps that could result in the terrestrial release of radiological materials. **(T-1)**

3.9.3.2.2. Environmental transport and dispersion. **(T-1)**

3.9.3.2.3. Consequence modeling. **(T-1)** Estimate of any health and environmental effects due to a radioactive material release. **(T-1)**

3.9.3.3. Mission risk estimate **(T-1)**:

3.9.3.3.1. Mission risk compared to Safety Guidelines and Risk Constraints (see paragraphs **3.21** and **3.22**). **(T-1)**. For all phases of the mission from RAM integration into launch vehicle to when RAM is recovered, no longer poses a risk to the biosphere, or, in the case of a suborbital launch system, at the end of the mission. **(T-1)**

3.9.3.3.2. Mission specific information or potential mishap site emergency response and recovery planning recommended for consideration. **(T-1)**

3.10. Mission Specific Safety Analysis Report (SAR). A SAR is the study of credible potential releases of nuclear material into the biosphere, presented in the form of a probabilistic risk assessment that: (a) uses launch vehicle mishap probabilities and mishap environment data as inputs to analysis tools that estimate the probabilities and magnitudes of source terms, (b) predicts transport through and deposition in the environment, (c) estimates mishap impacts, and (d) evaluates the variability and uncertainty of the estimates, including gaps of knowledge (i.e., missing or incomplete information) that could impact the calculated estimates. A SAR is required for Tiered missions per NSPM-20. **(T-0)**

3.10.1. DAF range users or DAF Program Offices using non-DAF ranges will prepare a SAR when a mission is projected to fall with-in the thresholds of a Tier I, II or III mission. **(T-0)**

3.10.2. A mission SAR will include calculated risk estimates from the time the radioactive material is mated to or integrated into the launch vehicle or missile at the launch site until the radioactive material is recovered, no longer poses a risk to the biosphere, or, in the case of a suborbital launch system, at the end of the mission. **(T-1)** At a minimum, the SAR will include the information listed in **Attachment 3** or as coordinated and agreed with AFSEC/SES. **(T-1)** As much as possible the safety analysis should incorporate relevant experience and analysis from previous missions. **(T-0)**

3.10.3. The range user will also provide any test information, models used, references, data, and any other information used to support SAR findings to the Range Safety Office, AFSEC/SES, or INSRB if requested. **(T-1)** A Tier I draft SAR will be delivered to the Range Safety Office and AFSEC/SES no later than 18 months prior to launch. **(T-1)** The final SAR will be delivered to the Range Safety Office and AFSEC/SES no later than 12 months prior to launch or as agreed upon between the range user, AFSEC/SES, and the Range Safety Office. **(T-1)** The Range Safety Office and AFSEC/SES will review the SAR against the Risk Constraints and Safety Guidelines. **(T-1)** AFSEC/SES may request additional review of the SAR by outside experts or organizations. AFSEC/SES may produce a safety assessment of the SAR and provide it to the Secretaries of the Military Departments or the SECDEF (or his/her designee) if requested.

3.10.4. The funding and safety review milestones of a Tier I SAR will be agreed upon between the DoD range user and AFSEC/SES early in the acquisition phase in the form of a Mission-specific Review Plan normally 2-5 years prior to launch. **(T-1)**

3.10.5. Tier II & III mission SARs will be developed, delivered, and reviewed in accordance with Mission-specific Review Plan agreed upon between the Program Office (DoD range user)

and the INSRB early in the acquisition phase, normally 3-5 years prior to launch. **(T-1)** The Mission-specific Review Plan will include funding and safety review milestones agreed upon between the Program Office (DoD range user) and the INSRB.

3.10.6. A mission's Tier projection may change as the safety analysis progresses, therefore it is important that the DoD range user have regular contact with AFSEC/SES as the SAR is developed, to determine and confirm SAR requirements are being met and to prevent program delays.

3.11. System-Specific SAR. Establishes a safety basis for a specific space nuclear system. The developer of the space nuclear system creates the System-Specific SAR. The safety basis provides a set of conditions under which safety analysis and hazard controls provide assurance of safe operation for the given system. Agencies responsible for system-specific SARs will review them annually and update them as necessary. **(T-0)**

3.11.1. System-Specific SARs, sponsored by any DoD organization, will be provided to AFSEC/SES on completion, including any changes made during annual reviews. **(T-1)**

3.11.2. A mission SAR may incorporate a System-Specific SAR or become the mission specific SAR. The mission SAR must demonstrate that the mission is within the parameters established in the System-Specific SAR, in which case it is not necessary to repeat the analysis supporting the System-Specific SAR or include supplemental safety analysis for any deviations and for which safety has therefore not yet been demonstrated. **(T-0)**

3.12. Nuclear Safety Review (NSR). An NSR is a review of a planned launch of radioactive material that qualitatively or semi-quantitatively addresses the radiological risk of the mission. It describes the form and quantity of radioactive material being launched, describing the relevant mission profile, providing an analysis of the probabilities of launch and in-flight mishaps. It provides a realistic and conservatively-biased estimate of the health and environmental effects of a radioactive material release in the considered mishap scenarios, and provides mission-specific information relevant for contingency planning and material recovery. An NSR is not required if the INSRB creates a Safety Evaluation Report (SER).

3.12.1. An NSR is required when a mission will use quantities of radioactive material that totals equal to or greater than A2. **(T-1)** An NSR is conducted by the Range Safety Office in the case of non-tiered missions equal to or greater than A2 and by AFSEC/SES in the case of a Tier I mission. The NSR is used to review a SAS, SAR, or other information provided by the range user to the Range Safety Office, but does not necessarily result in a formal document. The level of effort used for an NSR will be commensurate with the radiological risk. **(T-1)**

3.12.2. If a SAS or SAR are not created, then the information necessary to conduct an NSR must be provided by the Program Office or range user to the Range Safety Office, if it is not included in information already provided. **(T-1)**

3.12.2.1. The information required by the Range Safety Office may include, but is not limited to a description of the following:

3.12.2.1.1. Details of radioactive materials (i.e., isotopes, activity, A2 multiple).

3.12.2.1.2. Design of device or system containing the radioactive materials.

3.12.2.1.3. Safety and radiation protection methods used in the design.

3.12.2.1.4. Location of radioactive materials on launch or space vehicle.

3.12.2.1.5. Plans for handling radioactive materials (i.e., pre-launch, launch abort, mishap recovery, end of life).

3.12.2.1.6. Calculation of risk against the Risk Constraints and Safety Guidelines (see paragraphs **3.21** and **3.22**).

3.12.3. If NASA or another government mission sponsor's safety office conducts an NSR or equivalent, the Range Safety Office or AFSEC/SES can accept that review in place of their review or use the findings of the other agencies' NSR to augment their review.

3.13. Safety Assessments. Safety Assessments of missions using radioactive material may be created by AFSEC/SES for the Secretaries of the Military Departments or the SECDEF (or his/her designee). The Assessment can be included in the request for launch authorization to support the Secretaries of Military Departments' requirement to provide an assessment when requesting launch authorization per DoDI 3100.12., Sec. 5.5.4 and 6.5.1. A SER will normally meet the need for a Safety Assessment.

3.14. Interagency Nuclear Safety Review Board (INSRB) and Safety Evaluation Report (SER). The INSRB is an interagency board established by NSPM-20 and includes members from the DoD, National Aeronautics and Space Administration (NASA), Department of Energy (DOE), Environmental Protection Agency (EPA), Department of State (DOS), Department of Transportation (DOT), and the Nuclear Regulatory Commission (NRC). AFSEC/SES provides the DoD member of the board. This board evaluates the SARs produced for missions in Tiers II and III. This evaluation is recorded in the Safety Evaluation Report (SER), which is provided to the designated Launch Authorization Authorities. The evaluation is conducted as the SAR is developed and the SER is written simultaneously with the SAR in close coordination with the Program Office and SAR development subject matter experts (SME).

3.14.1. DoD Program Offices (range users) regardless of range used, will work with AFSEC/SES to request the INSRB evaluation, coordinate a mission specific review plan, and establish the cost and milestones of the evaluation. **(T-0)** This process normally begins 3-5 years prior to launch.

3.15. Tier Determination. DAF range users using any range and DoD range users using DAF ranges will follow the Tier determination process described in this section. **(T-1)** NASA or other government (non-DoD) range users using DAF ranges use the Tier determination process established by the sponsoring government agency. Commercial range users using DAF ranges follow the FAA Tier determination process. Ranges will accept the Tier determination of NASA or other government range users and commercial range users as presented by those government sponsors or the FAA license. **(T-1)** AFSEC/SES will determine the Tier for all DAF sponsored missions as well as all DoD missions using DAF ranges. **(T-1)**

3.15.1. Tier Determination takes place after the safety analysis and evaluation or review is final and before a request for launch authorization. Range user or program office will send a tier recommendation letter to AFSEC/SES. **(T-1)** This should take place at a time agreed upon between with AFSEC/SES and the range user. **(T-1)** The tier recommendation letter will include justification for the recommendation. **(T-1)** AFSEC/SES will validate the recommendation and make a tier determination. A Tier determination letter will then be added to the launch authorization request and sent to SECDEF (or his/her designee). The Launch

Authorization Authority for the tier may confirm the tier determination when considering launch authorization. Tier projections should be made early in a program based on the A2 multiple. However, tier projections should be reevaluated periodically as the safety analysis progresses to ensure all other tier requirements are met. It is possible for a mission's tier projection to change tiers as the safety analysis refines calculations on the probability of exposure.

3.15.2. Non-tiered missions do not require a tier determination, but do still require calculation of the A2 multiple to justify the exclusion from tier determination. **(T-1)** The Range Safety Office will determine the requirements of non-tiered missions based on the quantity of radioactive material and its A2 multiple. **(T-1)** If a non-tiered mission may challenge the Tier II or Tier III probability of exposure thresholds, AFSEC/SES must be notified as early as possible. **(T-1)**

3.16. Radiological Risk Management. The Program Office (range users) manages radiological risk in accordance with applicable regulations. The Program Office (range users) or equivalent sponsor of a DAF mission will manage the mission radiological risks in accordance with the safety risk management guidance within AFI 91-202 (AFI 91-202, Ch. 11 System Safety & Safety Risk Assessments) for all phases of the mission including development. **(T-1)** Other DoD Program Offices (range users) or equivalent sponsors using a DAF range will follow their respective system safety risk management guidance. **(T-1)** NASA or other non-DoD government range users using a DAF range follow the sponsoring agencies internal processes for radiological risk management and coordinate with range RSO for proper handling while the RAM is on the DAF range. The appropriate acceptance authority must formally accept known risks prior to exposing people, equipment, or the environment to the radiological hazard at all stages of the system's lifecycle. **(T-1)** At a minimum, the mission risk must be compared to the Safety Guidelines set out in **paragraph 3.22** of this manual throughout the lifecycle of the mission. **(T-1)** Range users may request support from the Range Safety Office or AFSEC/SES to understand launch risk associated with using radioactive material.

3.17. Launch Authorization. ("Approval" and "Authorization" are used interchangeably throughout the DAFMAN)**.**

Table 3.3. LAA Requirements for Launch Authorization for DAF Missions.

Tiers		**Launch Authorization Request Requirements***	**Coordinated Through**	**When request must be received by LAA**	**Designated LAA***
Non-Tiered Missions	Accepted Analyses	- NEPA	N/A	N/A	N/A
	≥ A2×0.001 to < A2	- NEPA	Internal PO coordination	N/A	PM**
	≥ A2 to < A2×500	- NEPA - NSR	Internal PO coordination	N/A	PEO**
	≥ A2×500 to < A2×1,000	- NEPA - SAS - NSR	Internal PO coordination	N/A	CAE**
Tiered Missions	Tier I	- NEPA - SAR - NSR	- AFSEC/SES - DoD Component Heads	NLT 6 months prior to launch	SECDEF

Tiers		Launch Authorization Request Requirements*	Coordinated Through	When request must be received by LAA	Designated LAA*
		- Safety Assessment if required - DoDI 3100.12 requirements - Alternative power sources - Impact on mil/intel - Overall risks to U.S.			
	Tier II	- NEPA - SAR - SER - DoDI 3100.12 requirements - Alternative power sources - Impact on mil/intel - Overall risks to U.S.	- AFSEC/SES - DoD Component Heads	NLT 6 months prior to launch	SECDEF
	Tier III	- NEPA - SAR - SER - DoDI 3100.12 requirements - Alternative power sources - Impact on mil/intel - Overall risks to U.S.	- AFSEC/SES - DoD Component Heads - SECDEF - APNSA	NLT 6 months prior to launch	President of the United States
*The Launch Authorization Authorities (LAA) and requirements are the same for DoD & Intel missions using DAF ranges. **The LAA for DAF non-tiered missions at non-DAF ranges are the same as at DAF ranges.					

3.17.1. The authorization for the launch of a particular mission using radioactive material has three authorities; the Program Office (or range user), the Launch Authorization Authority, and the Space Launch DEL/CC.

3.17.1.1. The Program Office (PO), range user, mission owner, or equivalent of a particular mission has the responsibility for identifying the mission radiological risk, accepting it, and providing a decision as to whether or not to proceed with the mission. **(T-1)** In addition to the launch authority described in this paragraph the PO may also provide the Launch Authorization Authority for non-tiered missions described in the next paragraph.

3.17.1.2. Launch Authorization Authority (LAA) is designated by the NSPM-20 or this DAFMAN (see paragraph **3.17.2** and **3.17.3**). **(T-0)** The LAA for tiered and non-tiered missions are responsible for assessing the total radiological risk of a mission, ensuring that safety guidelines are followed, and providing written launch authorization. **(T-0)** The LAA is the minimum risk acceptance authority for the mission's radiological risk. **(T-0)** This authorization includes the end of life plan of the radioactive material such as a planned disposal orbit or return of radioactive material to Earth (see **Table 3.3**). **(T-0)**

3.17.1.3. Space Launch Delta Commander (DEL/CC) or equivalent has responsibility for the safety of the people, environment, and operations of their range. **(T-1)** The DEL/CC determines launch authorization after assessing the launch radiological risk and after all other launch authorization requirements are met, such as receiving authorization from the LAA (see Tables **3.4** and **3.5**). **(T-1)**

3.17.2. Non-tiered Mission Authorization. LAA for DAF missions comes from the Program Office's acquisition chain of command. The program uses Radiological Risk Management (see **paragraph 3.16**) to identify the radiological risk involved in using radiological material for the life of the mission including mishaps during launch, normal operations, reentry, disposal etc. Non-tiered missions that have an Accepted Launch Safety Analyses (see **paragraph 3.19**) do not require additional authorization from a LAA.

3.17.2.1. LAA for non-tiered missions:

3.17.2.1.1. For a mission that carries RAM that is equal to or more than A2 × 0.001 the Program Manager (PM) or equivalent is the minimum LAA. **(T-1)**

3.17.2.1.2. For a mission that carries RAM that is equal to or more than A2 the Program Executive Officer (PEO) or equivalent is the minimum LAA. **(T-1)**

3.17.2.1.3. For a mission that carries RAM that is equal to or more than A2 × 500 the Component Acquisition Executive (CAE) or equivalent is the minimum LAA. **(T-1)**

3.17.2.2. Non-DoD government missions use their internal process and internal LAA for obtaining launch authorization for non-tiered missions.

3.17.3. LAA for Tiered Missions. LAA for Tiered missions is established in NSPM-20.

3.17.3.1. The SECDEF (or his/her designee) is the Tier designated Launch Authorization Authority for all DoD Tier I and Tier II missions. **(T-0)**

3.17.3.2. The sponsoring government agency head (or as delegated) is the tier designated LAA for all other government Tier I and Tier II missions. **(T-0)**

3.17.3.3. The President of the United States, through APNSA, is the tier designated LAA for all DoD and intelligence agency Tier III missions. **(T-0)**. The Director of OSTP or the President is the tier designated LAA for all other government agency Tier III missions.

3.17.3.4. A commercial tiered mission must have a License to Launch Space Nuclear Systems issued by the FAA to launch radioactive material from DAF ranges. This license provides the LAA required to launch a tiered mission.

3.18. Requests for Launch Authorization. See Tables **3.3, 3.4,** and **3.5** DAF range users and DoD range users using DAF ranges will follow the process for requesting launch authorization discussed in this section. **(T-1)** NASA and other government range users using DAF ranges follow internal procedures for requesting launch authorization. The range user will provide a launch authorization letter from the appropriate LAA to the Space Launch DEL/CC through the Range Safety Office not later than ten days prior to launch. **(T-1)** Commercial range users will follow FAA licensing procedures and deliver the appropriate license to the Range Safety Office not later than ten days prior to launch. **(T-1)**

Table 3.4. DEL/CC Launch Authorization Requirements for NASA/Government (Non-DoD) Missions at DAF Ranges.

Tiers		Required for DEL/CC Approval	Delivered to DEL/CC through	When LAA Authorization must be received by DEL/CC	Designated LAA
Non-Tiered Missions	Accepted Launch Safety Analyses	- NEPA	N/A	N/A	N/A
	> A2×0.001 to < A2×1,000	- LAA Authorization - NEPA - SAS if required* - Contingency Plan	- Range Safety Office	NLT 10 days prior to launch	Per sponsor's internal regulations
Tiered Missions	Tier I	- LAA Authorization - NEPA - SAR* - Contingency Plan	- Range Safety Office - AFSEC/SES	NLT 10 days prior to launch	Head of Agency/Dept. or as delegated
	Tier II	- LAA Authorization - NEPA - SAR* - SER - Contingency Plan	- Range Safety Office - AFSEC/SES	NLT 10 days prior to launch	Head of Agency/Dept. or as delegated
	Tier III	- LAA Authorization - NEPA - SAR* - SER - Contingency Plan	- Range Safety Office - AFSEC/SES	NLT 10 days prior to launch	OSTP or The President of the United States
*Including Risk Constraint, Contamination Impact Statement, and Safety Guidelines					

3.18.1. Non-tiered, DAF sponsored mission requests for LAA authorization will be made in accordance with the range user's internal process. **(T-2)** The range users are responsible for obtaining launch authorization from the appropriate LAA. **(T-1)** Authorization for non-tiered DAF missions will come from the DAF Program Office as a letter signed by the appropriate LAA stating that the program followed the appropriate risk acceptance procedures, identified the radiological risk of all phases of the mission, implemented appropriate mitigations, and authorizes it for launch. **(T-1)** The DAF range user will provide the launch authorization letter to the DEL/CC through the Range Safety Office not later than ten days prior to launch. **(T-1)** If the mission is using a non-DAF range, the authorization letter will still be provided to the range's safety office. **(T-1)**

Table 3.5. DEL/CC Launch Authorization Requirements for DAF Missions at DAF Ranges.

Tiers		Required for DEL/CC Approval*	Delivered to DEL/CC through	When LAA Authorization must be received by DEL/CC	Designated LAA*
Non-Tiered Missions	Accepted Launch Safety Analyses	- NEPA	N/A	N/A	N/A

Tiers		Required for DEL/CC Approval*	Delivered to DEL/CC through	When LAA Authorization must be received by DEL/CC	Designated LAA*
	> A2×0.001 to < A2×1,000	- LAA Authorization - NEPA - NSR if required - SAS if required*** - Contingency Plan	- Range Safety Office	NLT 10 days prior to launch	PM, PEO, or CAE as required** (See Table 3.3)
Tiered Missions	Tier I	- LAA Authorization - NEPA - SAR*** - NSR - Contingency Plan	- Range Safety Office - AFSEC/SES	NLT 10 days prior to launch	SECDEF
	Tier II	- LAA Authorization - NEPA - SAR*** - SER - Contingency Plan	- Range Safety Office - AFSEC/SES	NLT 10 days prior to launch	SECDEF
	Tier III	- LAA Authorization - NEPA - SAR*** - SER - Contingency Plan	- Range Safety Office - AFSEC/SES	NLT 10 days prior to launch	President of the United States
*The Launch Authorization Authorities (LAA) and requirements are the same for DoD & Intel missions using DAF ranges. **The LAA for DAF non-tiered missions at non-DAF ranges are the same as at DAF ranges. ***Including Risk Constraint, Contamination Impact Statement, and Safety Guidelines					

3.18.2. Tiered DAF sponsored mission requests for launch authorization will be made by the range user or Program Office to the LAA through the appropriate offices in accordance with NSPM-20, DoDI 3100.12, and this DAFMAN. **(T-1)**

3.18.2.1. Requests for launch authorization shall:

3.18.2.1.1. Include the appropriate environmental impact analysis, the required safety analysis report (SAR), and if required the safety evaluation report (SER) in accordance with DoDI 3100.12. **(T-0)**

3.18.2.1.2. Address, at a minimum, alternative satellite power sources capable of performing the mission, the impact on military, and intelligence activities, and overall risks and benefits to U.S. national security interests in accordance with DoDI 3100.12. **(T-1)**

3.18.2.1.3. Be coordinated through AFSEC/SES, who will include a tier determination letter and safety assessment if required. **(T-1)**

3.18.2.1.4. Request launch authorization from SECDEF (or his/her designee) through the DoD component heads in accordance with DoDI 3100.12 **(T-1)** DoD agency heads who do not report to military component heads request launch authorization directly from SECDEF (or his/her designee). **(T-1)**

3.18.2.1.5. Be delivered to SECDEF (or his/her designee) no later than six months prior to launch. **(T-1)**

3.18.3. SECDEF (or his/her designee) coordinates requests for launch authorization with the applicable offices at the Pentagon and as appropriate the Secretaries of the Military Departments in accordance with DoDI 3100.12. SECDEF (or his/her designee) will forward DoD launch authorization requests for Tier III missions to APNSA and President of the United States in accordance with NSPM-20. The signed launch authorization request will normally be delivered to the range user, AFSEC/SES, the Range Safety Office, and the DEL/CC no later than ten days prior to launch.

3.19. Accepted Launch Safety Analyses. The Accepted Launch Safety Analyses is a list that includes space nuclear systems (SNS) or quantities of specific radioisotopes that based on experience and technical justification are authorized for launch without additional safety analyses, a NSR, or authorization from a LAA. The Accepted Launch Safety Analyses list is maintained by AFSEC/SES. The Accepted Launch Safety Analyses list will only include SNS and radioisotope quantities that are less than A2 × 1000. In order to be added to the Accepted Launch Safety Analyses list, an SNS or quantity of radioisotope must have a safety analysis that shows that the severity of a mishap involving the SNS or quantity of radioisotope in question is negligible. Accepted Launch Safety Analyses will not apply to missions using both sources listed in the Accepted Launch Safety Analyses list and sources not listed in the same document without the concurrence of AFSEC/SES. **(T-1)**

3.20. Radiological Risk Review. Radiological Risk Review is a commander's tool used to understand the radiological risk of a given mission. The Space Launch DEL/CC, with the Range Safety Office conducts the Radiological Risk Review prior to launch. **(T-3)** The Radiological Risk Review is conducted for any mission carrying radioactive material but the depth of the review will be consistent with the degree of radiological risk. **(T-3)** It is important that the DEL/CC understands the radiological risk of a mission to the people, environment, assets, and operations of the range prior to providing launch authorization. The Radiological Risk Review may be accomplished as part of the Launch Readiness Review or earlier.

3.20.1. Radiological Risk Review may include the following:

3.20.1.1. The types and quantities of radiological materials on board the missile or launch vehicle, payload, containment systems, and safety systems as deemed necessary.

3.20.1.2. Ensure launch has the appropriate safety analysis and review as required.

3.20.1.3. Review radiological risk of the launch to the public, environment, and operations as appropriate.

3.20.1.4. Compare the mission's risk with the Risk Constraint and Safety Guidelines.

3.20.1.5. Ensure the launch has obtained the required LAA or the appropriate FAA license.

3.20.1.6. Review radiation safety and contingency plans in place for the mission, to include coordination with external agencies, regarding contingency, mitigation, response, recovery, and clean up as appropriate.

3.21. Risk Constraint. The risk constraint is intended to provide the range Space Launch DEL /CC and other launch decision authorities with a succinct radiological risk estimate that will help them to make an informed decision on the radiological safety of a given mission. The risk constraint to a member of the general public shall not exceed an individual Probability of Cancer Casualty (P_{CancerC}) of 1×10^{-6} (one in one million) with a confidence level of 90%. **(T-1)** This

carries with it an overall mean maximum individual effective dose goal of less than or equal to 0.1 rem or 100 millirem (mrem) per mission. For non-commercial missions, the range user shall provide the Range Safety Office the mission's $P_{CancerC}$ calculation with confidence level, the mean maximum individual effective dose, and the necessary information for a Contamination Impact Statement. **(T-1)** This constraint will be applied to missions using radioactive material greater than or equal to A2 or using a fission device. **(T-1)** The constraint can be calculated as part of the safety analysis process. The calculated constraint will be evaluated by the Range Safety Office, AFSEC/SES, and the INSRB as appropriate and will be reviewed by the Space Launch DEL/CC and the designated LAA as part of the launch authorization process. **(T-1)** It is recommended (but not required) that commercial range users provide in their safety analysis sufficient information to allow the Range Safety Office to calculate $P_{CancerC}$ if the calculation is not included in their safety analysis or license package.

3.21.1. $P_{CancerC}$. Assess the $P_{CancerC}$ as 1.2 times the Probability of a Latent Cancer Fatality (P_{LCF}). **(T-1)** This value provides the $P_{CancerC}$ associated with a projected 50-year cumulative increase in risk for fatal and non-fatal cancers (i.e., a casualty). This $P_{CancerC}$ is not aggregated with other mission risks. **(T-1)** General public risk that exceeds a $P_{CancerC}$ of 1×10^{-6} requires the Space Launch DEL/CC waiver approval. **(T-1)** When the general public risk exceeds a $P_{CancerC}$ of 100×10^{-6}, FLDCOM Commander or equivalent approval is required. **(T-1)** The DEL/CC shall notify AFSEC/SES before allowing launches that exceed a $P_{CancerC}$ of 1×10^{-6}. **(T-1)** See **Attachment 4** for calculation process examples.

3.21.2. Dose Goal. The overall mean maximum individual effective dose is the mean of the calculated maximum effective doses, based on various launch vehicle failure modes resulting in release of radioisotopes, received by the maximally exposed individual for a given mission. Each mission should not exceed the overall mean maximum individual total effective dose goal of 100 mrem. **(T-3)** However, if a mission exceeds the dose goal, the Space Launch DEL/CC may approve the launch after additional safety analysis. The DEL/CC must consider how the additional radiological risk contributes to the overall launch risks, any additional safety analyses, and contingency plans. **(T-3)** This includes but is not limited to the impacts of planned mitigation efforts and target organs of the mission radioisotopes. **(T-3)**

3.21.3. Contamination Impact Statement. A contamination impact statement estimates radiological risk to range assets and operations beyond the immediate exposures at the time of the mishap required to be considered per AFI 91-202 Sec. 10.7.2.1. The range user will provide the estimates of range contamination levels under credible scenarios and other information deemed necessary to the Range Safety Office. **(T-3)** The Range Safety Office will prepare the contamination impact statement for the Space Launch DEL/CC. **(T-3)**

3.21.3.1. The inputs for a contamination impact statement may be provided as part of a SAS or a SAR. At a minimum the range user will provide the following inputs for the contamination impact statement, in coordination with the Range Safety Office:

3.21.3.1.1. Isotopic composition. **(T-3)**

3.21.3.1.2. Estimate of material at risk. **(T-3)**

3.21.3.1.3. Estimated aerodynamic median diameter for released radioactive particles. **(T-3)**

3.21.3.1.4. Scenario describing how the material will be released, e.g., fire, explosion, criticality. **(T-3)**

3.21.3.1.5. Probability of release during phases when the range is at risk (through Phase 1). **(T-3)**

3.21.3.2. The Range Safety Office, with this information, can then factor the impact to scheduled operations and assets predicted to be present during the launch window. The contamination impact statement may include estimates of the area of impact, duration of impact, contingency plans, costs of recovery, and recovery options. **(T-3)** See **Attachment 5** for instructions on preparing an impact statement.

3.22. Safety Guidelines. The NSPM-20 safety guidelines consists of the following.

3.22.1. All United States Government entities involved in the launch of spacecraft containing RAM (including in the licensing of non-Government launches) shall seek to ensure safe operation. **(T-0)** For any mission that includes RAM, mission planners and launch authorization authorities should, as appropriate, seek to ensure that **(T-0)**:

3.22.1.1. Normal operation of the space nuclear system or the use of RAM in a space system is consistent with applicable Federal, State, and local requirements. **(T-0)**

3.22.1.2. A mishap resulting in exposure in excess of 25 millirem but less than 5 rem total effective dose (TED) to any member of the public is unlikely, such that the probability of such an event does not exceed 1 in 100. **(T-0)**

3.22.1.3. A mishap resulting in exposure in the range of 5 rem to 25 rem TED to any member of the public is extremely unlikely, such that the probability of such an event does not exceed 1 in 10,000. **(T-0)**

3.22.1.4. The probability of a mishap resulting in exposure in excess of 25 rem TED to any member of the public does not exceed 1 in 100,000. **(T-0)**

3.22.1.5. The operation of space nuclear systems (SNS) follows the safety guidelines found in the SPD-6, to include the following:

3.22.1.5.1. The operation and disposition of SNS systems shall be planned and conducted in a manner that protect human and environmental safety and national security assets. **(T-0)**

3.22.1.5.2. Fission reactor SNS systems may be operated on interplanetary missions, in sufficiently high orbits, and in low-Earth orbits if they are stored in sufficiently high orbits after the operational part of their mission. **(T-0)** A sufficiently high orbit is one in which the orbital lifetime of the spacecraft is long enough for the fission products to decay so that by the time it reenters the Earth's atmosphere the risk to the biosphere is acceptable and the risks to existing and future space missions, and of collision with objects in space are minimized. **(T-0)**

3.22.1.5.3. Spacecraft operating fission reactors or other SNS in low-Earth orbits shall incorporate a highly reliable operational system to ensure effective and controlled disposition of the radioactive materials. **(T-0)**

3.22.2. These safety guidelines apply to all missions using radioactive material per NSPM-20. **(T-0)** Missions required to provide a SAS or SAR must compare the missions safety to the

safety guidelines in the safety analysis. **(T-1)** The public exposure safety guidelines will be calculated as part of the safety analysis process. **(T-1)** The calculated safety guidelines will be evaluated by the Range Safety Office, AFSEC/SES, and the INSRB as appropriate and will be reviewed by the Space Launch DEL/CC and the designated LAA as required. **(T-1)** For missions that do not require a SAS or SAR the Range Safety Office may require the range user to calculate the probability of exposure to a member of the public, to be measured against these Safety Guidelines.

3.23. Member of The Public. The dose guidelines introduced in **paragraph 3.22** and **paragraph 3.21** apply to members of the public, but the implication is that this is a dose to the maximally exposed individual. Therefore, all individuals on a DAF range or installation are to be treated as Members of the Public when calculating the exposure probabilities for Tier Determination, the Risk Constraint, and Safety Guidelines. **(T-3)** The DEL/CC or Wing/CC in coordination with the range user may authorize the exclusion of Neighboring Operations Personnel or Launch Essential Personnel as Members of the Public when calculating exposure probabilities.

3.24. Radiological Contingency Planning. The range user will develop mission radiological contingency plans for launch-related radiological mishaps that are commensurate with the radiological risk and provide the plans to the Range Safety Office. **(T-1)** This safety and contingency planning process will include coordination with the appropriate agencies (e.g., Range, DOE, DHS, NASA, NRC, Navy, FAA, EPA, etc.) for response, recovery, and clean-up as applicable. **(T-1)**. The Range Safety Office and RSO will participate in the range user's contingency planning as needed and DEL/CC will review the radiological contingency plan when conducting the Radiological Risk Review and when considering launch approval. **(T-3)** The range will develop range radiological contingency plans for radiological mishaps at the range but the range user is responsible for developing a radiological contingency plan for their sponsored mission. **(T-1)**

3.25. Technical Support. The range user will provide technical support to Range Safety Office, AFSEC/SES and INSRB. **(T-1)** This support will be provided as necessary to conduct a safety overview, NSR, or INSRB evaluation. **(T-1)** In the case of a SAR, the technical support will be provided as early as possible in the development or acquisition phase of the program to inform the independent safety reviewers or evaluators of the mission profile, the science, technology, and methods used to conduct the safety analysis as it is accomplished. **(T-1)** The National Environmental Policy Act (NEPA) process documentation; preliminary, draft, and final SARs; and associated Technical Interchange Meetings (TIM) normally provide much of the necessary technical support required; however, in addition to these documents and meetings, if requested or if the information is relevant to the safety review, the range user will provide:

3.25.1. Initial range user's estimates, test plans, analyses, and results to Range Safety Office at the end of the NEPA review process or three years from the intended launch window, whichever is later for tiered missions and in a timely manner for non-tiered missions. **(T-1)**

3.25.2. Ongoing access to any information, design, tests, analyses, results, data, references, methods, models or reports used to support safety analysis findings. **(T-1)**

3.25.3. Documentation on specifications of any subsystems designed to eliminate or minimize release of radioisotopes in launch mishap scenarios (e.g., overpressure, impact, thermal, reentry environments) **(T-1)** Allow the Range Safety Office, AFSEC/SES, or INSRB to review design changes and testing of these systems. **(T-1)** Provide the Range Safety Office with any

test plans, reports, test failures, and design reviews associated with containment subsystems, in a timely manner, to allow the reviewers to understand and evaluate the information, technology, and the most current science related to the safety of the launch. **(T-1)**

3.25.4. Regular updates, as agreed upon, to Range Safety Office, AFSEC/SES or INSRB as tests and analyses are conducted and the range user finalizes results. **(T-1)**

3.25.5. Answers to questions or requests for data from Range Safety Office, AFSEC/SES or INSRB within 30 calendar days of request. **(T-1)**

3.25.6. Host TIMs. **(T-1)** TIMs include the subject matter experts from the mission's program office, those conducting the safety analysis, and those conducting the safety review or evaluation of the analysis. The subjects of these TIMs may include nuclear systems, spacecraft, launch vehicle, safety subsystems, overall risk, and mishap hazards including overpressure, impact, thermal, reentry, and others as requested by Range Safety Office, AFSEC/SES, or INSRB.

3.26. AFSEC/SES Contact Information.

3.26.1. AFSEC/SES email box: **AFSEC.SES@us.af.mil**

3.26.2. Web page: **https://www.safety.af.mil/Divisions/Space-Safety-Division/**

3.26.3. Phone numbers: (505) 853-1945 or (505) 846-8074

3.26.4. AFSEC/SES can provide classified means of communication when requested.

JEANNIE M. LEAVITT, Major General, USAF
Chief of Safety

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

National Security Presidential Memorandum #20 (NSPM-20), *Launch of Spacecraft Containing Space Nuclear Systems*, dated 20 August 2019

DoDD 3100.10, *Space Policy*, 18 October 2012

DoDD 3200.11, *Major Range and Test Facility Base*, 27 December 2007

DoDI 3100.12, *Space Support*, 14 September 2000

DoDM 3145.03, *DoD Chemical, Biological, and Radiological Clearance Guidance for Platforms and Materiel*, 8 May 2019

AFPD 91-1, *Nuclear Weapons and Systems Surety*, 24 October 2019

AFMAN 48-148, *Ionizing Radiation Protection*, 20 July 2020

AFI 91-202, *The US Air Force Mishap Prevention Program*, 12 March 2020

AFMAN 40-201, *Radioactive Materials (RAM) Management*, 29 March 2019

DAFI 33-360, *Publications and Forms Management*, 1 December 2015

AFI 33-322, *Records Management and Information Governance Program*, 23 March 2020

10 Code of Federal Regulations Part 835.2, *Occupational Radiation Protection*

Title 42, United States Code, §§4321-434, *National Environmental Policy Act*

IAEA SSR-6, *Regulations for the Safe Transport of Radioactive Material, Specific Safety Requirements*, International Atomic Energy Agency (IAEA), Safety Standards No. SSR-6, 2018 Edition

Space Policy Directive-6 (SPD-6), *Memorandum on the National Strategy for Space Nuclear Power and Propulsion*, dated 16 December 2020

ICRP-60, *1990 Recommendations of the International Commission on Radiological Protection*, Annuals of the ICRP, Publication 60, 1991

ICRP-103, *The 2007 Recommendations of the International Commission on Radiological Protection*, Annuals of the ICRP, Publication 103, 2007

Specific Safety Guide No. 26 (SSG-26), *Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material* (2012 Edition), IAEA, 2012.

Adopted Forms

Air Force Form 847, *Recommendation for Change of Publication*

Prescribed Forms

None

Abbreviations and Acronyms

AFI—Air Force Instruction

AFMAN—Air Force Manual

AFPD—Air Force Policy Directive

AF/SE—Department of the Air Force Chief of Safety

AFSEC—Department of the Air Force Safety Center

AFSEC/SES—Air Force Safety Center, Space Safety Division

AIC—accident initiating conditions

APNSA—Assistant to the President for National Security Affairs

Bq—becquerel

CAE—Component Acquisition Executive

Ci—Curies

DAF—Department of the Air Force

DAFI—Department of the Air Force Instruction

DAFMAN—Department of the Air Force Manual

DEL/CC—Space Launch Delta Commander

DHS—Department of Homeland Security

DoD—Department of Defense

DoDD—Department of Defense Directive

DoDI—Department of Defense Instruction

DOE—Department of Energy

DOS—Department of State

DOT—Department of Transportation

dpm—Disintegrations per minute

DRU—Direct Reporting Unit

EIS—Environmental Impact Statement

EPA—Environmental Protection Agency

FAA—Federal Aviation Administration

FLDCOM—Field Command

HE—health effects

HQ AF/SEC—Headquarters Air Force Safety Center

IAEA—International Atomic Energy Agency

ICRP—International Commission on Radiological Protection

INSRB—Interagency Nuclear Safety Review Board

LAA—Launch Authorization Authority

MAJCOM—Major Command

MBq—Megabecquerel

MID—maximum individual dose

mrem—millirem or one thousandth of a rem

mSv—milli Sievert or one thousandth of a Sievert

NASA—National Aeronautics and Space Administration

NEPA—National Environmental Policy Act

NLT—Not Later Than

NRC—Nuclear Regulatory Commission

NSPM-20—National Security Presidential Memorandum #20

NSR—Nuclear Safety Review

NSTC—National Science and Technology Council

OPR—Office of Primary Responsibility

OSTP—Office of Science and Technology Policy

PA—probability of an accident

PCancerC—probability of cancer casualty

PEO—Program Executive Officer

PLCF—probability of latent cancer fatality

PM—Program Manager

PO—Program Office

PR—conditional probability of release

PTR—total probability of release

RAM—Radioactive Material

rem—roentgen equivalent man

RHU—Radioisotope Heater Units

RPS—Radioisotope Power Systems

RSO—Radiation Safety Officer

RTG—Radioisotope Thermoelectric Generators

SAR—Safety Analysis Report

SAS—Safety Analysis Summary

SECDEF—Secretary of Defense

SER—Safety Evaluation Report

SME—Subject Matter Expert

SNPP—Space Nuclear Power and Propulsion

SNS—Space Nuclear Systems

SPD—Space Policy Directive

SPO—System Program Office

SRS—Space Reactor Systems

TBq—Terabecquerel

TED—Total Effective Dose

TIM—Technical Interchange Meeting

US—United States

Terms

A2 Value—A2 means the maximum activity of Class 7 (radioactive) material, other than special form material, low specific activity material, and surface contaminated objects, permitted in a Type A package (see **paragraph 3.1**).

Biosphere—The Earth and its environment. The regions of the surface, atmosphere, and hydrosphere of the Earth occupied by living organisms.

Contamination—The deposition of, or presence of, radioactive material where its presence is unintended or undesirable. A surface or object is considered contaminated if measurement indicates that the values for total activity in Table 2 of DoD Manual 3145.03 are exceeded. (From AFMAN 48-148)

Contingency Planning (Radiological Contingency Planning)—A course of action designed to help an organization respond to a radiological mishap that can reasonably be anticipated (see **paragraph 3.23**).

Launch Essential Personnel—The minimum number of persons necessary to successfully and safely complete an operation and whose absence would jeopardize the completion of the operation. This includes persons required to perform emergency actions according to authorized directives, persons specifically authorized by the Space Launch Delta Commander/System Program Office (SPO) Director to perform scheduled activities, and persons in training. The number of mission-essential personnel allowed within Safety Clearance Zones or Hazardous Launch Areas is determined by the Space Launch Delta Commander, SPO Director and the Range User with Range Safety concurrence. (From AFI 91-202)

Launch Radiological Risk—The radiological risk of a launch from pre-launch to orbital insertion of the spacecraft or completion of a suborbital launch system. This is a subset of Mission Radiological Risk (see *Mission Radiological Risk*).

Launch-related Radiological Mishaps—A mishap or postulated mishap involving a quantity of RAM ≥A2 × 0.001 after it is mated to or installed in a launch vehicle but before it reaches orbital insertion.

Launch Vehicle—Any means of transportation used to place an object into Earth orbit or deep space, including suborbital missiles that pass through space. (From AFI 91-202)

Mission—"A mission" in this DAFMAN includes the launch vehicle and all spacecraft or payloads on the launch vehicle, as used in NSPM-20.

Mission Radiological Risk—The radiological risk of a mission for all mission phases from development to end of life (i.e., recovery, permanent disposal, reentry, Earth impact, etc.). This includes Launch Radiological Risk (See *Launch Radiological Risk*).

Member Of The Public—Any individual except when that individual is receiving an occupational dose (see O*ccupational Dose*). (From AFMAN 48-148)

Neighboring Operations Personnel—**(**See *Launch Essential Personnel*) Individuals required to perform safety, security, or operationally critical tasks but not associated with the specific/current operation or launch under consideration. (From AFI 91-202)

Nuclear Safety Review—Is an assessment conducted by the Range Safety Office or AFSEC/SES of the safety products provided by the range user (see **paragraph 3.12**).

Occupational Dose—The dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to radiation or to RAM from regulated and unregulated sources of radiation, whether in the possession of the licensee or other person. Occupational dose does not include dose received from background radiation; from any medical administration the individual has received; from exposure to patients administered RAM and are properly released/discharged; from voluntary participation in medical research programs; or as a member of the public. (From AFMAN 48-148)

Program Office (PO) (*System Program Office [SPO]*)—Refers to the organization that owns, sponsors, or manages a mission. The PO may act as the range user who complies with the requirements of this manual.

Radiation Safety Officer (RSO)—The person that the commander designates, in writing, as the person responsible for the installation, organization, or unit radiation safety program. (From AFMAN 48-148)

Radiation Worker—An individual who may be occupationally exposed (see *Occupational Dose*) to ionizing radiation in the course of their duties or designated by the RSO. (From AFMAN 48-148)

Radioactive Material (RAM)—Material with nuclei, because of their unstable nature, that decay by emission of ionizing radiation. The radiation emitted may be alpha particles, beta particles, gamma rays, X-rays, or neutrons. (From AFMAN 40-201)

Radionuclide *(or Radioisotope)*—An unstable isotope of an element that decays or disintegrates spontaneously, thereby emitting radiation. (From AFMAN 40-201)

Range User—The organization that sponsors or owns a mission and holds primary responsibility for radiological safety of the mission per Memorandum on the National Strategy for Space Nuclear Power and Propulsion (SPD-6). DAF range users can be the System Program Office (SPO) or

Program Office sponsoring the mission. The organization that arranges for a mission to be placed on a range's launch schedule is considered the range user and expected to meet the requirements of this manual unless other arrangements are made with the range.

Risk Constraints—Safety thresholds established by this DAFMAN that must be considered by the Space Launch Delta Commander prior to authorizing a launch carrying RAM or a reactor (see **paragraph 3.21**).

Safety Analysis Summary (SAS)—A study of a mission's radiological safety risk conducted by the range user or Program Office (see **paragraph 3.9**).

Safety Guidelines—Guidelines established in NSPM-20 for the safe use of RAM and SNS in space which must be considered at all levels of a mission's development and authorization (see **paragraph 3.22**).

Spacecraft—An object designed to perform some function in space. This includes satellites and Human Space Flight objects in space. This term can also refer to the object while it is still on the ground. This does NOT include launch vehicle components separated from the spacecraft. (From AFI 91-202) For the purposes of this manual, the spacecraft includes both the spacecraft's bus and payloads.

Space Nuclear Systems (SNS)—Space nuclear systems are a system that use RAM to provide heat, power, or propulsion for a space system. Space nuclear systems include radioisotope power systems (RPSs), such as radioisotope thermoelectric generators (RTGs) and radioisotope heater units (RHUs). RPSs are systems that utilize heat from radioactive decay to either keep equipment from freezing or convert heat into electric power. Space nuclear system also include space reactor systems (SRS) and space nuclear propulsion, which are powered by nuclear fission. (From: NSPM-20 & DOE's *Joint DOE/DoD/NASA Classification and Unclassified Controlled Nuclear Information Guide for Space Nuclear Systems* [CG-SNS-1])

Space Systems—All the devices and organizations forming the space network. These consist of: launch vehicles; launch ranges; launch and range support equipment and systems; spacecraft; ground and airborne stations; and data links among spacecraft, mission, and user terminals. (From AFI 91-202)

Total Effective Dose (TED)—The sum of the effective dose (for external exposures) and the committed effective dose as defined in section 835.2 of title 10, Code of Federal Regulations.

Attachment 2

CALCULATION OF THE A2 VALUE

A2.1. A2 Calculation. Compliance with this attachment is mandatory. **(T-1)** The A2 multiple of a radioactive material present aboard a launch vehicle may determine the requirements or tier for a given mission.

A2.2. Single Isotope Missions.

A2.2.1. For missions that only involve a single radioisotope, determine the total activity present.

A2.2.2. Compare this activity to the documented A2 value in IAEA SSR-6 Table 2 (**Figure A2.1**). In the case where the A2 value is not provided in IAEA SSR-6 Table 2 for the radionuclide, utilize the appropriate value based on isotopic emissions from IAEA SSR-6 Table 3.

Figure A2.1. A2 Multiple Equation.

$$A2\ Multiple = \frac{Total\ Activity\ Aboard}{A2\ Value}$$

A2.2.3. Once the A2 multiple has been determined, evaluate against the thresholds as presented in IAEA SSR-6 Table 3.1.

A2.3. Mixed or Several Isotope Missions. When using several sources or a mixture of isotopes on a launch vehicle or spacecraft, the A2 multiple will be determined using the mixed isotope equation in **Figure A2.2**. **(T-0)**

Figure A2.2. Mixed Isotope Equation.

$$X_m = \sum_i \frac{a(i)}{X(i)}$$

Where: $a(i)$ is the activity or activity concentration of radionuclide i
$X(i)$ is the A2 value for radionuclide i
X_m is the derived A2 multiple for the mixture

A2.3.1. In the case where the A2 value is not provided in IAEA SSR-6 Table 2 for radionuclide *i*, utilize the appropriate value based on isotopic emissions from IAEA SSR-6 Table 3 for radionuclide *i*. **(T-1)**

A2.3.2. Example: (**Note**: All values presented here are just for example calculations purposes and bear no relation to an actual mission.)

A2.3.2.1. The program sponsor provides the following regarding the radioactive inventory (**Figure A2.3**):

Figure A2.3. Mixed Isotope Example.

- 4000 Megabecquerel (MBq) Pu-238 contained in a Radioisotope Heater Unit
- 1000 kg U-238 ballast which is 12.4 MBq
- 15 radio luminescent dials containing a total of 3.7E4 MBq of H-3 (A2 Value from Table 3 SSR-6)
- 2 electronic triggers with 3.7E5 MBq Kr-85 each

$$A2\ Multiple = \frac{4000\ MBq\ {}^{238}Pu}{1E-3\ TBq} + \frac{12.4\ MBq\ {}^{238}U}{Unlimited} + \frac{3.7E4\ MBq\ {}^{3}H}{0.02\ TBq} + \frac{7.4E5\ MBq\ {}^{85}Kr}{1E-1\ TBq}$$

$$A2\ Multiple = 4 + 0 + 1.85 + 7.4 = 13.25$$

A2.3.2.2. This example would result in a non-tiered mission at the third level.

A2.3.3. Modifying this example such that the launch vehicle held 2000 Curies (Ci) Pu-238 (**Figure A2.4**).

Figure A2.4. Modified Mixed Isotope Example.

$$A2\ Multiple = \frac{2000\ Ci\ {}^{238}Pu}{1E-3\ TBq} + \frac{12.4\ MBq\ {}^{238}U}{Unlimited} + \frac{3.7E4\ MBq\ {}^{3}H}{0.02\ TBq} + \frac{7.4E5\ MBq\ {}^{85}Kr}{1E-1\ TBq}$$

$$A2\ Multiple = \frac{7.4E13\ Bq\ {}^{238}Pu}{1E-3\ TBq} + \frac{12.4\ MBq\ {}^{238}U}{Unlimited} + \frac{3.7E4\ MBq\ {}^{3}H}{0.02\ TBq} + \frac{7.4E5\ MBq\ {}^{85}Kr}{1E-1\ TBq}$$

$$A2\ Multiple = 74000 + 0 + 1.85 + 7.4 = 74009$$

A2.3.4. The A2 multiple can be calculated once Ci is converted to Bq. This example yields an A2 value between 1000 and 100000. Therefore, this mission would be a Tier I mission.

Attachment 3

SAFETY ANALYSIS REPORT (SAR) REQUIREMENTS

A3.1. Safety Analysis Report. A SAR will include an executive summary, description, mishaps, probabilities, and environments associated with all mission phases, response of the RAM to mishap environments, environmental transport of radioactive materials, mission risk estimates, and other pertinent information as described below. **(T-1)** Compliance with this attachment is mandatory, unless coordinated with AFSEC/SES. **(T-1)**

A3.2. Executive Summary. (T-0)

A3.2.1. Brief overview of the mission. **(T-1)**

A3.2.2. Information relevant to a tier determination (per NSPM-20). **(T-0)**

A3.2.3. Comparison of mission risk to Safety Guidelines (per NSPM-20). **(T-0)**

A3.2.4. Comparison of mission risk to Risk Constraints. **(T-1)**

A3.2.5. Key safety features of mission that impact risk. **(T-1)**

A3.3. Description. (T-1)

A3.3.1. Program name and description. **(T-1)**

A3.3.2. Space or Missile system description. **(T-1)**

A3.3.2.1. Spacecraft. **(T-1)**

A3.3.2.2. Launch vehicle and Launch Complex. **(T-1)**

A3.3.3. Mission profile. **(T-1)**

A3.3.3.1. Proposed launch date, duration, and timeline. **(T-1)**

A3.3.3.2. Trajectory, launch azimuth, and orbital or flight parameters. **(T-1)**

A3.3.3.3. Description of all payloads. **(T-1)**

A3.3.3.4. Impact predictions and/or end of life/disposal plans as applicable. **(T-1)**

A3.3.4. Space nuclear systems and other radioactive materials (include all RAM on launch vehicle). **(T-1)**

A3.3.4.1. Inventory of all fissile materials and description of reactivity control methods. **(T-1)**

A3.3.4.2. Inventory of all radioactive materials (isotopes and activity of each in Terabecquerels [TBq], their location on launch vehicle, and description of proposed uses to include contributions from reactor operations and decay). **(T-1)**

A3.3.4.3. Radiation exposure levels. **(T-1)**

A3.3.4.4. Source and/or SNS construction, controls, safeguards, materials and design criteria, including any containment barriers and the chemical and physical form of the RAM. **(T-1)**

A3.3.4.5. Other information pertinent to assessing source integrity in normal and extreme operating conditions and potential mishap environments, such as special form status. **(T-1)**

A3.3.5. If the SNS is a reactor, safety system identification, and derivation of controls. **(T-1)**

A3.3.5.1. The safety function of the reactor components and mission parameter. **(T-1)**

A3.3.5.2. The formal derivation of controls or design features. **(T-1)**

A3.3.5.3. How controls or design features are protected. **(T-1)**

A3.4. Mishaps, Probabilities, and Environments Associated with All Mission Phases. (T-1)

A3.4.1. Potential launch vehicle and spacecraft mishap scenarios that could result in a release of RAM. **(T-0)**

A3.4.2. Mishap and release probabilities. **(T-1)**

A3.4.2.1. Likelihood of the scenario as a function of time and location. **(T-1)**

A3.4.2.2. Magnitudes of likelihood of the release of RAM. **(T-1)**

A3.4.2.3. Likelihood to result in nuclear criticality or reactivity excursion. **(T-1)**

A3.4.3. Uncertainty Analysis. **(T-1)**

A3.4.3.1. Reference to or description of methodology employed. **(T-1)**

A3.4.3.2. Test or analysis data to support the analysis. **(T-1)**

A3.4.3.3. Results. **(T-1)**

A3.5. Response of the RAM to Mishap Environments. (T-1)

A3.5.1. Effects of the mishap on the RAM or reactor containment, to include release or criticality. **(T-1)**

A3.5.2. Radiological effects resulting from both normal and abnormal reactor operations. **(T-1)**

A3.5.3. Radiological source term for analyzed mishaps to include internal and external exposure to members of the public. **(T-1)**

A3.5.3.1. For radioactive releases: isotopic content, activity, chemical form, reparability (e.g., particle size distribution), location, and other factors that may affect its transport through the environment and its biological uptake, as relevant. **(T-1)**

A3.5.3.2. For direct radiation exposure: source and type of radiation, radiation flux, location, surrounding materials, and other factors that may affect radiation type, flux, or exposure, as relevant. **(T-1)**

A3.5.3.3. Uncertainty analysis and references to methods, test, or analysis data to support the above conclusions. **(T-1)**

A3.6. Environmental Transport of Radioactive Materials. (T-1)

A3.6.1. Environmental transport and dispersion modeling through the biosphere to estimate human exposure to the released RAM. **(T-1)**

A3.6.2. Uncertainty analyses and references to methods, test or analysis data to support the above conclusions. Data may include meteorological, populations, and land usage data **(T-1)**

A3.7. Mission Risk Estimates. (T-1)

A3.7.1. Computation and discussion of metrics required for comparison to NSPM-20 thresholds and other launch authorization requirements. **(T-0)**:

A3.7.1.1. Maximum individual total effective dose in units of rem or comment if negligible. **(T-0)**

A3.7.1.2. Potential consequences to a maximally exposed individual. **(T-0)**

A3.7.1.3. Likelihood of an accident resulting in exposure to a member of the public in excess of 5 rem and the number of individuals who could potentially be exposed at that level. **(T-0)**

A3.7.1.4. Comparisons of potential exposure levels to other meaningful measures. **(T-0)**

A3.7.2. Risk Analysis Process. **(T-1)**

A3.7.2.1. Describe and evaluate mission risk landscape as it relates to locations and the phases of the mission. **(T-1)**

A3.7.2.2. Describe and evaluate risks associated with the end of mission and/or SNS/RAM life. **(T-1)**

A3.7.2.3. Describe and evaluate risks associated with SNS/RAM disposal considerations, especially in light of mishaps that might obviate those plans or cause unplanned reentry. **(T-1)**

A3.7.3. Uncertainties that address the characteristics of risk for the overall mission, and references to methods or analyses to support the above conclusions. **(T-1)**

A3.8. Other Pertinent Information. (T-1)

A3.8.1. Technical Peer Review Results. **(T-0)**

A3.8.2. Applicable System SAR, highlighting interfaces. **(T-0)**

A3.8.3. Reference to documents used to comply with NEPA or other requirements. **(T-0)**

A3.8.4. Demonstrate that normal operation of the space nuclear system is consistent with applicable Federal, State, and local requirements. **(T-0)**

A3.8.5. References, data and any other information, or programs used to support SAR findings. **(T-1)**

A3.8.6. Any additional information or analysis required by the INSRB. **(T-0)**

Attachment 4

RADIOLOGICAL LAUNCH RISK CONSTRAINT

A4.1. Risk Constraints. This attachment shows the three tests associated with the launch risk constraint and provides an example for each test. If a range user does not provide this type of information through their normal safety analysis process, the range user will need to arrange with AFSEC/SES or Range Safety Office a means of providing this data.

A4.2. Radiological Launch Risk Constraint Tests.

A4.2.1. Test 1. Probability of cancer casualty, $P_{CancerC} \leq 1 \times 10^{-6}$. Test 1 provides the probability of an individual developing cancer in the 50 years following a launch accident.

A4.2.2. Test 2. Confidence Level, $(P_{CancerC}) \geq 90\%$. Test 2 ensures the calculated confidence level of Test 1 is greater than or equal to 90%.

A4.2.3. Test 3. Dose, $D_{\text{Mean Maximum Individual Effective Dose}} \leq 100$ mrem/mission. Test 3 provides the overall mean maximum individual effective dose goal should be less than or equal to 100 mrem per mission, based on failure modes resulting in release received by the maximally exposed individual.

A4.3. Examples. The following examples provide a possible method for calculating each of the risk constraint tests. These examples are to show the process, not actual calculations.

A4.3.1. Test 1, Probability Individual Cancer Casualty risk calculation example:

A4.3.1.1. The probability of cancer casualty, $P_{CancerC} \leq 1 \times 10^{-6}$, can be calculated using information normally provided by the range user in documents such as the Environmental Impact Statement (EIS) and/or the Safety Analysis Report (SAR). $P_{CancerC}$ is a 50-year cumulative risk that any single person will suffer a cancer related consequence. See **Figure A4.1**.

Figure A4.1. Risk Calculation.

$$\text{Risk} = \text{Probability} \times \text{Consequence}$$

$$\text{Risk} = P_{TR} \times P_{LCF}$$

A4.3.1.2. Total Probability of Release, $P_{TR,}$ is defined as the product of the mean accident probability, P_A, and the conditional probability of release, P_R. See **Figure A4.2**.

Figure A4.2. Total Probability of Release.

$$P_{TR} = P_A \times P_R$$

A4.3.1.3. The Probability of developing a Latent Cancer Fatality, P_{LCF} following exposure to released radioisotopes may be based on the International Commission on Radiological Protection (ICRP) Publication 60 factor of 5.00E-04 health effect (HE), per rem. A different P_{LCF} may be used based on radiological isotope or target organ effects, if appropriately justified.

A4.3.1.4. Nuclear payload missions usually provide an estimate of the maximally exposed individual's (MID) dose given a release during each distinct phase of flight (e.g., early, late ascent, suborbital, orbital, and long-term reentry cases). See **Figure A4.3**.

Figure A4.3. Probability of Latent Cancer Fatality.

$$P_{LCF} = HE \times MID$$

A4.3.1.5. The individual Probability of Cancer Casualty, $P_{CancerC}$ is assessed as 1.2 times the P_{LCF} (ICRP, Pub. 60). This additional factor is used to account for non-fatal cancers and hereditary risk factors. See **Figure A4.4**.

Figure A4.4. Probability of Cancer Casualty.

$$P_{CancerC} = P_{TR} \times 1.2 \times P_{LCF}$$
$$P_{CancerC} = P_{TR} \times 1.2 \times HE \times MID$$

A4.3.1.6. For example, **Table A4.1**, provides the total probability of release for each mission phase based on the accident probability and conditional probability of release, given an accident has occurred. Overall mission values are weighted by total probability of release for each mission phase.

Table A4.1. Total Probability of Release.

Mission Phase	Accident Probability, P_A	Conditional Probability of Release, P_R	Total Probability of a Release, P_{TR}
0: Pre-Launch	2.30E-05	3.30E-01	7.59E-06
1: Early Launch	3.10E-03	2.80E-02	8.68E-05
2: Late Launch	3.60E-03	2.90E-03	1.04E-05
3. Suborbital	1.30E-02	1.30E-03	1.69E-05
4. Orbital	4.50E-03	5.20E-02	2.34E-04
5. Long-term Reentry	1.00E-06	9.40E-02	9.40E-08
Overall Mission	**2.42E-02**	**5.08E-01**	**3.56E-04**

A4.3.1.7. Using the example data along with the ICRP 60 HE factor and a postulated MID of 100 mrem, the $P_{CancerC}$ may be calculated as in **Figure A4.5**.

Figure A4.5. Probability of Cancer Casualty Example.

$$P_{CancerC} = 3.56E\text{-}04 \times 1.2 \times 5.0E\text{-}04 \times 0.100$$
$$P_{CancerC} = 2.1E\text{-}08$$

A4.3.1.8. The mean risk value or $P_{CancerC}$ for this mission, 2.1E-08 is less than the mean risk constraint of 1E-06 (one in a million).

A4.3.2. Test 2, Confidence Level, ($P_{CancerC}$) ≥ 90% risk calculation example:

A4.3.2.1. Confidence Level can be established by using information normally provided by the range user in documents such as the Environmental Impact Statement (EIS), the mission Databook, and the SAR.

A4.3.2.2. For example, most missions discuss uncertainty in the risk assessment results and have provided that this uncertainty is dominated by the associated launch vehicle accident probabilities. Dominant launch vehicle accident probability uncertainties are useful to examine those statistics and verify the confidence level.

A4.3.2.3. Normally an uncertainty analysis is provided describing launch vehicle accident scenarios. Information may be included that discusses the range of uncertainty obtained for all accident outcomes with key uncertainty distribution parameters for all the accident initiating conditions.

A4.3.2.4. The example accident initiating conditions (AIC) figure below provides a mean estimate of that distribution as 4.43E-02 (±1.54E-02). A 90% confidence interval of the overall probability spans from 2.26E-02 to 7.22E-02 approximately. The distribution is moderately skewed and is evident in the histogram in the graph that follows.

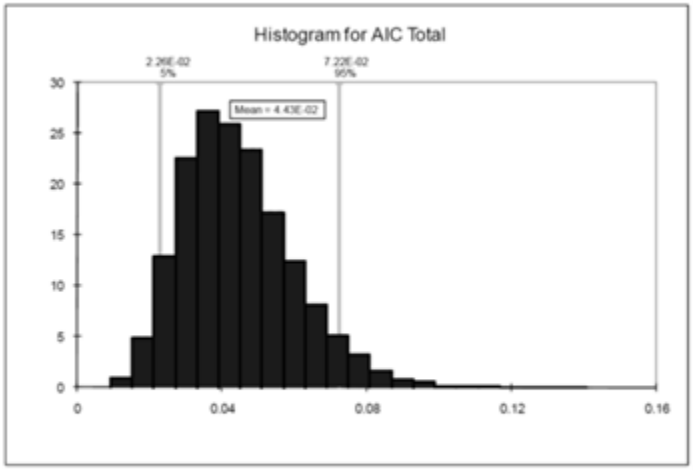
A4.3.2.5. For this example, these statistics are generated via the range user's launch vehicle accident Monte Carlo simulation software. Since the range user utilized a 90% Confidence Interval to generate the accident statistics, they have met the criterion (see **Figure A4.6**).

Figure A4.6. Examples of Accident Initiating Conditions (AIC) Distribution and Histogram.

Example Graph of AIC Distribution Parameters

Distribution Parameters	AIC Total
Mean	4.43E-02
Std. Deviation	1.54E-02
Variance	2.36E-04
Skewness	0.75
Kurtosis	3.97
Range Factor	1.79
Mode	3.89E-02
5%percentile	2.26E-02
10%percentile	2.63E-02
15%percentile	2.89E-02
20%percentile	3.10E-02
25%percentile	3.31E-02
30%percentile	3.52E-02
35%percentile	3.69E-02
40%percentile	3.87E-02
45%percentile	4.06E-02
Median	4.24E-02
55%percentile	4.44E-02
60%percentile	4.64E-02
65%percentile	4.85E-02
70%percentile	5.08E-02
75%percentile	5.36E-02
80%percentile	5.64E-02
85%percentile	6.01E-02
90%percentile	6.50E-02
95%percentile	7.22E-02

Example Graph of AIC Distribution Parameters



A4.3.3. Test 3, Dose calculation example:

A4.3.3.1. Dose, D Mean Maximum Individual Effective Dose ≤ 100 mrem/mission can be established by using information normally provided by the range user in documents such as the Environmental Impact Statement (EIS) or the final Safety Analysis Report (SAR).

These values may differ as additional information becomes known and the safety analysis is developed.

Attachment 5

CONTAMINATION IMPACT STATEMENT

A5.1. Contamination Impact Statement. In addition to the required information, the range user may use DOE's "Hotspot," DTRA's "Hazard Prediction and Assessment Capability (HPAC)," or another model to provide the estimated impact of credible release scenarios. The Range Safety Office can use the following worksheet (**Table A5.1**) to create the Contamination Impact Statement in addition to model outputs. The range's safety office may request assistance from AFSEC/SES, if needed.

Table A5.1. Contamination Impact Statement Worksheet.

1. Did all credible scenarios (probability of occurrence > TBD) have estimate of contamination level should there be a mishap?	Yes / No
2. Of these scenarios, what is the highest estimated contamination level?	dpm/cm^2
3. Were these estimates validated?	Yes / No
3.1. If yes, how?	Yes / No
4. At this contamination level, would there be an impact to operations?	Yes / No
4.1. If yes, which operations?	
4.2. If yes, would there be an impact to the operational schedule?	Yes / No
4.3. Schedule impact:	
5. At this contamination level, would any DoD or non-DoD assets require decontamination?	Yes / No
5.1. Which assets?	
6. At this contamination level, would any program assets require decontamination?	Yes / No
6.1. Which assets?	
7. Estimate the recovery costs?	$