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IONIZING RADIATION PROTECTION

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This manual implements Air Force Policy Directive (AFPD) 48-1, *Aerospace & Operational Medicine Enterprise*. This manual applies to all civilian employees and uniformed members of the Regular Air Force, Air Force Reserve and Air National Guard. It also applies to all tenants of Air Force controlled property, including Department of Energy personnel, in accordance with host-tenant support agreements, and Air Force contractors where specified herein and when required by the terms of their contracts. **See paragraph 1.2** for additional applicability. This manual specifies the requirements for the protection of Air Force (AF) personnel and the public from exposure to ionizing radiation resulting from AF activities. It defines responsibilities for the protection, monitoring and medical follow-up of military personnel for the full spectrum of military operations. This manual requires the collection and/or maintenance of information protected by the Title 5 United States Code (U.S.C.) Section 552a, *Privacy Act of 1974*, authorized by Title 10 Code of Federal Regulations (CFR), Section 20.2106, *Records of Individual Monitoring Results* and Title 29 CFR Section 1910.1096(b), *Exposure of Individuals to Radiation in Restricted Areas*, Title 29 CFR Section 1910.1096(n), *Record*s, and Title 29 CFR Section 1910.1096(o), *Disclosure to Former Employee of Individual Employee's Record.* The applicable system of records notice (SORN) F044 AF SG O, *United States Air Force Master Radiation Exposure Registry* is available at: **http://dpclo.defense.gov/Privacy/SORNs.aspx**. Ensure that all records created as a result of processes prescribed in this publication are maintained in accordance with Air Force Instruction (AFI) 33-322, *Management of Records and Information Governance Program*, and disposed of in accordance with the Air Force Records Disposition Schedule in the Air Force Records Information Management System. Refer recommended changes and questions about this publication to the Office of Primary Responsibility using the AF Form 847, *Recommendation for Change of Publication*; route AF

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SUMMARY OF CHANGES

This document has converted from an AFI to a manual; it has been substantially revised and must be completely reviewed. The document has been streamlined, revised, and updated. Major changes include radon policy revision, updated training requirements, revised clearance criteria, and updated local policy requirements.

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Chapter 1

PROGRAM OVERVIEW

1.1. Overview. This manual addresses the hazards associated with exposure to ionizing radiation, regardless of source, and specifies requirements to keep exposures as low as reasonably achievable (ALARA). It outlines ionizing radiation protection roles and responsibilities for all ionizing radiation threats including those encountered by nuclear capable units and weapons storage areas unless stated otherwise in Department of Defense (DoD) publications or AF 91-series publications. This manual should be read in conjunction with Air Force Manual (AFMAN) 40-201, *Radioactive Materials (RAM) Management*, AFMAN 48-125, *Personnel Ionizing Radiation Dosimetry* and AFI 91-108, *Air Force Nuclear Weapons Intrinsic Radiation and 91(b) Radioactive Material Safety Program*. Specific AF requirements for nuclear weapons and the AF Radioisotope Committee regulated RAM, are found in AFI 91-108 and AFMAN 40-201, respectively.

1.2. Applicability. The requirements outlined in this manual apply to all AF, or AF-led, installations with operations that involve:

1.2.1. Possession or use of RAM as specified in AFMAN 40-201 and AFI 91-108.

1.2.2. Possession or use of radiation producing devices including situations where emissions are incidental to use.

1.2.3. Use of RAM or radiation producing devices by contractors, as specified by contract. **Note:** Contractors are solely responsible for the health and safety of their employees in accordance with Occupational and Safety Health Administration and/or Nuclear Regulatory Commission requirements, to include ionizing radiation, unless otherwise specified by the contract. This manual does not prohibit providing workplace sampling and survey information to contractors, based on local arrangements or in order to determine AF personnel and public exposures from contractor activities.

1.2.4. Doses resulting from planned, emergency, or existing exposures.

1.3. Requirements Outlined. The requirements outlined in this manual apply at Air Force installations overseas, including deployed locations, so long as the requirements do not conflict with applicable provisions from any of the following: international agreements, the Overseas Environmental Baseline Guidance Document, country-specific final governing standards, geographic combatant command policy, and environmental annexes to operational orders, operational plans or other operational directive.

1.4. Objectives of the AF Radiation Protection Program.

1.4.1. Prevent radiation exposures that would result in deterministic effects (i.e., cataracts, skin erythema).

1.4.2. Limit the risk of stochastic effects (e.g., cancer and leukemia) for which the probability of occurrence is proportional to dose.

1.4.3. Ensure radiation workers are properly trained on the risks of radiation and methods to minimize exposure.

1.4.4. Assess health risks, recommend and implement controls, and document exposures to ionizing radiation.

1.5. Planned, Emergency, and Existing Exposures. For the purposes of radiation protection, there are three broad categories of exposure: planned, emergency, and existing.

1.5.1. Radiation Protection Policy for Planned Exposure. This manual considers all AF activities involving the routine use of radiation producing devices or RAM in medicine, research, industry and training to be planned exposures. In addition to occupational exposures, medical exposures of patients also fall within the "planned" category for radiation protection purposes.

1.5.1.1. Examples of planned exposures. Common practices resulting in potential occupational exposures include, but are not limited to: industrial radiography, depleted uranium munitions handling, research involving nuclear materials or radiation producing devices, soil density testing, diagnostic radiology, nuclear medicine, radiation therapy and activities involving maintenance of nuclear weapon systems.

1.5.1.2. Justification: Any proposed activity causing exposure to persons should yield a sufficient benefit to society, the individual (for medical exposures), or the military to justify the risks incurred by the radiation exposure.

1.5.1.3. Optimization: The magnitude of individual doses and the number of people exposed shall be kept ALARA.

1.5.1.4. Dose limits: The dose to an individual resulting from a combination of all relevant planned exposures shall not exceed the occupational or public limits, as applicable, specified in this manual, **see paragraph 4.4.1** for occupational limits and **paragraph 5.2.4** for public limits. **Note:** These limits do not apply to a patient who is prescribed radiation as part of a diagnostic or therapeutic medical procedure.

1.5.2. Radiation Protection Policy for Emergency Exposures. These are unexpected situations that may require urgent protective actions to be implemented to avoid or reduce exposures. Examples include, but not limited to, incident or contingency response activities required to save life or property, humanitarian assistance operations, and military operations conducted where national interests may force personnel to incur radiation doses beyond occupational limits.

1.5.2.1. Justification: A proposed emergency response should do more good than harm by balancing the goals of military objectives and/or humanitarian assistance with the increased risk of deterministic and/or stochastic effects.

1.5.2.2. Optimization: The form, scale, and duration of the emergency response should be optimized so the net benefit is maximized and the net detriment is minimized. Again, individual doses shall be maintained ALARA.

1.5.2.3. Dose guidance: Occupational or "planned" dose limits do not apply for emergency exposures. Instead, operational dose guidance is utilized which considers the factors of acceptable risk and mission importance.

1.5.3. Existing Exposures. These are exposure situations that already exist, such as natural background radiation.

1.5.4. Exposures to the Public. Public exposures may occur as a result of planned, emergency, or existing exposures. Public exposures of concern, for the purposes of this manual, include those resulting indirectly from AF occupational and medical practices, radon, and from radiological incidents and accidents.

Chapter 2

ROLES AND RESPONSIBILITIES

2.1. The Assistant Secretary of the Air Force for Installations, Environment and Energy (SAF/IE). The Assistant Secretary of the Air Force for Installations, Environment and Energy (SAF/IE) shall appoint a voting representative and alternate to the Air Force Radiation Safety Committee (AF-RSC).

2.2. The Assistant Secretary of the Air Force for Acquisition (SAF/AQ) shall:

2.2.1. Appoint a voting representative and alternate to the AF-RSC.

2.2.2. Ensure adequate acquisition procedures exist governing the life-cycle management of sources of radiation not covered by AFMAN 40-201 or AFI 91-108.

2.2.3. Ensure the AF-RSC is informed regarding the acquisition of new systems and upgrades that utilize sources of radiation not covered by AFMAN 40-201 or AFI 91-108 prior to fielding.

2.3. The Deputy Chief of Staff for Logistics, Engineering, and Force Protection (AF/A4) shall:

2.3.1. Appoint one voting representative and one alternate from among the staff of both AF/A4L and AF/A4C to the AF-RSC, who can represent their respective offices and will coordinate with AF/A4 functional areas as required.

2.3.2. Ensure adequate radiation safety guidance exist as they pertain to logistics, maintenance, civil engineering, and security.

2.3.3. Provide logistics, maintenance, civil engineering, and security consultation associated with accidents, incidents, or attacks involving RAM, radiation producing devices, or weapons of mass destruction.

2.4. The Surgeon General of the Air Force (AF/SG) shall:

2.4.1. Establish AF policy for controlling radiation hazards. Ensures AF policy compliance with relevant federal policies and accepted scientific practice.

2.4.2. Appoint an AF/SG Health Physics Consultant and an AF/SG Medical Physics Consultant, who can be one individual if qualified for both positions.

2.4.3. **The Assistant Surgeon General, Medical Operations (AF/SG3/4), shall:**

2.4.3.1. Oversee the use of sources of radiation not covered by AFMAN 40-201 or AFI 91-108 to ensure compliance with all Federal, DoD, and AF regulations and requirements.

2.4.3.2. Establish the AF-RSC to serve as the focal point for all ionizing radiation issues and medical non-ionizing radiation issues, e.g. magnetic resonance imaging and medical lasers.

2.4.3.3. Chair, or delegate a primary and alternate to chair the AF-RSC.

2.4.3.4. Appoint a voting representative and alternate from the Radioisotope Committee Secretariat to the AF-RSC. They will be the Executive Secretary of the AF-RSC (AF-RSCES). The AF-RSCES is authorized to conduct business on behalf of the AF-RSC such as setting the AF-RSC agenda, preparing for and conducting AF-RSC meetings, etc.

2.4.3.5. Appoint a voting representative and alternate from Bioenvironmental Engineering (AFMRA/SG3PB) to the AF-RSC.

2.4.3.6. Appoint the AF/SG Consultant on Medical Physics and an alternate medical physicist as voting representatives to the AF-RSC. The Consultant on Medical Physics serves as the liaison for the Air Force Medical Physics Working Group (AFMPWG) to the AF-RSC.

2.4.3.7. Appoint a voting representative and alternate from Medical Readiness (AFMRA/SG3X) to the AF-RSC.

2.4.3.8. Appoint a voting representative and alternate to the DoD Ionizing Radiation Working Group.

2.4.4. **AF/SG Consultant(s) for Health Physics and Medical Physics shall:**

2.4.4.1. Adjudicate conflicts in prioritization between competing health and medical physics requirements.

2.4.4.2. Provide a recommendation on the qualification status, to the Bioenvironmental Engineering Associate Corps Chief, for Air Force active duty medical physicists.

2.4.4.3. Manage the Air Force-Medical Physics Working Group to address medical physics policy, requirements, and standards.

2.5. The Commander, Air Force Inspection Agency shall:

2.5.1. Appoint a voting representative to the AF-RSC.

2.5.2. Conduct special emphasis inspections as requested by the AF-RSC.

2.6. The Chief, Weapons Safety Division, AF Safety Center (AFSEC) shall:

2.6.1. Appoint a voting representative to the AF-RSC to provide consultation on radiation programs related to nuclear weapon systems.

2.6.2. Consult with AF/SG3/4 on ionizing radiation exposures to personnel from nuclear weapon systems and nuclear weapons testing.

2.7. The Commander, Air Force Legal Operations Agency (AFLOA) shall:

2.7.1. Appoint one non-voting legal advisor and one alternate from AFLOA/JAC to the AF-RSC to attend all scheduled meetings of the AF-RSC.

2.7.2. Serve as chief counsel to both the AF-RSC and to the AF- RSCES on an as needed basis and collaborate with AF-RSCES to obtain and provide accurate interpretations of all statutes, regulations, instructions, and guidance documents affecting implementation of the AF radiation protection program for all AF components covered by this manual.

2.8. Major Commands (MAJCOM) shall:

2.8.1. **MAJCOM Surgeon Generals shall** appoint a voting representative and an alternate to the AF-RSC for consultation which may include: research and development, training, health risk surveillance, and medical readiness issues.

2.8.2. **The Commander, 711th Human Performance Wing, on behalf of the Commander, Air Force Materiel Command (AFMC/CC), shall** :

2.8.2.1. Appoint a voting representative and an alternate to the AF-RSC to provide consultation on research and development, training, and technical matters. **(T-1).**

2.8.2.2. Maintain a consultative service capable of addressing the radiation issues facing the AF. **(T-1).**

2.8.2.3. Provide operational health physics support during nuclear or radiological contingencies. **(T-1).**

2.8.2.4. Manage the Air Force Personnel Dosimetry Program and implement AFMAN 48-125 requirements. **(T-1).**

2.8.2.5. Maintain the AF Master Radiation Exposure Registry (MRER). **(T-1).**

2.8.2.5.1. Utilize the MRER to archive comprehensive dosimetry records for the lifetime of the AF Master Materials License, for all military personnel and for other personnel who use AF dosimetry services. **(T-0).**

2.8.2.5.2. Data from classified operations will be included to the fullest extent possible. **(T-0).** An individual's assessed dose, in most circumstances, is not classified. Where classification is deemed necessary, **see paragraph 6.5.4.2** for further guidance.

2.8.2.6. Update discrepancies (e.g., dates of birth, social security numbers, name spelling, MRER dose vs. historical hard copy records) in MRER based on credible evidence provided to the AF Dosimetry Center. **(T-1).** For significant MRER changes, as determined by the AF Dosimetry Center, present discrepancy in question to AF-RSC for adjudication. **(T-1).**

2.8.2.7. Provide operational reach back support to installations for radiation dosimetry to include consultation and supply of emergency dosimeters when available. **(T-2).**

2.8.2.8. Maintain a capability suitable for the collection of environmental and bioassay samples, conducts in-vivo monitoring, and performs radiochemical analysis of samples. **(T-2).** The capability shall support both operational requirements and medical-legal documentation of individual internal exposures during peacetime, combat and non-combat military operations, and war. **(T-2).**

2.8.2.9. Process, analyze and interpret bioassay and environmental samples in accordance with the most current, industry-accepted methods of sample analysis and assessments methodology to meet regulatory requirements. **(T-3).**

2.8.2.10. Maintain complete records of all bioassay samples, sample analysis results, and estimation of internal dose for the lifetime of the AF Master Materials License, including estimates below detection limits of the analytical method. **(T-2).**

2.8.2.11. Provide a dose estimate, resulting from bioassay analysis, to the supported commander's medical staff. **(T-2).**

2.8.2.12. Provide technical advisory services on radiation protection issues, examples include health risk assessments, exposure reconstructions, radiation safety program reviews, radiation safety quality assurance program development, radiation safety training, and decommissioning survey reviews. **(T-2).**

2.9. The Air Force Radiation Safety Committee (AF-RSC) shall:

2.9.1. Provide direction on uses of radiation, not otherwise covered in AFMAN 40-201 (e.g. machine generated radiation) and AFI 91-108, and grants authority to the AF-RSC Executive Secretariat to conduct all business on its behalf (**reference Chapter 9**). **Note:** Issues related to the AF Master Materials License, or directed energy, to include non-medical lasers, are addressed by other groups.

2.9.2. Serve as the primary AF point of contact for communications with federal, state, and host nation regulatory authorities regarding radiation issues, not otherwise covered in AFMAN 40-201 and AFI 91-108. **Note:** HQ AFSEC is the single point of contact for material controlled under Section 91 of the Atomic Energy Act of 1954 codified in Title 42 U.S.C. Section 2121, *Authority of Commission*.

2.9.3. Recommend policies to AF/SG for keeping radiation exposure ALARA.

2.9.4. Identify new or special inspection needs and reports them to the Air Force Inspection Agency.

2.9.5. Establish the AFMPWG via the Associate Corps Chief for Bioenvironmental Engineering and the AF/SG Consultant for Medical Physics. **Note:** The AFMPWG reports on medical physics issues to the AF-RSC and to the Associate Corps Chief for Bioenvironmental Engineering for planning purposes of the Bioenvironmental Engineering Corporate Board.

2.9.6. Meet as often as necessary, but not less than semi-annually, and delegate action items to voting representatives or other technical representatives. A quorum of at least 50% of the appointed representatives is required for each meeting.

2.9.7. Publish and makes available minutes to all members.

2.9.8. Provide final resolution for allegations concerning the safe use of radiation in compliance with all regulations, not otherwise covered in AFMAN 40-201 and AFI 91-108.

2.9.9. Be comprised of the members identified **in Table 9.1**, but may add non-voting members as deemed necessary.

2.9.10. **The AF-RSC Executive Secretariat (AF-RSCES) shall:**

2.9.10.1. Manage the affairs and executes the decisions of the AF-RSC and maintains AF policy pertinent to ionizing and medical non-ionizing radiation safety.

2.9.10.2. In collaboration with relevant AF/SG consultant(s), determine whether individuals are qualified by training, education, and experience to use radiation covered by this AFMAN.

2.9.10.3. Prior to making a recommendation to procure and field new sources of ionizing radiation covered by this AFMAN, ensure safe operating procedures exist, ionizing radiation hazards are fully characterized, and exposures to operators, maintainers, and personnel are kept ALARA using engineering controls, administrative controls, or personal protective equipment. **Note:** Equipment procured through the Air Force Diagnostic Imaging and Radiotherapy Board is outside the scope of the AF-RSC.

2.9.10.4. Prior to making a recommendation to procure and field new ionizing radiation detectors or dosimeters, ensure the devices are appropriate for the desired use, proper calibration requirements exist, and adequate training requirements are identified.

2.9.10.5. Consult with AFLOA/JAC or SAF/GCN, as designated in Headquarters Air Force Mission Directive 1-14, *General Counsel and The Judge Advocate General*, on questions regarding federal regulations, Department of Defense instructions (DoDIs) and AF publications; AFLOA/JAC and SAF/GCN will coordinate with each other on consultation requests, consistent with HAFMD 1-14, when significant or non-routine matters are at issue.

2.9.10.6. As necessary, conduct visits, respond to incidents and mishaps within the scope of this manual, and accompany the Air Force Inspection Agency during inspections where special emphasis investigations are being addressed.

2.10. The Wing or Installation Commander, as appropriate, shall:

2.10.1. Ensure the wing or installation radiation safety program is comprehensive, compliant with current requirements, and fully integrates the radiation safety programs of units, tenant units, and geographically separated units. Specific tasks include:

2.10.2. Appoint, in writing and by name, a qualified individual to be the installation radiation safety officer (IRSO) and an alternate if possible. Qualifications for IRSOs are **listed in Chapter 3. (T-1).**

2.10.3. Ensure tenant organization and unit radiation safety programs are fully integrated into the wing or installation radiation safety program. **(T-2).**

2.10.4. **The IRSO shall:**

2.10.4.1. Ensure the overall coordination of installation radiation safety activities and provide direct support and information to the installation commander on radiation health and safety issues and effectiveness of measures to control radiation hazards to comply with Federal, DoD and AF requirements (reference: AFMAN 40-201, AFI 91-108, and AFMAN 48-125). **(T-1).**

2.10.4.2. Joint Basing. If an Air Force wing is not lead agent on a joint base, lead service will appoint IRSO; if AF member is not appointed IRSO, the AF wing commander must designate a wing radiation safety officer (RSO) to execute IRSO responsibilities for wing-owned personnel and operations. **(T-2).** The wing RSO is equivalent to IRSO and must meet same requirements. **(T-2)**.

2.10.4.3. Develop and maintain specific written guidance for the execution of all applicable AFIs, AFMANs, and federal regulations concerning radiation protection on the installation (e.g. installation-level guidance memos, instructions, or AFMAN supplements, etc.). **(T-3).**

2.10.4.3.1. Annually review the installation guidance. **(T-3).**

2.10.4.3.2. For an AF-led joint base or joint operation, the guidance must be signed by each co-located service component commander in addition to the installation commander. **(T-2).**

2.10.4.4. Establish and manage the overall installation radiation safety program **in accordance with Chapter 4**. **(T-1).** The program must include at least: annual reviews of current procedures and practices; status or outcome of any new facility designs and work orders; current and new restricted areas; radiation training status; exposure control (including dosimetry trends and results); and monitoring/surveillance (e.g. compliance and shipping surveys) activities. **(T-1).** Reports deviations from this manual and local policy, as applicable, to the installation commander, AFMRA/SG3PB or AFSEC/SEW, and through the MAJCOM/SGPB, as applicable. **(T-1).** This review is separate from intrinsic radiation and radioactive material permit reviews that may also need to be done at the installation in accordance with AFI 91-108 and AFMAN 40-201, but they may all be done within one document.

2.10.4.4.1. Brief the installation commander at least annually regarding the results of this review. **(T-1). Note:** Providing this briefing to the Environmental, Safety, and Occupational Health Council satisfies this requirement; may be done in conjunction with similar AFI 91-108 and AFMAN 40-201 requirements if applicable to the installation.

2.10.4.5. Assist commanders with the development of installation radiation safety policies, operating instructions or radiation safety manuals, as appropriate and requested. **(T-3).**

2.10.4.6. Ensure radiation workers receive training on the risks of radiation, methods to minimize exposure, and the ALARA principle. **(T-0).**

2.10.4.7. Conduct public dose assessments and radon monitoring and assessment **described in Chapters 5 and 7**. **(T-1).**

2.10.4.8. Assist Civil Engineering as requested to ensure adequate design of facilities containing radiation sources and/or devices or requiring radon mitigation. **(T-3).**

2.10.4.9. Manage installation's personnel dosimetry and bioassay program in accordance with AFMAN 48-125 requirements.

2.10.4.10. Ensure discrepancies in radiation dosimetry reports due to lost or damaged radiation monitoring devices are corrected in the MRER in coordination with the AF Dosimetry Center within 30 days of identification. **(T-1).**

2.10.4.11. Forward unit personnel's off-duty or moonlighting radiation dose records to United States Air Force School of Aerospace Medicine (USAFSAM) for inclusion into the MRER. **(T-0).**

2.10.4.12. Document radiation source incidents **(T-2)** and coordinate with Bioenvironmental Engineering to ensure installation personnel's potential workplace radiation hazards are referenced in the appropriate Defense Occupational and Environmental Health Readiness System similar exposure group. **(T-1).**

2.11. Organization or Unit Commander, as appropriate, shall:

2.11.1. Designate, in writing, a unit RSO (URSO) when in possession of RAM (not requiring a permit RSO in accordance with AFMAN 40-201, such as generally licensed devices) or radiation producing devices. **(T-2). Note:** This URSO is separate from, and in addition to, requirements of URSO and permit RSO appointments in AFI 91-108 and AFMAN 40-201. However, the same member may be appointed if qualified to fulfill this manual's, AFMAN 40-201, and/or AFI 91-108 requirements. Units possessing only exempt radioactive material (e.g. magnesium-thorium components, thoriated optics, or check sources not covered by permits) do not require URSOs. Commanders may appoint URSO for their units possessing only exempt radioactive material, for purposes of appropriate control of the material and program.

2.11.2. Provide facilities, equipment, and resources for radiation protection and safety. The nature and extent must be commensurate with the ALARA concept and the radiation hazards of the workplace. **(T-0).**

2.11.3. Implement policies, procedures, and a radiation protection program to ensure the requirements of this manual are met. **(T-1).**

2.11.4. Ensure implementation of AF radiation dosimetry and/or bioassay program, as necessary. **(T-2).**

2.11.5. Ensure radiation workers receive education and training in accordance with this manual. **(T-3).** Ensure radiation workers are properly trained on the risks of radiation, methods to minimize exposure, and the ALARA principle. **(T-0).**

2.11.6. Ensure reports are made and records are maintained in accordance with this manual. **(T-1).**

2.11.7. Ensure workers incidentally exposed to ionizing radiation in their workplace (not otherwise directly related to or required by their work) receive the same level of protection as if they were members of the public. **(T-1).**

2.11.8. Integrate risk management into operations, activities, and planning during establishment, review, and approval of procedures involving ionizing radiation exposure in accordance with established policy (DoDI 6055.01, *DoD Safety and Occupational Health (SOH) Program* and AFI 90-802, *Risk Management*). **(T-3).**

2.11.9. Notify the IRSO before procurement or making changes regarding RAM, radiation or radiation producing devices (RPD) (i.e., the amount or types of RAM or RPDs; new or altered radiation producing devices; special operations; solicitation of goods or services using RAM or RPDs; or construction of new facilities). **(T-1).** The IRSO shall also be notified prior to any change in facilities affecting source or device security requirements, increased potential for personnel exposures, the location of RAM or radiation producing devices, or the potential for release of RAM. **(T-1).**

2.11.10. **Unit Radiation Safety Officer (URSO) shall:**

2.11.10.1. Meet the qualifications for URSOs **listed in Chapter 3**. **(T-1).**

2.11.10.2. Provide technical support to organization or unit commanders on radiation protection issues; inform organization/unit commanders and the IRSO about radiation health and safety issues and effectiveness of measures to control radiation hazards. **(T-1).**

2.11.10.3. Establish and manage the organization or unit radiation safety program **in accordance with Chapter 4**, as applicable. **(T-2).** The program must include review of procedures and practices, facility design review and classification, training, exposure control activities, and routine monitoring and surveillance activities. **(T-2).**

2.11.10.4. Provide commanders assistance in developing organization specific radiation safety operating instructions and radiation safety manuals. **(T-3).**

2.11.10.5. Maintain and manage records as required by this manual. **(T-2).**

2.11.10.6. Ensure radiation workers are properly trained on the risks of radiation, methods to minimize exposure, and the ALARA principle. **(T-0).**

2.11.10.7. Forward unit personnel's off-duty or moonlighting radiation dose records to IRSO for inclusion into the MRER. **(T-0).**

2.12. Medical Treatment Facility (MTF) Commander or equivalent, as appropriate, shall:

2.12.1. Ensure either measured or estimated radiation dose received by personnel during occupational practices and/or contingency operations is available to the monitored individual. **(T-1).**

2.12.1.1. Ensure dose determination records are forwarded to USAFSAM for incorporation into the MRER (to include locally performed bioassays). **(T-1).**

2.12.1.2. Maintain and ensure accessibility to all radiation exposure data for organizations or units including classified operations. **(T-1).**

2.12.2. Ensure collection of bioassay and laboratory specimens as necessary to assess internal exposures from ingested or inhaled RAM or contaminated wounds. **(T-1).** Samples shall be forwarded to USAFSAM for analysis and interpretation. **(T-1).**

2.12.3. Ensure medical follow-up of personnel receiving significant exposures **in accordance with paragraph 6.7 (T-1).**

2.12.4. If the MTF maintains qualified medical physicists:

2.12.4.1. Support medical physics regional mission as **identified by Chapter 8**. **(T-1).**

2.12.4.2. Shall ensure the resourcing of assigned medical physicists consistent with AFMPWG recommendations to the Bioenvironmental Engineering Associate Corps Chief, The Joint Commission requirements and Air Force Diagnostic Imaging Review Board equipment outfitting recommendations. **(T-1).**

2.12.5. If the MTF does not maintain qualified medical physicists:

2.12.5.1. Shall request support from their regional medical physics office at least 90 days in advance of a requirement; if the regional consulting physics office does not deem direct support as feasible and advantageous, the MTF shall seek support through alternative means under advisement of the regional office. **(T-1). Note:** MTFs receive baseline funding for one routine medical physics visit per year, and shall be responsible

for the funding and logistical support of their organization's medical physics requirements. **(T-3).**

2.12.5.2. Final reports of testing performed by non AF medical physicists must be forwarded to the designated regional consulting medical physics office for review within 30 days of receipt and, for initial testing, prior to equipment acceptance. **(T-1). Note: See Chapter 8**, Medical Treatment Facility Specific Guidance and Requirements, for additional and more detailed guidance.

2.13. The Commander (or Director, or Chief), Installation Contracting, shall:

2.13.1. Ensure that all contracts involving RAM or use of RPDs contain required contract clauses and incorporate a detailed performance work statement or statement of work. **(T-1).**

2.13.2. Ensure requirements likely to contain RAM or use RPDs contain IRSO approval documented in the requirement package prior to procuring goods or services. **(T-1). Note:** Common equipment that contains RAM or RPDs include: x-ray machines, medical diagnostic imaging equipment, chemical detectors, laboratory analysis equipment (e.g. gas chromatographs and lead paint analyzers), and moisture density gauges. Common contracted services that may utilize RAM or RPDs include: medical shielding surveys, soil moisture density testing, and lead based paint surveys.

2.14. The Commander (or Director, or Chief), Installation Civil Engineering, shall:

2.14.1. Design facilities **in accordance with paragraph 4.2 (T-3).**

2.14.2. Incorporate radon reduction measures in the construction of new facilities as required in current DoD and AF policy **(T-1)**; mitigate structures with radon **exposures in accordance with Chapter 7**. **(T-3).**

2.14.3. Manage radioactive waste generated during remedial actions or emergency operations, and ensure wastes are disposed of via the Air Force Radioactive Recycling and Disposal Office in accordance with AFMAN 40-201, AFI 91-108 and AFMAN 32-7002, *Environmental Compliance and Pollution Prevention*. **(T-1).**

2.15. Referring medical practitioners shall:

2.15.1. Consult with an expert in radiation bio-effects (e.g. radiologist, nuclear medicine authorized user, radiation oncologist, and/or medical physicist) regarding abnormally high potential/actual radiation doses or demonstrable radiation injuries prior to advisement of a patient to pursue an irreversible action based on radiation concerns (e.g. termination of a pregnancy based on radiation exposure). **(T-3).**

2.15.2. Request a dose estimate consult from a qualified medical physicist following an exposure of a conceptus to a primary radiation field (i.e. direct beam of radiation) or internalization of radioactive material. **(T-3).**

2.16. Radiological medical practitioners. Radiologists, radiation oncologists, nuclear medicine physicians, other qualified physicians, and qualified radiological technologists that use radiation devices and/or RAM shall:

2.16.1. Control all aspects of the conduct and extent of the examinations. **(T-3).**

2.16.2. Ensure radiographic examinations, radiation therapies or nuclear medicine procedures are only performed by properly trained personnel with adequate knowledge of the physical properties and harmful effects of radiation. **(T-3).**

2.16.3. Ensure the procedures used are appropriate and the minimum necessary radiation used for the clinical problem presented. **(T-3).**

2.17. Medical physicists shall: s upport diagnostic imaging, nuclear medicine, radiation oncology, and/or related medical radiation protection functions within their MTF or medical physics region as applicable, within the scope of their practice. **(T-1).**

2.18. Workplace supervisors shall:

2.18.1. Ensure workplace adherence to the requirements of this manual. **(T-2).**

2.18.2. Ensure protection of Airmen and AF civilians from occupational exposures. Contractors shall comply with this manual regarding the use and control of radiation devices and are solely responsible for the health and safety of their personnel as specified in their contract. **(T-1).**

2.18.3. Ensure protection of the public from workplace practices. **(T-1).**

2.18.4. Ensure personnel are trained on radiation hazards in the workplace and appropriate protection requirements. **(T-2).**

2.18.5. Ensure radiation safety procedures are current and adhered to by radiation workers. **(T-2).**

2.18.6. Notify the IRSO and URSO, as soon as practicable after identification, of changes in practices or procedures involving radiation, potential violations of this manual, unsafe work practices involving radiation, or accidents or incidents involving radiation. **(T-1).**

2.18.7. Ensure radiation workers are properly trained on the risks of radiation, methods to minimize exposure, and the ALARA principle. **(T-0).**

2.18.8. For MTF supervisors where ionizing radiation and/or RAM are used: designate personnel to execute the patient dose monitoring, occupational dosimetry, personal protective equipment (PPE) inventory and testing, radiation safety training, and equipment quality control programs in their area. **(T-2).**

2.19. Radiation worker shall:

2.19.1. Follow applicable rules or procedures, and receive information, instruction, and training for radiation protection and safety specified by organizational management and this manual. **(T-1).**

2.19.2. Use issued dosimeters and personal protective equipment correctly. **(T-1).**

2.19.3. Provide the URSO and/or IRSO information on past and current work relevant to ensure comprehensive effective protection and safety for themselves and others, to include any moonlighting dosimetry data to the URSO and IRSO. **(T-1).**

2.19.4. Perform operations in a manner that maintains doses ALARA. **(T-1).**

2.19.5. Notify workplace supervisors of changes to procedures or operations that could affect exposure, potential violations of this manual, unsafe work practices involving radiation, or accidents or incidents involving radiation. **(T-1).**

2.19.6. An active duty pregnant female shall, on becoming aware she is pregnant, notify her workplace supervisor or primary care manager. **(T-1). Note:** A non-military or civilian member is encouraged to notify her workplace supervisor or Public Health office of her pregnancy. It is important to remember that it is the decision of a civilian woman whether or not she declares her pregnancy. This applies to female radiation workers and not all females.

Chapter 3

TRAINING AND QUALIFICATIONS

3.1. General. This chapter provides the training requirements and qualifications required for all AF radiation workers and radiation safety officers (RSOs). In general, the AF has three types of RSOs: installation radiation safety officer (IRSO), URSO, and permit RSO.

3.2. IRSO Qualifications.

3.2.1. A Primary IRSO shall:

3.2.1.1. Be a fully qualified Bioenvironmental Engineer (43E3X) or 1306 Series General Scale (GS) employee who meets at least one of the following: **(T-1)**

3.2.1.1.1. Attended the Bioenvironmental Engineer Officer Course prior to 1999 or after 2007; or

3.2.1.1.2. Be a fully qualified Bioenvironmental Engineer Health Physics Specialty (43E3G); or

3.2.1.1.3. Is a certified health physicist; or

3.2.1.1.4. Has received 40 hours of RSO training (**reference Table 3.1**) via a formal course.

3.2.1.2. Knows the radiation hazards on the installation in order to fulfill the IRSO requirements of this manual, AFMAN 40-201, and AFI 91-108 IRSO requirements as applicable to the installation. **(T-3). Note:** Bioenvironmental Engineering Radiation Skills Course completion is preferred but not required for IRSO appointment.

3.2.1.3. In the absence of a 43E3X or 1306 Series GS employee, or if a unit is geographically separate from one, the IRSO may be a 43E2X or a 7-level Bioenvironmental Engineering Craftsman (4B071) provided they meet at least one of the criteria in **paragraphs 3.2.1.1.1, 3.2.1.1.2, 3.2.1.1.3, or 3.2.1.1.4**

3.2.2. Alternate IRSO. A 43E3X, 1306 Series GS employee, 43E2X, or a 7-level Bioenvironmental Engineering Craftsman (4B071) may be appointed as an alternate IRSO provided they meet at least one of the criteria in **paragraphs 3.2.1.1.1, 3.2.1.1.2, 3.2.1.1.3, or 3.2.1.1.4**

3.2.3. Contractors cannot be the IRSO or alternate. **(T-1).**

3.2.4. Permittees listed on a permit issued by the AF Radioisotope Committee Secretariat cannot be an IRSO or alternate. **(T-1).**

3.3. URSO Qualifications.

3.3.1. URSO qualifications are based upon radioactive material and/or radiation producing devices used by the unit. URSOs shall have the required training **listed on Table 3.1 (T-1).**

3.3.2. URSOs responsible for general licensed devices will be trained on: locations of use and storage of RAM, material control and accountability, transfer and disposal, and AFMAN 40-201. **(T-0).**

3.3.3. URSOs for nuclear capable units (intrinsic radiation programs) will be appointed and trained in accordance with AFI 91-108 requirements. **(T-1).**

3.4. Permit RSOs Qualifications. See AFMAN 40-201.

3.5. Radiation Workers. All radiation workers will have the training **listed on Table 3.1 (T-3).** Initial and annual training is provided by the IRSO, URSO, or permit RSOs depending on scope and use as determined by the IRSO. **(T-3).**

Table 3.1. Training guidance for radiation safety officers and radiation workers.

Topic	IRSO[1]	URSO[2]	Radiation Worker[3]
Radioactivity, radioactive decay, and radiation production devices (x-rays, neutrons)	X	As Applicable	As Applicable
Radiation vs. contamination	X	X	X
Internal vs. external exposure and dose	X	X	X
Biological effects of radiation	X	X	X
Types and hazards associated with RAM or devices	X	X	X
ALARA concept	X	X	X
Training in the principles of time, distance, and	X	X	X
Radiation detection and measurement	X	As Applicable	As Applicable
Personnel dosimetry	X	X	X
Applicable regulations and reporting requirements	X	X	X
License/Permit conditions, amendments, renewals	X	-	-
Locations of use and storage of RAM	X	As Applicable[4]	As Applicable
Material control and accountability	X	As Applicable[4]	As Applicable
Annual audit of radiation safety program	X	As Applicable	As Applicable
Transfer and disposal	X	As Applicable[4]	As Applicable
Record keeping	X	X	X
Prior events involving permitted material	X	-	-
Managing incidents and mishaps	X	X	X
Recognition and assurance of radiation warning signs; visibility and legibility	X	X	X
Inspection by regulatory agencies	X	X	-
Requirement for complete and accurate information	X	X	-
Employee protection	X	X	X
Deliberate misconduct	X	X	X
Emergency response procedures	X	X	X
Protective action guides	X	-	-
Air monitoring procedures	X	-	-
Bioassay techniques	X	As Applicable	As Applicable

[1] These are the minimum topics for a 40 hr course to train IRSOs.
[2] Specific training requirements for permit RSOs are contained in AFMAN 40-201 and intrinsic radiation URSOs are contained in AFI 91-108.
[3] Specific training requirements for intrinsic radiation workers are contained in AFI 91-108.
[4] Required for general licensed device URSOs in accordance with DoDI 6055.08, *Occupational Ionizing Radiation Protection Program*. **(T-0).**
Note: Medical unit RSOs should ensure radiological medical practitioners are additionally trained on national initiatives for patient dose reduction or optimization (e.g. "Image Wisely", "Image Gently") for compliance with accrediting bodies.

Chapter 4

RADIATION PROTECTION FOR OCCUPATIONAL PRACTICES

4.1. Organization and Administration. Every organization or installation that uses non-exempt quantities of RAM, RPDs, or has the potential for exposures to residual RAM associated with AF operations shall implement a radiation safety program commensurate with the scope of the program and its potential health hazards and have a URSO. **(T-1).** Critical program elements are found in this chapter and are generic to all AF practices involving potential exposure to ionizing radiation.

4.1.1. Installation Radiation Safety.

4.1.1.1. IRSO. The IRSO has overall responsibility and authority over the installation or Air Force owned operations requiring a radiation safety program, as described in **paragraph 2.10**, to include suspension of radiological operations, see AFMAN 40-201 para 2.9.2. **(T-1).**

4.1.1.2. URSO. This individual shall be directly responsible to senior management of the organization, properly resourced to execute the requirements of the radiation safety program, and have ready access to all levels of the organization that may use radiation. **(T-3).**

4.1.1.3. Radiation Safety Committee (RSC) shall be established when directed by federal standard (e.g. Title 10 CFR Section 33.13, *Requirements for the Issuance of a Type A Specific License of Broad Scope*, or Title 10 CFR Section 35.24, *Authority and Responsibilities for the Radiation Protection Program*) or when specified as a permit condition issued by the AF Radioisotope Committee Secretariat. **(T-0). Note:** Optional RSCs may be established by commanders of facilities, organizations, or installations with extensive radiation protection program requirements after advisement from their respective IRSO or URSO(s). Examples include installations with many diverse operations involving radioactive material permits or activities with large radiation sources (e.g. irradiators, radioactive waste facilities). Optional RSCs should be composed of senior management, the IRSO, URSO(s), and other individuals knowledgeable and responsible for RAM and radiation producing devices. The RSC should meet at a frequency appropriate to evaluate the purpose, safety, and compliance of the radiation safety program and regulatory requirements.

4.1.2. Radiation Safety Program Policy, Instructions, Procedures and Manuals.

4.1.2.1. Commanders, URSOs, and workplace supervisors shall institute a radiation safety policy that defines the goals of the radiation safety program, the organization and administrative controls required for use of RAM and radiation producing devices, and state a commitment to radiation protection policy. **(T-1).**

4.1.2.2. Commanders, URSOs, and workplace supervisors shall ensure radiation safety procedures are incorporated into appropriate procedures or instructions. **(T-1).** These procedures and instructions should describe the actions or steps necessary to safely conduct a particular task involving a radiation source and document performance of the task. Radiation safety procedures and instructions shall be clearly written, readily

available to all users of radiation producing devices, and annually reviewed and updated, as necessary. **(T-1).** They shall describe the safety controls and procedural safeguards necessary to limit exposure and actions to be followed in the event of a mishap or emergency. **(T-1).**

4.2. Facility Design, Layout, and Area Classification.

4.2.1. Facility Design.

4.2.1.1. Facilities in which non-exempt quantities of RAM, nuclear weapons or components, 91(b) material, or radiation producing devices are used shall be designed so that exposures from normal operation of the facility are ALARA and do not result in exposures that exceed applicable limits as provided in **paragraph 4.4.1** **(T-1).** Where appropriate, facilities shall also be designed so as to prevent or mitigate radiation mishaps. **(T-1).**

4.2.1.2. Consideration shall be made, but not limited to: site selection, facility layout, equipment and system design, shielding, ventilation (including fume hoods and glove boxes), RAM waste management, monitoring and surveillance requirements, and access controls (References: National Council on Radiation Protection (NCRP) Report No. 127, *Operational Radiation Safety Program*, **Chapter 4**, Facility Design, NCRP Report No. 88, *Radiation Alarms and Access Control Systems*, NCRP Report No. 147, *Structural Shielding Design for Medical X-Ray Imaging Facilities*, and NCRP Report No. 151, *Structural Shielding Design and Evaluation Megavoltage X- and Gamma-Ray Radiotherapy Facilities*). **(T-1).**

4.2.1.3. AF facilities designed, whether new construction or renovation project, for use of RAM or radiation producing devices shall be constructed so that a member of the public will not likely receive more than 0.02 milliSievert (mSv) (2 mrem) deep-dose equivalent in any one hour and 1 mSv (100 mrem) total effective dose equivalent in a calendar year from the normal operation of the facility. **(T-0).**

4.2.1.4. The planning and design of new or significantly modified facilities shall include a review by a qualified expert (as defined in **Attachment 1**) to ensure appropriate radiation safety features are incorporated. **(T-1).** Where local expertise is unavailable, contact USAFSAM for assistance. AFMRA/SG3PB should be contacted on questions regarding policy implementation.

4.2.1.5. Administrative controls and personal protective equipment shall not be used as a substitute for engineering controls and appropriate facility design. **(T-3).**

4.2.1.6. Consider future decommissioning requirements during the design phase for facilities using unsealed RAM, accelerators producing photons with energies greater than 13 mega-electron volt, or neutron sources. **(T-1).**

4.2.2. Classification of Areas.

4.2.2.1. Restricted Areas. Restricted areas shall be established, as required, to control radiation exposures, spread of contamination, or access to RAM and devices. **(T-1).** Restricted areas shall:

4.2.2.1.1. Be delineated appropriately through engineered and physical controls, signage, and/or administrative controls, as appropriate. **(T-1).**

4.2.2.1.2. Have access controlled so personnel having approval of the unit or organization are permitted unescorted access. Visitors and other personnel (e.g., patients) entering restricted areas shall be escorted. **(T-3).**

4.2.2.2. Radiation areas, high radiation areas, and very high radiation areas shall:

4.2.2.2.1. Be considered restricted areas. **(T-3).**

4.2.2.2.2. Adhere to posting and other requirements in accordance with Title 10 CFR Part 20, *Standards for Protection Against Radiation* or Title 29 CFR Section 1910.1096, *Ionizing Radiation*, as applicable. **(T-0).**

4.3. Training.

4.3.1. Radiation Workers (non-intrinsic radiation). All personnel (military, civilians and in-house contractors) who have the potential to be occupationally exposed to 1 mSv (100 mrem) in a year shall receive initial and annual training that is appropriate in breadth and depth to the radiation hazards present in the workplace. **(T-0).** IRSO may identify other populations for training including emergency responders.

4.3.1.1. Train according to guidance **in Table 3.1 (T-0).**

4.3.1.2. The radiation training shall be developed by the unit, organization, or IRSO; reviewed and revised as necessary to reflect changes in practices in the workplace; and included in the Job Safety Training Outline in accordance with AFI 91-202, *The US Air Force Mishap Prevention Program*. **(T-2).**

4.3.1.3. Record Keeping. Training programs presented, course curricula, and attendance shall be maintained for a period of three (3) years unless otherwise specified. **(T-1).** Training shall be documented in accordance with AFI 91-202. **(T-1).**

4.3.2. Intrinsic radiation safety training shall be given to all nuclear weapons specialists (2W2) assigned to nuclear weapons capable units or to units with 91(b) materials in accordance with AFI 91-108 training requirements and frequency. **(T-1). Note:** The content of training is provided at the AFMRA Radiation Programs website located on AFMS Knowledge Exchange; **https://kx.health.mil/kj/kx5/radiationprograms/Pages/home.aspx**. Additionally, the IRSO and URSO can expand the scope of this training as appropriate (e.g. handlers, loaders, security forces, and aircrew).

4.4. Radiation Exposure Control.

4.4.1. Dose Limits. Personnel shall not exceed dose limits specified by 10 CFR Part 20 for either radioactive material or machine produced radiation. **(T-0).**

4.4.2. Radiation exposures investigations are used to correct dose assignments and/or to enhance current radiation control practices, **see paragraph 4.5.2**

4.4.3. Exposure Control. Radiation workers shall use the following techniques under the judgment and discretion of the IRSO to ensure dose limits are not exceeded and exposures are ALARA.

4.4.3.1. Time, Distance, and Shielding. As appropriate, minimize the time around sources of external radiation, maximize the distance to RAM and radiation producing

devices, and utilize radiation shielding between radiation source and potential exposed personnel to control external radiation doses. **(T-1).**

4.4.3.2. Personal Protective Equipment. Personal protective equipment, including lead aprons, glasses and thyroid shields to protect from x-rays, plastic face shields and glasses to protect from beta particles, and clothing and gloves to protect from contamination shall be used to the greatest extent possible. **(T-1)**. Respiratory protection is normally limited to specific permitted operations and emergencies, and use is managed in accordance with AFI 48-137, *Respiratory Protection Program*. Use personal protective equipment except when such use may result in overall more significant internal or external radiation exposure, or other health risks more severe than that posed by the potential radiation exposure. **(T-1)**.

4.4.3.3. Contamination Control.

4.4.3.3.1. In the absence of superseding regulatory or advisory guidance, a surface is contaminated if total radioactivity is above the screening levels in DoD Manual (DoDM) 3145.03, *DoD Chemical, Biological, and Radiological Clearance Guidance for Platforms and Materiel*. **(T-1).** If screening levels are met, free release criteria are met. **(T-1). Exception:**

4.4.3.3.1.1. Routine low-level contamination by short-lived radionuclides (half-life less than 120 days).

4.4.3.3.1.2. Permitted material which is covered under specific permit conditions.

4.4.3.3.1.3. Derived, case by case, clearance levels greater than screening levels, if approved by AFMRA/SG3PB.

4.4.3.3.2. Operational guidance for use of contaminated material is based on exposure guidance and screening levels found in DoDM 3145.03.

4.4.3.3.3. Always prevent or keep radioactive contamination ALARA. **(T-1).**

4.4.3.4. Access Control and Alarm Systems. Provide access control and/or alarm systems to prevent access to or warn of a radiation hazard, as appropriate for areas that can be classified as high or very high radiation areas under **paragraph 4.2.2** **(T-3).** For additional information, consult USAFSAM.

4.4.3.5. Radiation Safety Procedures and Work Permits. Implement, use and at least annually review radiation safety procedures and radiation work permits, as appropriate. **(T-3).**

4.4.3.6. Change of Duty or Curtailment. Individuals who are likely to exceed the occupational dose limits, even with application of the above measures, shall have duties modified or curtailed so that limits are not exceeded. **(T-1).** Such changes in duty shall remain in effect until the individual's projected dose will be less than the prescribed limits. **(T-1).**

4.4.3.7. Change of Duty or Curtailment of Pregnant Radiation Workers. Based on the exposure information and workplace assessment of the IRSO, the female radiation worker's primary care manager (if military) or health care provider (if civilian) will determine any recommended restrictions to the radiation worker's duties involving

occupational radiation exposure in accordance with AFMAN 48-125. **(T-1).** The following guidelines are prudent and should be taken into consideration for declared pregnant radiation workers:

4.4.3.7.1. Declared pregnant technologists or providers should be recommended for restrictions to perform fluoroscopic and interventional procedures.

4.4.3.7.2. Declared pregnant technologists can perform routine radiographic studies, portable examinations to include the operating room (except fluoroscopy or C-arm), computed tomography, mammography, and radiation therapy.

4.4.3.7.3. Declared pregnant nuclear medicine technologists may work in imaging rooms; but should be recommended for restrictions to compound radiopharmaceuticals, dose patients, and work in the hot lab.

4.4.3.7.4. Female nuclear weapons specialists (2W2) who declare pregnancy should be recommended for restrictions of duty requiring contact with or occupancy in rooms where Hydrogen-3 (tritium) vapors/oxides are present. If operational requirements of the unit make it necessary for pregnant females to work in those areas, then the unit commander shall review the exposure potential. The unit commander shall consult AFSEC (Weapons Safety Division), the IRSO, and/or the radiation worker's primary care manger to discuss the potential for exposure and risk. **(T-1).**

4.5. Radiation Dosimetry.

4.5.1. Personnel Monitoring Criteria. Individuals who are occupationally exposed to ionizing radiation as part of their duties must be provided dosimetry and bioassays as described in AFMAN 48-125 when any of the following apply: **Note:** For non-permitted material environmental radon exposures **see Chapter 7** for separate requirements.

4.5.1.1. Exposures are measured or calculated to exceed 1 mSv (100 mrem) total effective dose equivalent in a year, 2% of a committed effective dose equivalent based annual limit of intake, or 2% of the occupational limits. **(T-1).**

4.5.1.2. If the type of radiation is detectable by the AF personnel monitoring program, at the discretion of the IRSO, dosimetry services may be provided in the following cases:

4.5.1.2.1. Monitoring to demonstrate compliance with ALARA work practices;

4.5.1.2.2. Monitoring is desirable to evaluate potential exposure conditions to relieve worker concern;

4.5.1.2.3. Requested by the individual.

4.5.1.3. Individuals entering a high or very high radiation area. **(T-0).**

4.5.1.4. Members of the 2W2 career field assigned to a nuclear capable unit shall be monitored for both gamma and neutron dose in accordance with AFI 91-108, except those assigned to duties not having the potential for intrinsic radiation exposure (i.e., administrative positions). **(T-1).**

4.5.1.5. Pregnant occupational radiation workers must be monitored monthly throughout their gestational period, see AFMAN 48-125. **(T-0).**

4.5.1.6. Aircrew: U-2 pilots will have radiation dose assessed, see AFMAN 48-125. **(T-1).**

4.5.1.7. Contractors will only be provided dosimetry when legally required, as specified in the contract. **(T-1).** The contract should state the contractor's employer (not the USAF) will provide dosimetry. The AF always has the responsibility to control exposures due to licensed radioactive material in accordance with 10 CFR Part 20. **(T-0).**

4.5.2. Radiation Exposure Investigations.

4.5.2.1. Abnormal Investigations. Personnel should not receive a dose in excess of 25% of the applicable annual dose limits in a quarter, or 8% of the applicable annual dose limits in a month without proper justification and optimization of the procedure. See AFMAN 48-125 for threshold values. If these reference levels are exceeded, this will drive an abnormal investigation as described in AFMAN 48-125. **(T-1).**

4.5.2.2. Potential Overexposure Investigations. Personnel receiving doses in excess of applicable annual dose limits will drive a potential overexposure investigation as described in AFMAN 48-125. **(T-1).**

4.5.2.3. Investigation Action Level Investigations. IRSOs or the RSC where applicable, shall ensure the local program includes documented acceptable dose threshold levels based upon historical dosimetry and bioassay results, and/or surveillance (see investigation action level in **attachment 1**). **(T-1)**. IRSOs shall conduct an investigation into causative factors and identify corrective measures when this threshold level is exceeded. **(T-1).** Refer to AFMAN 48-125 for additional information. **Note:** Investigation action level investigations should follow the methodology of abnormal investigations, however reports are internal to the installation and used as a tool to improve radiation protection practices locally. **Note:** These reporting requirements established here do not replace or supersede the reporting requirements associated with a nuclear reactor or radiological mishap as established in AFI 91-204, *Safety Investigation and Reports*.

4.5.2.4. Investigations for members of the public, **see paragraph 5.2.6**

4.5.3. Previous or Concurrent Occupational Dose. The IRSO shall make a reasonable effort to collect dosimetry records for individuals having either past or present non-AF employment involving radiation exposure. **(T-1).** AF personnel moonlighting in jobs where they are monitored for radiation exposure shall make arrangements to routinely (e.g., annually or based on monitoring period) provide these results to the IRSO or shop supervisor. **(T-1).** The IRSO shall ensure these results are forwarded to USAFSAM for incorporation in the MRER. **(T-1).** The individual bears ultimate responsibility for ensuring any non-AF dosimetry results become part of the MRER. **(T-1).** See AFMAN 48-125 for additional requirements on previous or concurrent occupational dose.

4.5.4. Administrative Doses. Assignment of administrative doses are required for lost or damaged dosimeters or for those individuals with exposures other than the purpose for which it was intended. **(T-1).** Exposure information from recovered dosimeters shall replace administrative dose estimates. **(T-1). Note:** Recovered badges can only be analyzed by the dosimetry center 6 months after the end of monitoring period. Assigned doses must be

estimated by the IRSO using the procedures in AFMAN 48-125. **(T-1).** The IRSO shall ensure the assigned dose replaces the null placeholder in the MRER within 30 days. **(T-1).**

4.6. Monitoring and Surveillance Programs and Instrumentation.

4.6.1. Types of Surveys. Two types of surveys are common: routine surveys conducted on a fixed, periodic basis at common locations to determine changes or trends in the radiation environment and non-routine surveys performed to evaluate new or expected changes in a radiation field. Surveys shall be conducted in areas where the potential exists for exposure to external radiation fields, airborne contamination, or surface contamination. **(T-0).**

4.6.1.1. Non-routine surveys and routine surveys shall be performed by a qualified expert (see **Attachment 1**) following requirements of this manual. **(T-2).**

4.6.1.2. For non-routine surveys, new survey measurements must be taken after any modification of the facility impacting the shielding or RAM control, replacement or change of the radiation source, and/or a significant change in practice or the uses of the radiation source. **(T-2).** The survey shall determine the efficacy of any installed shielding to protect surrounding areas from primary or scattered radiation, as applicable. **(T-2).** In all cases, the survey shall be conducted within 90 calendar days of the facility acceptance date or the change in the radiological characteristics of the source; this includes nuclear weapons storage and maintenance facilities, as well as facilities housing 91(b) materials. **(T-2).**

4.6.2. Instrumentation. Instrumentation used to perform surveys, shall be appropriate to the type(s) of radiation and emitted energy(ies). **(T-0).** IRSOs shall consult with USAFSAM on instrumentation requirements prior to performing intrinsic radiation, atmospheric radiation, high energy (>13 mega-electron volt) accelerator surveys or other mixed radiation environments. **(T-3).**

4.6.2.1. Instrumentation shall be calibrated annually, or at a frequency specified in the applicable Air Force RAM permit; use National Institute of Standards and Technology traceable radiation sources for calibration or post-calibration verification. **(T-0).**

4.6.2.2. Instrument performance shall be checked before each use, in accordance with manufacturer's recommendations, as applicable. **(T-1).**

4.6.3. Record Keeping.

4.6.3.1. Survey results shall be maintained for a period of three years or as specified in the applicable AF RAM permit, whichever is most stringent. **(T-0). Note:** Additional specific record keeping requirements for radiation protection programs utilizing RAM can be found in AFMAN 40-201.

4.6.3.2. Survey results shall include: a description and/or drawing of each measurement location; measured dose and/or contamination levels at each location; the type, model number, serial number, and calibration date of the instrument; name of individual performing the survey; date of the survey and applicable comments. **(T-1).**

4.7. Radioactive Waste Management.

4.7.1. Radioactive waste minimization: waste generation shall be minimized, or preferably prevented at the source. **(T-1).**

4.7.2. Radioactive waste storage: all waste pending disposition shall be stored in a restricted area, in clearly marked containers. **(T-2).**

4.8. Occupational Medical Surveillance and Follow-Up. For personnel who are occupationally exposed and whose doses do not exceed the applicable dose limits, testing and monitoring should be the same as standard clinical preventive services that follow guidelines for the general population (e.g., routine mammography, pap smears, etc.). Medical surveillance of overexposures shall be evaluated on a case-by-case basis by the MAJCOM/SG in coordination with AFMRA/SG3PB and USAFSAM (**see paragraphs 6.6 and 6.7**). **(T-3).**

Chapter 5

RADIATION PROTECTION OF THE PUBLIC

5.1. General. Public dose is the dose received by a member of the public from exposure to radiation or radioactive material used in AF practices, or radon within Air Force controlled buildings. Public dose does not include occupational dose or doses from other background radiation sources or any medical administration the individual has received.

5.2. Control of Public Exposures from AF Practices. Administrative and engineering controls, policies, or procedures are implemented to control public dose from AF practices. The following requirements are specified for all AF practices that may result in public exposure.

5.2.1. All practices shall be conducted to minimize public exposure utilizing the ALARA principle. **(T-0).**

5.2.2. Members of the public shall not occupy vehicles during cargo or vehicle inspections that use scanning systems employing radiation. **(T-2).**

5.2.3. All practices shall be conducted in such a manner that a member of the public will not exceed the applicable dose limits specified. **(T-0).** For non-medical practices, the IRSO shall be responsible for the determination, either by measurement or calculation that this dose is not exceeded, and maintain this record permanently using Defense Occupational and Environmental Health Readiness System (documented in the similar exposure group process). **(T-1).** For medical practices, the permit RSO, responsible medical physicist, health physicist or BEE, as appropriate, shall be responsible for this determination. **(T-1).**

5.2.4. Unrestricted Areas. The dose in any unrestricted area resulting from AF controlled radiation will not exceed 0.02 mSv (2 mrem) in any one hour, or 1 mSv (100 mrem) in a year, occupancy and use factors being taken into account. This requirement does not apply to those excepted by Title 10 CFR Section 35.75, *Release of Individuals Containing Unsealed Byproduct Material or Implants Containing Byproduct Material*. **(T-0).** The IRSO shall be responsible for the assessment, either by measurement or calculation, that these dose limits are not exceeded and maintain this record permanently (i.e., Defense Occupational and Environmental Health Readiness System, documented in the similar exposure group process). **(T-1).**

5.2.5. Control of Visitors.

5.2.5.1. Visitors to any restricted area must be accompanied by personnel knowledgeable about the protection and safety measures in the area. **(T-1).**

5.2.5.2. Visitors must be provided adequate information and instruction before they enter a restricted area to ensure appropriate protection of the visitors and of other personnel in the area. **(T-1).**

5.2.5.3. Visitors entering a location defined as "Radiation Area" or "High Radiation Area" or that could incur a deep dose equivalent in excess of 0.10 mSv (10 mrem) shall be provided personal monitoring devices (i.e. a dosimeter). **(T-1).** A log of all such monitored individuals shall be maintained and the results communicated to the individual. **(T-1).**

5.2.6. Public Overexposures. If an individual member of the public may have received a dose in excess of the applicable limit, this dose and practice shall be immediately investigated by the IRSO. **(T-0).** If appropriate, the unit, organization or IRSO should implement, with commander's approval, protective actions to mitigate further exposures. **(T-0).**

5.2.6.1. Notification. When a member of the public may have received a dose above the applicable limits, the IRSO shall be contacted immediately. **(T-1).** The IRSO shall contact USAFSAM to validate the assessment of dose. **(T-1).** If the dose is validated, the IRSO shall immediately notify the MAJCOM BEE and AFMRA/SG3PB. **(T-1). Note:** Report to the AFMRA/SG3PB by calling DSN 761-6946, Commercial (703) 681-6946; or to report after normal duty hours, call the Andrews Regional Command Post, DSN 858-5058, Commercial (301) 981-5058.

5.2.6.2. Reporting. The IRSO shall investigate suspected exposures above the limits, with a written report of the investigation submitted through the MAJCOM BEE to AFMRA/SG3PB within 7 days of notification. **(T-1).** The written report must include: **(T-1).**

5.2.6.2.1. The organization's name and office symbol where the exposure occurred;

5.2.6.2.2. A brief description of the event;

5.2.6.2.3. A description of the person(s) exposed and their estimated dose equivalent;

5.2.6.2.4. Why the event occurred; and

5.2.6.2.5. What actions, if any, have been taken or are planned to prevent recurrence.

5.3. Protection of the Public During Emergencies. Specific protective measures and guidance that can be implemented are contained in the Environmental Protection Agency's (EPA) Manual: EPA-400/R-17/001, *Protective Action Guides and Planning Guidance for Radiological Incidents*. The decision to invoke a protective action, i.e., sheltering or evacuation, should be based on whether the action will allow the population to avert (or avoid) the recommended threshold dose provided with a given action or intervention.

Chapter 6

RADIATION PROTECTION OF AF PERSONNEL DURING EMERGENCIES

6.1. General. This chapter provides guidance for protecting AF personnel conducting actions in uncontrolled radiation environments. These environments may include garrison or deployed locations where known or suspected nuclear or radiological hazards exist and radiological environments created by hostile action or industrial, medical, nuclear incident or accident. Emergency exposure interventions are specific actions performed in these environments to mitigate the source(s) of exposure, to save life or limb, protect high value assets, or achieve higher objectives that may merit personnel incur risks greater than those permitted for practices. This section also applies to nuclear capable units and units with 91(b) material. It includes radiation protection considerations described in Joint Publication (JP) 3-11, *Operations in Chemical, Biological, Radiological, and Nuclear Environments*.

6.2. Radiation Protection Principles and Guidance for Emergencies.

6.2.1. There are three basic principles of ionizing radiation protection used to manage the risks associated with ionizing radiation exposure.

6.2.1.1. Justification. No unnecessary exposure should be undertaken.

6.2.1.2. Optimization. The level of individual doses, number of people exposed and likelihood of incurring exposure should be kept ALARA.

6.2.1.3. Limitation. The dose to an individual conducting operations shall be monitored and limited in accordance with the commander's operational exposure guidance. **(T-1).**

6.2.1.4. For public dose guidance, reference EPA-400/R-17/001, **see paragraph 5.3**

6.2.2. Applying radiation protection principles should not introduce a higher level or more severe risk to the unit or mission. Complete risk management requires:

6.2.2.1. Information. Personnel must assess risk using an all hazards approach using all available information such as measurements, visual observations, and modeling.

6.2.2.2. Justification. Consideration of threshold and random health consequences of radiation exposure needs to be considered. Unnecessary risks to health should not be accepted.

6.2.2.3. Optimization. To minimize the potential effects of exposure, emergency planning should involve efforts to reduce the time in a radiation area, maintaining the maximum distance possible from RAM and radiation producing devices, and using shields between exposed personnel and RAM and radiation producing devices to keep radiation exposures ALARA.

6.2.3. Dose guidance should be developed for a given emergency. Dose limits do not apply for emergencies. Instead, the operational exposure guidance is applicable. The commander's decision to allow this exposure should be based on the radiation exposure status category found in JP 3-11 and made in the context of the situation and balance the anticipated benefit with both short and long-term health risks the exposure may cause. The exposure will vary depending on whether the mission is critical, priority, or routine and the

severity of the radiological threat. Operational exposure guidance should be set for each mission with potential for exposure, for decontamination of personnel or equipment, or for immediate or operational decontamination.

6.2.3.1. Dose due to the ingestion or inhalation of RAM cannot be accurately measured in the field but can be estimated for operational purposes. Depending on the type of RAM and its dispersed form, the internal dose may be much larger than the external dose for a given operation.

6.2.3.2. Medical authorities should recommend PPE, including respiratory protection. Commanders will dictate PPE use based on operational risk analysis. **(T-3).** Operational risk analysis should include the detriment posed by reduced vision, hearing, mobility, and tactile sensation; increased heat and psychological stress; increased time to complete tasks, and decreased task accuracy when wearing PPE. These in turn can lead to increases in external radiation exposures and the magnitude of other mission risks.

6.2.4. Voluntary Participation. Where practical, emergency operations predicted to result in significant exposures (those greater than practice limits) should make use of volunteers to the greatest extent possible. Experienced volunteers may be preferred, since experienced workers typically can complete an operation in a timelier manner, reducing their dose.

6.2.5. Excluded Populations. Operational personnel that are, or may be pregnant, or that are less than 18 years of age shall not conduct emergency radiological operations. **(T-1).**

6.3. Allowable Contamination Levels. Recommended contamination levels for clothing, skin, and equipment shall be managed to levels that are ALARA **consistent with paragraph 4.4.3.3** or guidance provided by the assigned radiation protection personnel. **(T-1).**

6.4. Training and Risk Communication. Personnel participating in an emergency operation shall be informed of the potential health risks their radiation exposure may result in, and trained in the necessary principles and procedures to minimize their exposure consistent with **paragraph 4.3 (T-1).** Depending on the nature of the operation, training should be provided by medical radiation protection personnel.

6.5. Monitoring During Emergency Operations. Implementing risk management and supporting operational dose guidance requires the ability to estimate or measure individual doses. This is optimally done through the use of radiation survey instruments, environmental sampling, personnel dosimeters, and/or bioassays.

6.5.1. Personnel deployed in known or potential radiation environments shall be provided individual dosimeters if the potential to exceed 1 mSv (100 mrem) exists. **(T-0).**

6.5.2. Personnel entering contaminated environments should be afforded in-vitro or in-vivo bioassays to determine the extent of internal exposures if internal contamination is suspected.

6.5.3. If individual dosimetry or prompt bioassay measurements are not available, efforts will be made to estimate individual doses through group dosimetry, radiation survey, environmental monitoring data, modeling, or dose reconstructions **(T-0).**

6.5.4. Systematic, individual dose records for external and internal exposure result shall be maintained indefinitely in the AF MRER, even if the dosimeter or bioassay result is zero. **(T-0).**

6.5.4.1. For units for which group dosimetry is used, doses as measured may be averaged and applied to the entire group for the purposes of applying the commander's operational exposure guidance. The RSO supporting the unit shall track unit doses, determine the acceptability of the unit dose to reflect individual doses, and forward this dose information for each unit member for inclusion in the MRER. **(T-0).**

6.5.4.2. Classification of exposure data may prevent its inclusion in the MRER. Medical authorities for the command conducting classified operations shall maintain and be able to access all classified exposure data, ensuring all releasable data is available for maintenance in the MRER and to the monitored individual. **(T-0).**

6.5.5. Reports of dosimetry or bioassay results shall be given promptly to the potentially exposed individual and their commander or delegated representative. **(T-0).**

6.6. Medical Diagnosis and Treatment. Medical professional should use Army Techniques Publication (ATP) 4-02.83, *Multiservice Tactics, Techniques, and Procedures for Treatment of Nuclear and Radiological Casualties*, as a reference when evaluating or treating personnel who receive unknown doses of radiation or doses exceeding the applicable established limits.

6.7. Medical Surveillance.

6.7.1. Doses greater than 50 mSv (5 rem): On completion of a military operation or operations involving radiation exposure, long term, periodic health monitoring is required for individuals receiving cumulative effective doses in excess of 50 mSv (5 rem). **(T-1).** Such follow-up shall be performed through USAFSAM **(T-1)**, and may include, but not be limited to:

6.7.1.1. Creation of a registry for the impacted population;

6.7.1.2. Submission of biological or bioassay samples to determine absorbed dose and residual burdens of RAM, respectively; and/or

6.7.1.3. Annual or biannual medical examination through the local Base Operational Medicine Clinic, particularly following the latent periods of known radiogenic cancers. Known radiogenic cancers include leukemia, multiple myeloma, lymphomas, thyroid, breast, lung, esophageal, stomach, urinary tract, skin, and colon cancer.

6.7.2. Doses less than 50 mSv (5 rem): For those personnel who have received doses less than current occupational dose limits, there is not a requirement to conduct follow up medical testing and monitoring. Personnel should continue with normally prescribed medical procedures authorized by their primary care provider, such as those testing and monitoring programs included in guidelines for the general population (e.g., routine mammography and pap smears).

6.7.2.1. Health monitoring may include submission of bioassay samples to document intakes of radionuclides, and screening for cancers consistent with current medical practices.

Chapter 7

INDOOR RADON EXPOSURE SURVEILLANCE AND MITIGATION

7.1. Radon Exposure Guidance. Note: This radon guidance does not apply to Nuclear Regulatory Commission regulated radioactive material that would generate a radon hazard, follow AFMAN 40-201 guidance on managing Nuclear Regulatory Commission regulated (AF permitted materials). **(T-0).**

7.1.1. Exposure to radon will be assessed by radon progeny exposure in the units of Working Level Months in a year (WLM/yr). **(T-1).** Radon-222 gas concentration in the units of Becquerel per meter cubed (Bq/m^3) (traditional units are picoCuries per liter, pCi/L) may be used as a surrogate to estimate the exposure in WLM/yr; radon gas concentration will most likely be used to determine compliance due to its convenience in measurement. However radon gas concentrations must be converted to a time-weighted exposure to determine compliance. **(T-1). Note:** Equilibrium Factor (EF) can be assumed to be as low as 0.4, unless it is assessed directly by measurements; time (hours/yr) is the duration of occupant exposure. For housing, a conservative 100% occupancy may be assumed. To convert radon gas concentrations to WLM/yr, one may use the following equation.

Figure 7.1. Convert Radon Gas Concentrations to WLM/yr.

$$X\left\{\frac{\text{WLM}}{\text{yr}}\right\} = \frac{\left(\text{Radon}^{222}\ \text{Concentration}\left\{\frac{\text{pCi}}{\text{L}}\right\}\right) \times (\text{EF}\{\text{unitless}\}) \times \left(\text{Time}\left\{\frac{\text{hours}}{\text{yr}}\right\}\right)}{\left(17000\left\{\frac{\text{pCi}}{\text{L}} \times \frac{\text{hours}}{\text{WLM}}\right\}\right)}$$

7.1.1.1. Residential housing example: Estimating WLM/yr from Radon-222 gas concentration of 4 pCi/L using 8760 hours/yr (100% occupancy):

Figure 7.2. Residential Housing Example.

$$X\left\{\frac{WLM}{yr}\right\} = \frac{\left(4\left\{\frac{pCi}{L}\right\}\right) \times (0.4) \times \left(8760\left\{\frac{hours}{yr}\right\}\right)}{\left(17000\left\{\frac{pCi}{L} \times \frac{hours}{WLM}\right\}\right)}$$

$$X \cong 0.8\ \frac{WLM}{yr}$$

7.1.1.2. Occupied workplace example: Estimating WLM/yr from Radon-222 gas concentration of 16 pCi/L using 2000 hours/yr:

Figure 7.3. Occupied Workplace Example.

$$X\left\{\frac{WLM}{yr}\right\} = \frac{\left(16\left\{\frac{pCi}{L}\right\}\right) \times (0.4) \times \left(2000\left\{\frac{hours}{yr}\right\}\right)}{\left(17000\left\{\frac{pCi}{L} \times \frac{hours}{WLM}\right\}\right)}$$

$$X \cong .75\,\frac{WLM}{yr}$$

7.1.2. The annual limit is 4 WLM/yr. **(T-1).**

7.1.3. The AF goal is the annual average concentration of radon gas in occupied buildings (homes, schools, child development centers, work centers, and office buildings) be maintained at or below to concentration where exposure from radon progeny does not exceed 0.8 WLM/yr.

7.1.4. Mitigation will begin at exposures greater than 0.8 WLM/yr. **(T-1).**

Table 7.1. Mitigation Timelines. (T-3).

Radon Progeny Exposure, WLM/yr	Mitigation Timeline	Comments
< 0.8	Not applicable	none
0.8 to < 1.6	Mitigate within 5 years	After remediation, if result is still between 0.8 to < 1.6 WLM/yr further remediation may not be warranted or beneficial. For housing: Give tenant option to move
1.6 to < 4	Mitigate within 2 years	Recommend not using facility if mitigation will be delayed beyond timelines. For housing: Give tenant option to move, do not re-lease until mitigated.

> 4	Mitigate within 6 months	Recommend not using facility if mitigation will be delayed beyond timelines. For housing: Give tenant option to move, recommend moving as soon as practicable if mitigation will be delayed; do not re-lease until mitigated.

7.2. Housing, Child Development Centers, and DoD Education Activity Schools.

7.2.1. All installations must have radon assessments for structures supporting housing, child development centers, and DoD Education Activity schools. **(T-1).** Results of testing will be made available to occupants. **(T-3). Note:** If radon assessments were completed, this requirement does not necessitate resampling.

7.2.2. This applies to all installations, except deployed locations (**see paragraph 7.4.8**) **(T-1)**; **see paragraph 7.4.6** for privatized housing requirements.

7.2.3. Housing structure assessments may be based on representative sampling, e.g. 10% of dwellings, provided that all screening values are less than 0.8 WLM/yr **(T-2)**, consistent with historical housing screening programs implemented by the DoD services.

7.2.4. Only long-term sampling must be reported to occupants. **(T-3).**

7.2.5. DoD housing residents will not be required to live in a home or assessed a turndown option for refusing a home with an assessment of 0.8 WLM/yr or higher. **(T-1).**

7.2.6. Follow mitigation timelines **in Table 7.1 (T-3).** If post-mitigation sampling results in exposure less than 1.6 WLM/yr; then no further mitigation may be warranted or beneficial.

7.3. Occupied Workplace Buildings (Structures not included in paragraph 7.2).

7.3.1. Assess the concentration of radon in occupied workplace buildings according to a sampling plan, particularly the six installations previously documented as having high-risk to radon. **(T-1). Note:** Sampling plan guidance and high-risk installations can be found in USAF School of Aerospace Medicine's *Bioenvironmental Engineer's Guidebook for Radon Management.* One hundred percent assessment of installation facilities may not be required, *see* **paragraph 7.3.3**

7.3.2. Installations not identified as high-risk to radon but have facilities that may pose a risk to high radon exposure (e.g. subterranean buildings, facilities with inadequate ventilation) should only be sampled after consultation with the IRSO and/or USAFSAM.

7.3.3. If facilities tested are less than the goal of 0.8 WLM/yr, additional testing of like structures may not be needed after consultation with USAFSAM.

7.3.4. IRSO will ensure occupants are notified of exposure levels greater than 0.8 WLM/yr and are provided radon awareness training annually in accordance with AFI 48-145, *Occupational and Environmental Health Program*. **(T-1).**

7.3.5. Document radon measurement results in Defense Occupational and Environmental Health Readiness System in accordance with AFI 48-145 procedures. **(T-1).** See the *Bioenvironmental Engineer's Guidebook for Radon Management* for best practices.

7.3.6. Follow mitigation timelines **in Table 7.1 (T-3).** If post-mitigation sampling results in exposure less than 1.6 WLM/yr; then no further mitigation may be warranted or beneficial.

7.4. Additional Radon Requirements.

7.4.1. IRSO will apply ALARA to exposure mitigation, building mitigation strategy, and facility design reviews. **(T-1).** IRSO may consider using risk assessment codes, as warranted, to assist with installation funding prioritization and make commanders aware of risk levels.

7.4.2. Radon measurements must be conducted, analyzed, documented and periodically re-evaluated in accordance with the *Bioenvironmental Engineer's Guidebook for Radon Management*. **(T-2).**

7.4.3. Long-term sampling and post mitigation results must be reported to occupants. **(T-3).**

7.4.4. New structures should not be tested for one year after construction to allow for foundation settling; it is acceptable to occupy a facility in the absence of initial radon test results. **(T-2).**

7.4.5. Civil Engineering will notify the IRSO within 5 days after completion of facility construction or facility radon mitigation. **(T-3).** Radon mitigated facilities should have radon testing initiated within 90 days after the mitigation system is installed. **(T-3).**

7.4.6. Radon testing and mitigation in current privatized housing will be accomplished by the project owner as specified in the applicable project documents; new privatized housing projects will assure radon testing and mitigation is accomplished by the project owner as specified in the applicable project documents. **(T-2).**

7.4.7. Radon-related guidance published in the Unified Facility Criteria will be followed for construction and renovations in DoD housing, privatized housing, child development centers, and other facilities. **(T-1).**

7.4.8. Enduring deployment locations will monitor facilities consistent with this manual at the discretion of the MAJCOM Bioenvironmental Engineering overseeing industrial hygiene at the location **(T-2)**; radon assessment will be included in the Occupational and Environmental Health Site Assessment. **(T-2).**

Chapter 8

MEDICAL TREATMENT FACILITY SPECIFIC GUIDANCE AND REQUIREMENTS

8.1. Introduction. This section outlines some various radiation program elements specific to medical operations to ensure safe and optimal use of ionizing radiation in medicine.

8.2. Not Used.

8.3. Medical Credentialing, Authorizations and Qualifications.

8.3.1. Referring Medical Practitioners (i.e. Requesting Health Professionals). The use of ionizing radiation or radioactive materials for the purposes of diagnosis or treatment of disease or injury can be ordered (i.e. requested) by individuals who are appropriately privileged within the applicable health care facility consistent with the following provisions:

8.3.1.1. Imaging studies or therapeutic procedures may be requested by doctors of medicine or osteopathy who are licensed in the United States (or a United States territory or possession) or are certified by an appropriate certifying agency.

8.3.1.2. Doctors of dental surgery or dental medicine may request appropriate examinations of the head, neck and chest. Such requests are normally confined to the oral region.

8.3.1.3. Podiatrists and chiropractors may request x-ray examinations appropriate to their specialty.

8.3.1.4. The chief of medical staff (SGH), in consultation with the lead radiologist, may authorize the credentials committee to grant privileges to order radiographic exams to other healthcare providers (e.g. physician assistants, nurse practitioners, physical therapists, occupational therapists, etc.), consistent with their training and abilities.

8.3.2. Medical and Dental Use of Machine Produced Ionizing Radiation. Machine produced ionizing radiation for medical and dental use can only be applied by radiological medical practitioners, radiological dental practitioners, diagnostic radiologic technologists, dental technicians, or other individuals approved by the SGH for specialty applications. **(T-1).**

8.3.2.1. Radiological medical practitioners are health professionals with education and specialist training in the medical uses of radiation that are competent to independently perform or oversee procedures involving medical exposure in a given specialty.

8.3.2.1.1. Radiologists are licensed physicians that are certified in radiology or diagnostic radiology by the American Board of Radiology or the American Osteopathic Board of Radiology, or have completed a diagnostic radiology residency program approved by the Accreditation Council for Graduate Medical Education or the American Osteopathic Association.

8.3.2.1.2. Other physicians who use ionizing radiation for imaging outside the radiology department, e.g., fluoroscopy in the operating room; when acting as a radiological medical practitioner, have the same responsibilities for imaging protocols and for supervising equipment operation that would otherwise be assigned to a radiologist.

8.3.2.2. Radiological dental practitioners are health professionals, with education and specialist training in the dental uses of radiation, who are competent to independently perform or oversee procedures involving dental exposure in a given specialty.

8.3.2.3. Diagnostic radiologic technologists are the primary personnel who operate medical imaging equipment, deliver radiation to patients, and capture diagnostic images. Active duty member proficiency is demonstrated by award of the AF specialty code 4R0X1, skill level 3. Civilian proficiency can be evidenced by accreditation with the American Registry of Radiologic Technologists, or by meeting specific requirements delineated within applicable job core documents and performance work statements.

8.3.2.4. Dental technicians that operate ionizing radiation producing equipment receive appropriate education and training in the areas of anatomy, physics, technique and principles of radiographic exposure, radiation protection, radiographic positioning, and image processing that are relevant to dental imaging. Proficiency can be demonstrated by award of the AF specialty code 4Y0X1, skill level 3 or satisfying existing state certification programs for dental auxiliaries.

8.3.2.5. Medical and dental residents may operate ionizing radiation equipment in their specialty while under the general supervision of a fully qualified radiological medical or dental practitioner.

8.3.2.6. Diagnostic radiologic technologist trainees and dental technician trainees may operate ionizing radiation equipment in their specialty while under the direct supervision of a fully qualified radiologic technologist or dental technician.

8.3.2.7. The SGH, in consultation with the lead radiologist and URSO, may approve other individuals to operate ionizing radiation equipment for specialty medical and dental applications. These operations must be conducted under the supervision of a radiological medical/dental practitioner. **(T-1).** Examples of such operations include, but are not limited to: directed operating room usage of fluoroscopy by nurses; operation of grenz-ray systems, and operation of bone densitometry systems. The SGH, lead radiologist, and URSO may impose caveats on such operations as deemed necessary.

8.3.2.8. Initial and Annual Medical RPD Operator Training. Training shall be provided initially prior to utilization of equipment and at least annually thereafter for all staff that operate RPDs. **(T-1).** In addition, those staff that operate or supervise the operation of fluoroscopy systems must receive initial and annual training that covers at a minimum The Joint Commission requirements. **(T-1).** Continued education, with local radiation staff approval, may satisfy the annual training.

8.3.2.9. For deployed locations not subject to The Joint Commission requirements, active duty medics not specified **in paragraphs 8.3.2.1 through 8.3.2.6**, may use diagnostic imaging equipment of limited scope provided they follow a training plan approved by the: radiology consultant, dental consultant, radiologic technologist career field manager, or dental assistance career field manager as appropriate. **(T-1).** Or, these medics may be individually approved in writing by the radiology consultant or radiologic technologist career field manager after suppling adequate documented training of diagnostic imaging equipment technique and safety. **(T-1).**

8.3.3. Medical use of RAM: All use of RAM for medically licensed or permitted activities must be conducted by, or under the general supervision of, an authorized user and comply with associated license or permit conditions. **(T-0).**

8.3.4. Uses of Ionizing Radiation and RAM Ancillary to Medicine and Dentistry. Ancillary uses of ionizing radiation and RAM (e.g. equipment testing, quality control, calibration, training, and protocol development) that are reasonably expected to further safety and clinical efficacy objectives are allowable contingent on the following:

8.3.4.1. All applicable regulatory and accreditation qualification requirements are met and measures are implemented as necessary to ensure staff and public safety. **(T-0).**

8.3.4.2. Ionizing radiation and RAM shall not be applied to a human. **(T-0).**

8.3.4.3. The use is performed directly by, or under the general supervision of: an IRSO or URSO, a qualified medical physicist (QMP), a qualified biomedical equipment technician, service engineer, or an individual authorized to use the same equipment or RAM. **(T-1).**

8.3.5. Medical and Dental Research Use of Ionizing Radiation and RAM. The use of ionizing radiation and RAM for medical and dental research is allowable contingent on the following:

8.3.5.1. The research complies with DoDI 3216.02_AFI 40-402, *Protection of Human Subjects and Adherence to Ethical Standards in Air Force Supported Research*, **(T-0)** and measures are implemented as necessary to ensure staff and public safety in consultation with the URSO or IRSO. **(T-1).**

8.3.5.2. Ionizing radiation and RAM use that is not indicated for medical care shall not be applied to a human without investigational review board approval granted in consultation with a qualified medical physicist or radiation safety committee. **(T-1).**

8.3.6. Qualified Medical Physicists (QMPs). QMPs are competent authorities for quality control of modalities within the medical physics scope of practice. In this capacity, QMPs have authority to deem equipment or practices unsafe. Following such a determination, only a QMP can reinstate the equipment/practice. **(T-1).** Correspondingly, an individual will be deemed a QMP for a particular medical physics function under the following conditions:

8.3.6.1. All applicable regulatory and accreditation qualification requirements are met, and the individual is an Air Force active duty or civil service member that meets the approved qualification standard certified by the AF/SG consultant for medical physics. **(T-1).** (**Note:** The AF specialty code for medical physics is 43EXM.), *or*

8.3.6.2. All applicable regulatory and accreditation qualification requirements are met and the individual has been deemed by a different federal or state agency, professional certifying agency, or applicable host nation government as being qualified for the particular function. **(T-1).** In cases of ambiguity (e.g. differing qualification categorization schemes) an Air Force QMP for that particular function or the AF/SG consultant for medical physics can determine the individual's qualification status.

8.3.7. Medical physicist assistants are individuals that may perform certain medical physics functions under the general supervision of a QMP. Allowable functions are those that they have been deemed qualified for by the supervising QMP and are not precluded by applicable

regulations. **(T-1).** Medical physicist assistants shall have previously obtained a bachelor's degree (or higher) in a relevant field or certification as a radiologic technologist, nuclear medicine technologist, radiation therapist, or biomedical equipment technician. **(T-1).** Medical physicist assistants may be required to obtain supplemental training and qualifications to support radiology information technology systems. Medical physicist assistants possess the authority to temporarily deem equipment and practices unsafe pending consultation with a QMP.

8.4. Equipment Requirements.

8.4.1. The technical requirements in this section are applicable to medical and dental devices that use ionizing radiation, radioactive material, ultrasound, medical grade diagnostic displays, and magnetic fields for diagnostic or therapeutic purposes on a human that are owned, and under the operational control of, the Air Force. Contract devices operated by personnel provided under the terms of the contract shall provide the Air Force with documentation demonstrating ongoing compliance with all pertinent requirements of the applicable state or host nation. Other devices (e.g. Air Force owned equipment at an Army location) shall have a written arrangement between the affected parties to ensure that all applicable regulatory and accreditory requirements are met. **(T-3).** All devices sited at locations under Air Force jurisdiction shall comply with Air Force occupational and public safety requirements. **(T-1).**

8.4.2. All clinics shall implement a quality control program for each diagnostic imaging, nuclear medicine, and radiation therapy modality present. **(T-0).** These programs are aimed at ensuring staff and public safety while optimizing clinical efficacy and patient radiation dose. QMPs are deemed the subject matter experts for quality control of these systems and all associated quality control programs are subject to their inspection. In cases of conflict, the AF/SG consultant for medical physics is the final arbiter.

8.4.3. Equipment performance evaluations (EPEs) of medical ionizing radiation producing or imaging systems shall be performed in the following situations:

8.4.3.1. Initial EPEs (i.e., acceptance testing) shall be performed before the first use of a therapeutic or mammographic system on a human. **(T-0).** Other non-therapeutic (diagnostic) systems can be used in conjunction with vendor overseen applications setup or training after consultation with medical physicist. **(T-1).** An initial EPE must be conducted prior to all other uses of these systems on a human. **(T-3).**

8.4.3.2. Sustainment EPEs shall be performed annually (i.e. 12 months +/- 2 months) unless otherwise determined for a particular function by the AFMPWG. **(T-1).**

8.4.3.3. Post-modification EPEs shall be performed following repair, upgrade, modification, or relocation in a manner that may significantly affect the equipment's performance relative to a demonstrable standard. **(T-1).** The evaluation scope may be limited to that necessary for accessing compliance with potentially effected standards. However, evaluations that do not cover all components of a sustainment EPE cannot reset the evaluation cycle. The need for a post-modification EPE shall be determined by an individual qualified to perform an EPE on the subject equipment. **(T-1).** A qualified individual should be consulted prior to system modification.

8.4.3.4. Extensions in evaluation timelines can be granted by a QMP for up to 30 days of clinical use if the extension does not pose significant risk of harm or violate applicable regulations or accreditation standards.

8.4.3.5. The AF/SG consultant for medical physics can waive EPE requirements when compliance is incompatible with military necessity (e.g. use of a system immediately following repair during combat.). **Note:** See AFI 41-201, *Managing Clinical Engineering Programs,* for additional guidance. The QMP may be consulted for assistance with understanding manufacturer or accreditation requirements pertaining to EPEs.

8.4.4. Equipment performance evaluations (EPEs) of medical ionizing radiation producing or imaging systems shall comply with the following:

8.4.4.1. Applicable regulations, accreditation requirements and AFI 41-201. **(T-1).**

8.4.4.2. Existent AFMPWG standards for technical requirements. **(T-1).** In the absence of these standards, industry standards or vendor methodology should be used.

8.4.4.3. Existent AFMPWG standards for personnel qualifications. **(T-1).** QMPs may certify work of others provided that no applicable regulations or accreditation requirements are violated and the QMP verifies the technical acceptability of the work.

8.4.4.4. Initial EPEs shall not be performed by an equipment vendor or their representative. **(T-1).** Equipment vendors, or their representative, may assist in the evaluation (e.g. familiarize the evaluator with a novel equipment interface). The availability of a vendor representative during initial testing should be integrated into purchase agreements.

8.4.4.5. EPE records shall be published within 30 days of the completion of the EPE. **(T-3).**

8.4.4.6. For non-therapeutic devices, EPE records shall be maintained for the life of the equipment plus three years. **(T-1).**

8.4.4.7. For therapeutic devices, EPE records shall be maintained for the life of the equipment plus five years. **(T-1).**

8.4.5. Identified discrepancies of applicable regulations or accreditation requirements shall be managed consistent with those requirements. **(T-1).** If no corrective action timeline for the applicable regulation and accreditation requirements is defined; QMPs can define requirements and establish parameters for follow-up evaluations.

8.5. Facility Requirements.

8.5.1. **See paragraph 4.2** for design and classification requirements.

8.5.2. Facilities shall ensure that departments that medically use orally or intravenously administered radioactive material have a dedicated patient bathroom for that purpose. **(T-3).**

8.5.3. Facilities shall maintain records of installed radiation shielding until the relevant shielding is removed. **(T-1).**

8.5.4. Facilities shall post signs consistent with the following:

8.5.4.1. Signs advising patients to inform staff of potential pregnancies shall be clearly posted in departments where unsealed radioactive material is medically administered or ionizing radiation may be directly applied to the abdomen or pelvis. **(T-1).**

8.5.4.2. Signs demarcating magnetic resonance imaging safety zones 2, 3, and 4 consistent with American College of Radiology's magnetic resonance imaging safety zone recommendations. **(T-1).** (**Note:** Zone 1 is defined to be all areas freely accessible to the general public and does not need to be posted).

8.5.4.3. Warning signs on the entry to areas where magnetic fields may exceed 5 gauss. Signs shall communicate the area as being restricted to screened patients (if applicable) and trained personnel only. **(T-1).** Signs shall communicate if magnetic fields are present continuously or during use only. **(T-1).**

8.5.4.4. Doors and walls that contain lead, or other intentional radiation shielding material, shall be posted and include thickness information. **(T-3).** This requirement can be consolidated into a single placard for each effected room.

8.5.4.5. Signs shall be in English and in the language of the host nation (if different). **(T-1).**

8.6. Clinical Requirements.

8.6.1. The clinical requirements in this chapter are applicable to medical and dental devices that use ionizing radiation, radioactive material, ultrasound, medical grade diagnostic displays, and magnetic fields for diagnostic or therapeutic purposes on a human that are owned, and under the operational control of, the Air Force.

8.6.2. Each MTF shall have and implement written operating and safety procedures. **(T-1).**

8.6.3. AF clinics with mammography services offered, see requirements outlined in AFI 44-102, *Medical Care Management*.

8.6.4. During imaging or treatment, the operator shall be able to see, speak to, and hear the patient. **(T-1).** This capacity can be facilitated by electronic means (e.g. video cameras).

8.6.5. The following general imaging principles should be followed to the greatest extent possible consistent with clinical objectives.

8.6.5.1. Minimize patient radiation dose.

8.6.5.2. The minimum necessary anatomy should be exposed (e.g. limit computed tomography (CT) scan range, utilize radiographic collimation).

8.6.5.3. Unnecessary repeat studies should be avoided.

8.6.5.4. Imaging parameters (e.g., kilovoltage peak, milliampere-seconds, CT pitch) should be optimized for the patient's age and habitus.

8.6.6. For fluoroscopy and CT, patient exposure information shall be recorded in each patients' medical record and cumulative logs maintained. **(T-1).** The pertinent consulting regional medical physics office is the final arbiter in the sufficiency of recorded information.

8.6.7. Fluoroscopy (excepting microampere systems) shall be performed only by or under the immediate supervision of a physician granted fluoroscopy privileges. **(T-1).**

8.6.8. Exposure of Fertile Women to Radiation for Treatment or Diagnosis. Due to the increased radiation exposure risks to the conceptus (including all embryonic and fetal development stages), the possibility of pregnancy shall be addressed for any woman of reproductive capacity when considering any nuclear medicine procedure and/or any radiographic examination involving the lower abdomen. **(T-1).**

8.6.8.1. Before any medical procedure involving radiation is performed, the patient shall be asked if she is pregnant; if the patient is pregnant or there is a possibility that she could be pregnant, the attending physician shall be immediately informed. **(T-1).** Before any therapeutic procedure, a pregnancy test shall be given to all fertile women no sooner than 48 hours preceding the treatment. **(T-1).** Any inconclusive pregnancy test or statement made by the patient as to the potential of being pregnant should delay treatment until a conclusive negative pregnancy test can be obtained. **Note:** A pregnancy test cannot detect the presence of an embryo until several days post implantation.

8.6.8.2. Following an exposure of a conceptus to a primary ionizing radiation field (i.e., within the imaging field of view), or internalization of radioactive material, the responsible clinic shall request a fetal dose consult from a qualified medical physicist. **(T-1).** The patient's physician shall then ensure this consult is recorded in the medical record and interpreted to the patient. **(T-1).** If applicable, adhere to the reporting requirements in **paragraph 8.8** **(T-1).**

8.7. Staff and Public Safety Requirements.

8.7.1. Direct exposure to ionizing radiation shall comply with the following:

8.7.1.1. Individuals shall not be exposed to a direct ionizing radiation beam unless it is conducted as part of a study or procedure ordered by a referring medical practitioner or under an IRB approved research protocol. **(T-1).** Deliberate exposure of an individual for training, demonstration, or other non-healing art is specifically prohibited.

8.7.1.2. No staff or ancillary personnel should be exposed to a direct ionizing radiation beam outside of their own medical care. If a patient must be held in position, mechanical supports or immobilization aids should be used for all therapy applications and when feasible for diagnostic applications. In diagnostic applications, where mechanical devices cannot be used, the individual selected to hold the patient should be a willing, non-pregnant, adult relative or guardian (18 years of age or older). If a relative or guardian is not available, the patient should be held by a staff member from a department other than diagnostic imaging. Diagnostic imaging staff should be the last resort for holding a patient. The individual holding the patient shall be positioned as far away as possible from the direct beam and provided PPE to the extent it does not preclude clinical objectives. **(T-3).**

8.7.1.3. For fluoroscopic applications, if direct beam exposure is unavoidable, care should be exercised to minimize the extent of the exposure. The use of PPE (e.g. leaded gloves) is highly discouraged in the direct beam on systems with automatic brightness control due its pronounced effect on patient dose and the concomitant increase in scatter radiation experienced by the staff. The use of PPE adjacent to the direct beam, or in the direct beam on a system not operating with automatic brightness control, is encouraged provided it does not preclude clinical objectives.

8.7.2. Indirect exposure to ionizing radiation shall comply with the following:

8.7.2.1. Individuals, other than the patient, shall not be in linear accelerator vaults or high dose rate brachytherapy vaults during machine use. **(T-1).**

8.7.2.2. Only individuals whose presence is necessary shall be in the room during the operation of a stationary RPD or within 6 feet of the x-ray source, or patient, during operation of a portable RPD. **(T-1).** Individuals within these exclusion zones shall be protected with shielding appropriate for the situation as determined by the URSO and/or IRSO (e.g., PPE, portable shields, etc.). **(T-1).**

8.7.2.3. Exceptions can be granted by the URSO and/or IRSO if specific circumstances still enable compliance with dose limits and the ALARA principle.

8.7.3. See **paragraph 4.5** and AFMAN 48-125 for occupational radiation monitoring requirements.

8.7.4. Departments utilizing RPDs shall implement a PPE program in consultation with the URSO or IRSO. **(T-3).** Pertinent details include:

8.7.4.1. Sufficient quantities of PPE should be readily available to staff.

8.7.4.2. PPE should be stored in manner that preserves its effectiveness.

8.7.4.3. PPE shall be inventoried and inspected initially and annually for defects. **(T-1).** Inspection may be conducted either radiographically or through a combination visual and tactile approach.

8.7.4.4. The URSO or IRSO is the final arbiter for the adequacy of PPE and inspection criteria.

8.8. Adverse Medical Incident Reporting and Notification.

8.8.1. Urgent matters that could result in future patient, staff, or public injury, (e.g. identification of significant defects in equipment that is widespread) shall be promptly reported to AFMRA/SG3PB. **(T-1).**

8.8.2. MTFs shall comply with reporting and notification requirements levied by regulatory agencies (e.g. Food and Drug Administration) **(T-0)**, applicable accreditation agencies (e.g. Joint Commission) and other DoD or AF regulations **(T-1)**. Pertinent examples include:

8.8.2.1. Incident reporting requirements levied by AFI 91-204.

8.8.2.2. Radioactive material incident reporting requirements levied by Title 10 CFR Section 35.3045, *Report and Notification of a Medical Event*, and AFMAN 40-201.

8.8.2.3. Medical device reporting requirements levied by the Safe Medical Devices Act of 1990, Title 21 CFR Part 803, *Medical Device Reporting*, to Title 21 CFR Part 807, *Establishment Registration and Device Listing for Manufacturers and Initial Importers of Devices*, and AFI 44-119, *Medical Quality Operations*. **Note:** This reporting is for incidents involving device malfunction, not operator misuse, with potential to cause serious harm or death. Reporting is accomplished through the medical logistics in accordance with AFI 41-201 and may be facilitated by the SGH's patient safety program.

8.8.2.4. Joint Commission reviewable sentinel events involving ionizing radiation. Reporting and coordination of follow-up actions for sentinel events is performed by the patient safety manager or as directed by the SGH in accordance with AFI 44-119. **(T-1).**

8.8.3. Adverse Medical Incident Determination.

8.8.3.1. Adverse medical incidents that require reporting to AFMRA/SG3PB (Radiation Program) include:

8.8.3.1.1. Medical Events. A medical event is defined as an adverse event which places a patient or human research subject at risk of injury, that was not due to the noncompliance of the individual, in which the use of radiation for medical applications results in: **(T-1).**

8.8.3.1.1.1. An unintended event where a physician determines that demonstrable damage has occurred to an organ or a physiological system of an individual due to, or suspected to be due to, exposure to medical ionizing radiation.

8.8.3.1.1.2. Prolonged fluoroscopy with a cumulative dose exceeding 15 Gy to a single region of skin.

8.8.3.1.1.3. For radioactive material applications; meeting the criteria specified in 10 CFR 35.3045.

8.8.3.1.1.4. For external beam radiotherapy; meeting one of the following criteria:

8.8.3.1.1.4.1. The total dose delivered differs from the prescribed dose by 10% or more;

8.8.3.1.1.4.2. The fractionated dose delivered exceeds the prescribed dose, for a single fraction, by 50% or more;

8.8.3.1.1.4.3. The treatment is delivered to the wrong individual;

8.8.3.1.1.4.4. The wrong treatment modality is used; or

8.8.3.1.1.4.5. The treatment is delivered to the wrong site or target volume.

8.8.3.1.2. Patient Facilitated Adverse Incidents. A patient facilitated adverse incident is defined as an adverse event that occurred due to the noncompliance of a patient or human research subject, in which radiation has or may cause unintended permanent functional damage to an organ or a physiological system, as determined by a physician.

8.8.3.1.3. Reportable Doses to a Conceptus or Nursing Child. MTFs shall report any total effective dose equivalent to a conceptus (i.e., embryo or fetus) or nursing child that is greater than 50 mSv (5 rem) that is a result of the administration of machine produced radiation and/or RAM to a pregnant individual or nursing mother from studies or treatments where the resultant dose was not specifically approved, in advance, by the requesting physician. **(T-0).**

8.8.3.2. The associated clinic shall notify the responsible MTF's SGH, or their designee, and the URSO or IRSO no later than the next calendar day after discovery of a potential adverse medical incident. **(T-1).** The SGH, or designee, will determine if an actual

reportable incident occurred. **(T-1).** Consultation with an expert in radiation (e.g. radiologist, nuclear medicine authorized user, radiation oncologist, and/or medical physicist) is advised.

8.8.4. Adverse Medical Incident Reporting and Notification.

8.8.4.1. If a reportable adverse medical incident is determined to have occurred, or it is determined that one could have occurred but cannot be excluded out at that time, the MTF will initiate reporting and notification requirements. **(T-1).**

8.8.4.2. A verbal report shall be provided to AFMRA/SG3PB (Radiation Program) within 7 calendar days of the discovery and a written report within 15 calendar days of the discovery. **(T-1).** Written reports will be routed through the responsible MAJCOM/SGP and will include **(T-1):**

8.8.4.2.1. The clinic's organization and base;

8.8.4.2.2. The name and unit of the prescribing physician, chief of radiation oncology or diagnostic imaging, and any associated medical physicists or radiation safety officers;

8.8.4.2.3. A brief description of the event and its cause;

8.8.4.2.4. The effect, if any, on the individual(s) that received radiation exposure.

8.8.4.2.5. Actions taken, or planned, to prevent recurrence;

8.8.4.2.6. The status of notification to the individual (or the individual's responsible relative or guardian) and any information that was provided; and

8.8.4.2.7. The report may not contain personal identifiable information.

8.8.4.3. The following notifications shall be made:

8.8.4.3.1. The clinic shall notify the referring physician, or, if unavailable, the responsible referring clinic chief within 24 hours. **(T-1).**

8.8.4.3.2. The affected individual shall also be notified no later than 24 hours after its discovery, unless the referring physician or clinic chief elects to personally inform the individual or that, based on medical judgment, telling the individual would be harmful. **(T-1).**

8.8.4.3.3. The clinic is not required to notify the affected individual without first consulting the referring physician. However, if the referring physician or the affected individual cannot be reached within 24 hours, the clinic shall notify the individual as soon as possible thereafter. **(T-1).**

8.8.4.3.4. The clinic may not delay any appropriate medical care, including any necessary remedial care as a result of the medical event, because of a delay in notification. **(T-1).**

8.8.4.3.5. To meet the requirements of this section, notification may be made to that affected individual's responsible relative or guardian. For reportable doses to a conceptus or nursing child; the affected individual may be regarded as the mother.

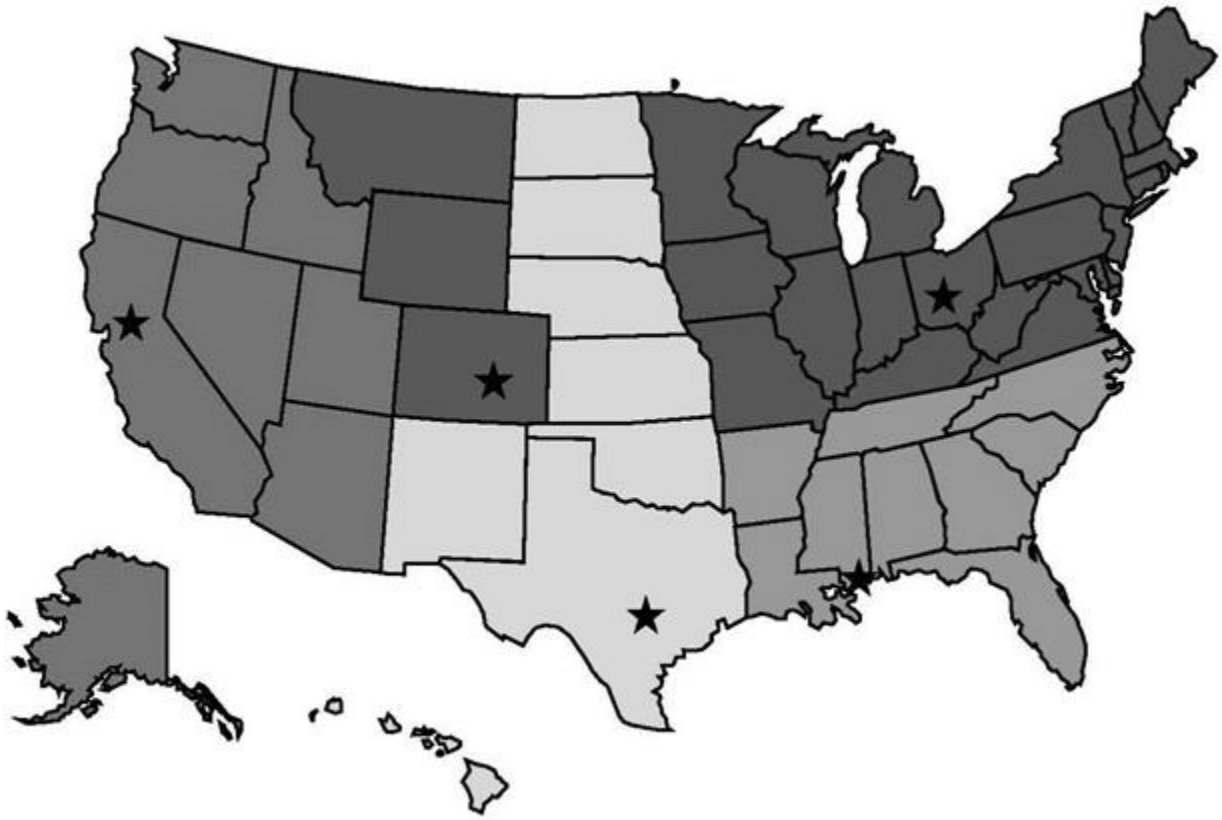
8.8.4.4. If the affected individual was notified under **paragraph 8.8.4.3**, the clinic shall also provide a written report to the individual within 15 days after discovery of the incident. **(T-1).** A clinic may send either:

8.8.4.4.1. A copy of the report that was submitted to the MAJCOM/SGP; or

8.8.4.4.2. A brief description of both the event and the consequences that may affect the individual.

8.8.4.5. The clinic shall retain a record of a medical event or patient facilitated adverse incident for 50 years per the Air Force records disposition schedule. **(T-1).** The record shall contain the information specified in **paragraph 8.8.4.2** **(T-1).**

Figure 8.1. REGIONAL CONSULTING MEDICAL PHYSICS OFFICES.



Note:

1. The AF/SG consultant for medical physics can authorize deviations from the above map, define regional consulting offices for locations not listed where the Air Force is the lead service, and will determine other worldwide locations' regional consulting offices based on manning availability.
2. Active duty members possessing medical physics qualifications that are not assigned to a regional consulting office can be called upon to support regional requirements. They are considered adjunct staff to the regional office covering the geographic area in which they are assigned.

3. Regional offices can derive support from other Air Force sites and federal entities when needed and available.
4. Support can be sought by alternative means if the overseeing regional medical physics office deems direct support to not be feasible and advantageous to the government.

5. Support provided in accordance with written agreements between the leadership of effected organizations (e.g. telerad agreements, memorandums of agreement with other DoD entities, etc.) are not confined by the above map.

Table 8.1. REGIONAL CONSULTING MEDICAL PHYSICS OFFICES.

Region	Regional Consulting Medical Physics
Northeast	Wright Patterson AFB
Southeast	Keesler AFB
Central	JBSA-Lackland
Mountain	USAF Academy
West	Travis AFB
Other	AF/SG MP Consultant Determined

Chapter 9

AIR FORCE RADIATION SAFETY COMMITTEE (AF-RSC)

9.1. Purpose. The AF-RSC is responsible for providing oversight of sources of radiation not covered by AFMAN 40-201 or AFI 91-108 to ensure they are operated in a safe and compliant manner. The AF-RSC is also responsible for the development and execution of the AF's radiation protection program for both planned and emergency exposure situations as outlined in this manual.

9.2. AF-RSC Members Organizations and Responsibilities.

9.2.1. **Table 9.1** summarizes the membership of the AF- RSC. At the request of the AF-RSCES or the AF-RSC chairman additional advisors can be invited.

9.2.2. AF-RSC chair: Open AF-RSC meetings, and preside over their proceedings. Assist in maintaining the discussion focus of the agenda items, and resolve disagreements. Adjourn meeting once completed.

9.2.3. AF-RSC executive secretary (AF-RSCES): Organization, scheduling and planning of the AF-RSC meeting, and generation of meeting minutes.

9.2.4. AF-RSC members: Ensure either they or their alternates attend scheduled AF-RSC meetings to represent their functional areas or commands, and are prepared to address agenda items.

Table 9.1. AF-RSC Membership.

Role	AF-RSC Voting Membership	
	Primary	Alternate
Chair, AF-RSC (AF/SG3/4 or delegate)	1	1
Executive Secretary, AF-RSC (AFMRA/SG3PB)	1	1
AF/SG Consultant for Medical Physics (AFMRA/SG3PB)	1	1
Bioenvironmental Engineering Representative (AFMRA/SG3PB)	1	1
Medical Readiness (AFMRA/SG3X)	1	1
Installations, Environment and Energy Representative (SAF/IE)	1	1
AF Acquisition Representative (SAF/AQ)	1	1
AF Logistics Representative (AF/A4L)	1	1
AF Civil Engineering Representative (AF/A4C)	1	1
AF Inspection Agency Representative (AFIA/SG)	1	
Command Surgeons Representative (ACC/SG; AETC/SG; AFCENT/SG; AFGSC/SG; AFMC/SG; AFRC/SG; AFSOC/SG; AMC/SG; ANG/SG; PACAF/SG; USAFE-AFFRICA/SG)	1	1
USAFSAM Representative (711 HPW)	1	1

Air Force Safety Center Representative (AFSEC/SEWN)	1	
Legal Advisor (AFLOA/JAC)	1 (non-voting)	1 (non-voting)

9.3. Business Practices.

9.3.1. A formal AF-RSC meeting will occur at least semi-annually, but more frequently if determined necessary by the Chair or the majority of the committee. AF- RSC meetings are scheduled by the AF-RSCES.

9.3.2. Ad hoc meetings can be called by the chair on an as needed basis. These meetings are called to address emergent issues that require timely action by the AF-RSC.

9.3.3. Rapid staffing of an action can be approved by the chair to address emergent issues for which an ad hoc meeting cannot be convened. For a rapid staffing the AF- RSCES will prepare a staffing package that addresses the issue and provides the voting members of the AF-RSC the ability to vote without meeting. All rapid staffing actions will be discussed at the next AF-RSC meeting.

9.3.4. Quorum for a meeting is established by having a least one-half of the voting members present.

9.3.5. The chair and the AF-RSCES will establish the specific procedures for the conduct of routine meetings, ad hoc meetings and rapid staffing actions.

9.3.6. Motions and Voting.

9.3.6.1. Only members and guests recognized by the chair may speak.

9.3.6.2. Generally, before any item can be discussed, there should be a motion made and seconded. Once a motion has been seconded, discussion will follow. After discussion, one of four things can happen:

9.3.6.2.1. There can be a vote on the motion. In the event of a tie, the chair casts the deciding vote.

9.3.6.2.2. The motion can be amended (second required). Then there can be discussion on the amendment. The amendment can be voted. If the amendment passes, the motion automatically passes. If the amendment fails, the motion still stands and can be discussed until voted.

9.3.6.2.3. The motion can be tabled (second required). There can be no discussion on a motion to table; a vote must be taken immediately. If the vote is to table, no further discussion can take place on the motion.

9.3.6.2.4. There may be no action on the motion; therefore, it becomes old business at a future meeting.

9.3.6.3. Motions must be clear and concise. A motion to "improve practices" would be vague and discussions could meander. However, a motion to "implement x-ray radiation safety practices for a new x-ray device" is specific and could be effectively discussed and acted on.

9.4. Disagreement Resolution. The chair of the meeting is responsible for maintaining order. On procedural questions, the chair's ruling will be determinative and final.

9.5. Record Keeping.

9.5.1. The AF-RSCES will ensure that appropriate files are maintained for each. This will include as a minimum, the agenda, meeting minutes, copy of all reference materials, background information, memoranda, standing reports, and presentations applicable to that quarters meeting.

9.5.2. Committee members are responsible for providing applicable materials to the AF-RSCES as requested.

9.5.3. Records of AF-RSC meetings, to include agendas, presentations, and meeting minutes, shall be kept for the duration of existence of the AF-RSC.

DOROTHY A. HOGG
Lieutenant General, USAF, NC
Surgeon General

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

5 U.S.C. Section §552a, *Privacy Act of 1974*

10 CFR §20.2106, *Records of Individual Monitoring Results*

10 CFR §33.13, *Requirements for the Issuance of a Type A Specific License of Broad Scope*

10 CFR §35.2, *Definitions*

10 CFR §35.24, *Authority and Responsibilities for the Radiation Protection Program*

10 CFR §35.3045, *Report and Notification of a Medical Event*

10 CFR §35.59, *Recentness of training*

10 CFR §35.75, *Release of Individuals Containing Unsealed Byproduct Material or Implants Containing Byproduct Material*

10 CFR §35.190, *Training for uptake, dilution, and excretion studies*

10 CFR §35.290, *Training for imaging and localization studies*

10 CFR §35.390, *Training for use of unsealed byproduct material for which a written directive is required*

10 CFR §35.392, *Training for the oral administration of sodium iodide I-131 requiring a written directive in quantities less than or equal to 1.22 gigabecquerels (33 millicuries)*

10 CFR §35.394, *Training for the oral administration of sodium iodide I-131 requiring a written directive in quantities greater than 1.22 gigabecquerels (33 millicuries)*

10 CFR §35.490, *Training for use of manual brachytherapy sources*

10 CFR §35.590, *Training for use of sealed sources and medical devices for diagnosis*

10 CFR §35.690, *Training for use of remote afterloader units, teletherapy units, and gamma stereotactic radiosurgery units*

10 CFR, Appendix B to Part 20, *Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage*

10 CFR Part 20, *Standards for Protection Against Radiation*

21 CFR Part 803, *Medical Device Reporting*

21 CFR Part 807, *Establishment Registration and Device Listing for Manufacturers and Initial Importers of Devices*

21 CFR Part 900, *Mammography*

29 CFR §1910.1096, *Ionizing Radiation*

29 CFR §1910.1096(b), *Exposure of Individuals to Radiation in Restricted Areas*

29 CFR §1910.1096(n), *Record*s

29 CFR §1910.1096(o), *Disclosure to former employee of individual employee's record*

42 U.S.C. §263b, *Certification of Mammography Systems*

42 U.S.C. §2121, *Authority of Commission*

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

EPA-400/R-17/001, *Protective Action Guides and Planning Guidance for Radiological Incidents*, January 2017

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Joint Publication 3-11, *Operations in Chemical, Biological, Radiological, and Nuclear Environments*, 29 October 2018

NCRP Report No. 127, *Operational Radiation Safety Program*, 1998

NCRP Report No. 147, *Structural Shielding Design for Medical X-Ray Imaging Facilities*, 19 November 2004

NCRP Report No. 151, *Structural Shielding Design and Evaluation for Megavoltage X- and Gamma- Ray Radiotherapy Facilities*, 2005

NCRP Report No. 88, *Radiation Alarms and Access Control Systems*, 1986

Safe Medical Devices Act of 1990

PL 109-58, *Energy Policy Act of 2005*

SORN F044 AF SG O, *United States Air Force Master Radiation Exposure Registry*

USAFSAM, *Bioenvironmental Engineer's Guidebook for Radon Management,* current edition

Prescribed Forms

AF Form 2753, *Radiological Sampling Form*

Adopted Forms

AF Form 847, *Recommendation for Change of Publication*

Abbreviations and Acronyms

AF—Air Force

AFI—Air Force Instruction

AFMAN—Air Force Manual

AFMPWG—Air Force Medical Physics Working Group

AFMRA—Air Force Medical Readiness Agency

AFPD—Air Force Policy Directive

AF-RSC—Air Force Radiation Safety Committee

AF-RSCES—Air Force Radiation Safety Committee Executive Secretariat

AFSEC—Air Force Safety Center

ALARA—As Low As Reasonably Achievable

ATP—Army Techinque Publication

Bq—Becquerel

CFR—Code of Federal Regulations

Ci—Curie

CT—Computed Tomography

DoD—Department of Defense

DoDI—Department of Defense Instruction

DoDM—Department of Defense Manual

EF—Equilibrium Factor

EPA—Environmental Protection Agency

EPE—Equipment Performance Evaluation

GS—General Scale

IRSO—Installation Radiation Safety Officer

JP—Joint Publication

MAJCOM—Major Command

MRER—Master Radiation Exposure Registry

MTF—Military Treatment Facility

NATO—North Atlantic Treaty Organization

NCRP—National Council on Radiation Protection

pCi/L—picoCurie/Liter

PPE—Personal Protective Equipment

QMP—Qualified Medical Physicist

RAM—Radioactive Material

rem—Roentgen Equivalent Man

RPD—Radiation Producing Device(s)

RSC—Radiation Safety Committee

RSO—Radiation Safety Officer

SGH—Chief of Medical Staff

SI—International System of Units

SORN—System of Records Notice

mSv—milliSievert

URSO—Unit Radiation Safety Officer

USAFSAM—United States Air Force School of Aerospace Medicine

U.S.C.—United States Code

WLM—Working Level Month

Terms

91(b) Material—RAM exempted from Nuclear Regulatory Commission licensing controls under Section 91(b) of the AEA of 1954, as amended, in the interest of national defense, under the possession of the DoD. These include the RAM in nuclear weapons – e.g., uranium isotopes, plutonium isotopes, tritium, and other radioactive components of nuclear weapons. These also include the components of nuclear reactors that fall under the definition of 91(b).

Absorbed Dose (D)—The energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the rad and the Gray (1 rad = 0.01 Gray).

Activity—The rate of disintegration (transformation) or decay of radioactive material. The units of activity are the Curie (Ci) and the Becquerel (Bq).

Administrative Dose—A value assigned in a dose report in cases where a dosimeter is not returned for processing at the end of the wear period, is damaged, or cannot be evaluated due to other factors.

AF Radioisotope Committee—A committee established to satisfy the requirements of with the Air Force master materials license to coordinate the administrative and regulatory aspects of licensing, possessing, distributing, using, transferring, transporting and disposing of all radioactive material in the Air Force except that transferred from Department of Energy to the Department of Defense in nuclear weapon systems, certain radioactive components of weapons systems and nuclear reactor systems, components and fuel controlled under Section 91 of the Atomic Energy Act of 1954, as amended.

ALARA—Acronym for "as low as is reasonably achievable" means making every reasonable effort to maintain exposures to radiation as far below applicable dose limits as is practical, consistent with the purpose for which the activity is undertaken, taking into account the state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations and in relation to utilization of nuclear energy, RAM, and radiation in the public interest.

Annual Limit on Intake—The derived limit for the amount of radioactive material taken into the body of an adult (individual 18 or more years of age) worker by inhalation or ingestion in a year. Annual limit on intake is the smallest value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent of 50 mSv (5 rem) or a committed dose equivalent (H_T) of 500 mSv (50 rem) to any individual organ or tissue. Annual limit of intakes are listed in 10 CFR, *Appendix B to Part 20*.

Authorized User—For non-medical permits, authorized users are approved by the RSC or in the absence of an RSC, the RICS based on a review of qualifications, or by the Permittee if authorized by a permit condition. For medical permits, in accordance with 10 CFR §35.2: a physician, dentist or podiatrist who meets the requirements in 10 CFR §35.59, and §35.190(a), §35.290(a), §35.390(a), §35.392(a), §35.394(a), §35.490(a), §35.590(a) or §35.690(a), and is an authorized user as specified on a USAF RAM permit.

Background Radiation—Radiation from cosmic sources and naturally occurring radioactive materials. This includes radon (except as a decay product of source or special nuclear material) and global fallout as it exists in the environment from the testing of nuclear explosive devices.

The term "background radiation" does not include radiation from source, byproduct, or special nuclear materials regulated by the Nuclear Regulatory Commission.

Becquerel (Bq)—The International System of Units (SI) unit of radioactivity is equivalent to one disintegration per second. One Ci is equivalent to 3.7E10 (37 billion) Bq.

Bioassay (Radio-bioassay)—The determination of kinds, quantities or concentrations, and, in some cases, the locations of RAM in the human body, whether by direct measurement (in-vivo counting) or by analysis and evaluation of materials excreted or removed (in-vitro) from the human body.

Byproduct Material—Any radioactive material (except source or special nuclear material) yielded in, or made radioactive by, exposure to the radiation incident to the process of producing or using source or special nuclear material. The definition of byproduct material has changed with Public Law 109-58, *Energy Policy Act of 2005* to include some forms of naturally occurring or accelerator produced radioactive material (reference AFPD 40-2, *Radioactive Materials (Non-Nuclear Weapons)*).

Committed Dose Equivalent ($H_{T,50}$—)—The dose equivalent to organs or tissues that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

Committed Effective Dose Equivalent ($H_{E,50}$)—The whole body dose equivalent obtained by adding the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent ($H_{T,50}$) of these organs or tissues.

Conceptus—The developing human organism from conception until time of birth. Referred to as the embryo/fetus.

Curie—A unit of radioactivity equal to 37 billion Becquerels; see Becquerel.

Declared Pregnant Individuals—All pregnant AF military occupational radiation workers. Also AF civilian occupational radiation workers who have voluntarily informed their workplace supervisor or primary care manager, in writing, of her pregnancy and the estimated date of conception. The declaration remains in effect until the declared pregnant individual withdraws the declaration in writing or is no longer pregnant.

Deterministic Effect—Biological effects for which the severity of the effect in an exposed individual varies with the dose, and for which a threshold usually exists (e.g., skin erythema and cataracts). The adherence to federal dose limits eliminates these effects; however commanders need to be aware of deterministic risks when exceeding these limits in incident or contingency operations.

Deep Dose Equivalent (H_D)—Dose assigned to personnel from external whole-body exposure, it is the dose equivalent at a tissue depth of one cm (1000 mg/cm2) which is expressed in units of rem or Sievert (Sv).

Dose (radiation dose)—A generic term that includes absorbed dose, dose equivalent (H_T), effective dose equivalent (H_E), committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent.

Dose Equivalent (H_T—)—The product of the absorbed dose in tissue (D_T) and the quality factor (Q), and all other necessary modifying factors at the location of interest where $H_T = D_T * Q$. The

units of dose equivalent are the rem and Sievert (Sv) (0.01 Sv = 1 rem). The dose equivalent in Sv is equal to the absorbed dose in Gray multiplied by the Q. Its purpose is to have a single unit, regardless of the type of radiation, describing the radiation effect on humans.

Effective Dose Equivalent—The sum over specified tissues of the dose equivalent multiplied by a weighting factor for that tissue, w_T. Expressed in unit of Sievert (Sv) or rem (100 rem = 1 Sv).

Exposure—In radiation protection, the act or occurrence of being exposed to radiation or RAM. In risk management, the frequency and length of time subjected to a hazard.

General Supervision—Circumstance in which an individual has authority and responsibility for an action, but is not required to be physically present during the performance of the action.

Gray—The SI unit of any absorbed dose. One Gray is equal to the absorption of one joule per kilogram of material (1 Gray = 100 rad).

Hazard—Any real or potential condition that can cause injury, illness, death of personnel, damage to or loss of equipment or property, or mission degradation.

High Radiation Area—Any area with dose rates greater than 0.1 rem (1 mSv) in one hour, 30 centimeters from the source, or from any surface through which the ionizing radiation penetrates. Areas at licensee facilities must be posted as "high radiation areas" and access into these areas is maintained under strict control. **(T-0).**

Installation—A grouping of facilities located in the same vicinity, which support particular functions. Installations may be elements of a base. The term installation applies to real properties such as depots, arsenals, hospitals, terminals, and other special mission installations.

Intrinsic Radiation—Radiation emitted through the weapon surface or directly from exposed components of nuclear weapons.

Investigation Action Level—1) A dose equivalent value or radionuclide intake activity set by the IRSO that requires further investigation when exceeded. A 10% default value is recommended for all dose types (e.g., 125 mrem for whole body quarterly badges, 375 mrem for lens of eye quarterly badges, 1250 mrem for extremity quarterly badges, 25 mrem for pregnant women monthly badges), however, at the IRSO discretion, levels can be tailored to each using section's historical dosimetry data in order to promptly identify and correct adverse trends; (2) The committed effective dose equivalent from radioactive material ingested, inhaled, or otherwise taken into the human body or dose equivalent from an external radiation source to which the worker is occupationally exposed which justifies further investigation.

Ionizing Radiation—Any electromagnetic or particulate radiation capable of producing ions, directly or indirectly during its passage through matter. It includes gamma rays, x-rays, alpha particles, beta particles, neutrons, protons and other particles and electromagnetic waves capable of producing ions.

Medical Event—An event that meets the criteria in paragraph 8.8.3.1.1.

Member of the Public—Any individual except when that individual is receiving an occupational dose.

Occupancy Factor—The fraction of time an area of interest is physically occupied by the same individual.

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/disharged; from voluntary participation in medical research programs; or as a member of the public.

Prescribed Dose—(1) For brachytherapy, stereotactic radiosurgery, or other radiation therapy procedures involving radioactive material, the total dose as documented in the written directive;

(2) For external beam radiotherapy, the total dose and dose per fraction as documented in the written directive.

Qualified Expert—A person who, by virtue of training and experience, can provide competent authoritative guidance about certain aspects of radiation safety or a person having knowledge and training to provide advice regarding radiation protection principles, standards and measurements. In general, a BEE or health physicist with training and experience appropriate to the radiation protection issues to be managed is considered a qualified expert. Ideally, persons should have certification from the American Board of Health Physics, the American Board of Medical Physics, the American Board of Radiology, or the American Board of Industrial Hygiene, to be considered a qualified expert in these respective fields.

Note—A biomedical equipment repair technician is considered a qualified expert to support quality control, equipment repair, collection of data and calibration in accordance with AFI 41-201.
Note—Nuclear medicine or diagnostic radiology: A medical or health physicist may be considered a qualified expert when they have had modality specific training and performed three surveys for a particular type of equipment under the supervision of a board certified medical physicist or a medical physicist who meets all the education, training and experience necessary to complete all aspects of American College of Radiology or American Board of Medical Physics board certification.
Note—Radiation therapy: A medical physicist must be supervised by a board certified radiation therapy physicist until all education, training and experience necessary to complete board certification is met. **(T-1).**
Note—Mammography physics: A qualified expert must meet the education, training and experience in Food and Drug Administration's Mammography Quality Standards Act as codified in 42 U.S.C. § 263b, *Certification of Mammography Systems.* **(T-1).**
Note—A senior health physicist or BEE with readiness experience (e.g., a current or former member of Air Force Radiation Assessment Team unit type codes) can be considered a qualified expert for purposes of accident and incident response and/or consequence management involving radiological and nuclear materials.
Note—Qualified Medical Physicists (QMPs) and Medical Physicist Assistants qualifications are delineated **in paragraphs 8.3.6 and 8.3.7**, respectively.

Quality Factors and Dose Equivalent—The probability of stochastic health effects (like cancer) is dependent not only on the absorbed dose, but also on the type of radiation causing the

dose. This has been taken into account by weighting the absorbed dose at a point in tissue with a radiation weighting factor, w_T, for a given radiation. The radiation weighting factor in turn is based on the density of ionization along a track of the radiation as it traverses a tissue, referred to as its linear energy transfer. The weighted absorbed dose under this system is called the dose equivalent, H, and expressed in units of rem. The dose equivalent is the dosimetric quantity used in Title 10, Code of Federal Regulations, Part 20, for the purposes of radiation protection from RAM. For the purposes of individual monitoring using personnel dosimetry, three specific quantities of dose equivalent are used:

Rad—A conventional unit for the measurement of absorbed dose. One rad is equal to an absorbed dose of 100 ergs per gram of material (1 rad = 0.01 Gy = 1 cGy).

Radiation—For the purposes of this regulation, unless otherwise specified, ionizing radiation and specific, medical uses of non-ionizing radiation, such as radio- or microwaves, or visible, infrared, or ultraviolet light.

Radiation Area—Any area with radiation levels greater than 5 millirem (0.05 milliSievert) in one hour at 30 centimeters from the source or from any surface through which the radiation penetrates.

Radiation Safety—For the purposes of this manual, a scientific discipline whose objective is the protection of people and the environment from unnecessary exposure to radiation. Radiation safety is concerned with understanding, evaluating, and controlling the risks from radiation exposure relative to the benefits derived. Health physics and radiation protection are synonyms.

Radiation Safety Committee—A group of individuals appointed by a Permittee to oversee all uses of permitted byproduct material. The Radiation Safety Committee (RSC) must include an authorized user of each type of use permitted, the RSO(s), a representative of the nursing service (for medical RSCs only), and a representative of management who is neither an authorized user nor an RSO. RSCs may include other members the licensee considers appropriate.

Radiation Safety Officer—The person that the commander designates, in writing, as the person responsible for the installation, organization or unit radiation safety program. The term "Radiation Safety Officer" is a functional title and does not denote a commissioned status or specialty code. The RSO must have the education, training, and professional experience needed for the job.

Radiation Source—Any non-exempt quantity of RAM, equipment, or devices which spontaneously generate or are capable of generating ionizing radiation. Examples include nuclear reactors, medical and dental radiographic and fluoroscopic x-ray systems, particle generators and accelerators, certain electromagnetic generators operating at electrical potentials that result in the production of x-rays, x-ray diffraction, industrial radiographic and spectrographic equipment, electron microscopes, electron-beam welding, melting, and cutting equipment, nuclear moisture or density gauges, byproduct, source, and special nuclear materials, natural or accelerator-produced radioactive materials, materials containing induced or deposited radioactivity and radioactive commodities.

Radiation Worker—An individual who may be occupationally exposed to ionizing radiation in the course of their duties or designated by the IRSO. For the purposes of this regulation, the term radiation worker does not broadly include contractors, see **Purpose, Applicability, and paragraph 2.13** for contractor related distinctions.

Rem—The conventional unit of any of the quantities expressed as dose equivalent. The dose equivalent in rem is equal to the absorbed dose in rad multiplied by a radiation quality factor, Q (1 rem = 0.01 Sv = 1 cSv).

Restricted Area—An area, access to which is limited by the facility for the purpose of protecting individuals against undue risks from exposure to RAM and radiation producing devices. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

Risk—The probability and severity of loss or adverse impact from exposure to various hazards.

Risk Assessment—The process of detecting hazards and their causes, and systematically assessing the associated risks.

Risk Management—A logical six step thought process, applicable to any situation or environment, for identifying and controlling hazards to protect the force.

Sentinel Event—The Joint Commission defines a sentinel event as a patient safety event that reaches a patient and results in either: death, permanent harm, or severe temporary harm and intervention required to sustain life. This includes: prolonged fluoroscopy with a cumulative dose >15 Gy to a single field, and delivery of radiotherapy to the wrong body region or 25% above the planned radiotherapy dose.

Shallow or Skin Dose Equivalent—The external exposure of the skin or an extremity, taken as the dose equivalent at a tissue depth of 0.007 cm (7 mg/cm^2 – the average depth of the germinal cell layer) averaged over an area of 1 cm^2.

Shallow Dose Equivalent (Hs)—Dose equivalent measured at a tissue depth of 0.007 cm (7 mg/cm2, the average depth of the germinal cell layer) averaged over an area of 1 cm^2.

Sievert (Sv)—The SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in Sievert is equal to the absorbed dose in Gray multiplied by appropriate radiation weighting factors, w_R; 1 Sv = 100 rem. One milliSievert (mSv) is 0.001 Sv (0.1 rem or 100 mrem).

Stochastic Effects—Health effects that occur randomly and for which the probability of the effect occurring, rather than its severity, is assumed to be a linear function of dose without threshold. Hereditary effects and cancer incidence are examples of stochastic effects. Commanders should be aware of individual dose histories when planning future operations where radiation threats exist.

Surveys—An evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present.

Therapeutic Source—In the healing arts, a source of radiation used in the treatment of disease, normally cancer. Includes high energy linear accelerators generating x-rays and/or electron beams used in radiation therapy, RAM based therapy units (e.g., using Co-60), sealed radioactive sources (e.g., Cs-137, Ir-192, I-125) temporarily or permanently implanted within a patient, and unsealed radioactive drugs (e.g., I-131) used for patient treatment.

Total Effective Dose Equivalent—The sum of the deep dose equivalent (Hd) (for external exposures) and the committed effective dose equivalent (for internal exposures) expressed in units of either rem or Sv.

Unrestricted Area—Any area access to which is neither limited nor controlled for the purposes of radiation safety.

Use Factor—The fraction of time a particular device is utilized, or the fraction of time the primary beam of a device is directed towards a given area.

Very High Radiation Area—An area accessible to individuals, in which radiation levels exceed 500 rad (5 Gy) in one hour at 1 meter from the source or from any surface that the radiation penetrates.

Note—For very high doses received at high dose rates, units of absorbed dose (rad or Gy) are appropriate, rather than units of dose equivalent (rem and Sv).

Weighting Factor (Organ or Tissue)—For an organ or tissue, the proportion of the risk of stochastic effects resulting from irradiation of that organ or tissue to the total risk of stochastic effects when the whole body is irradiated uniformly.

Working Level Months—Exposure to radon and its progeny is not measured in the conventional dosimetric quantities described above. Instead exposures are generally indicated by the working-level, a unit originally developed to describe exposures of uranium miners to radon. One working level is defined as that concentration of radon daughters in air that has a potential alpha energy release of 1.3E5 mega-electron volt in a liter of air, equivalent to 2E-5 Joule per cubic meter of air (J/m^3). One working level month (WLM, or 3.5E-3 Jh/m^3) would be the exposure received by being present in that concentration for one working month, equivalent to 170 hours. Exposure to one WLM results in an estimated absorbed dose to the lung of 4 to 13 mGy (0.4 to 1.3 rad). Based on data gather regarding occupational exposures uranium miners, lung cancer probabilities are estimated in the broad range of 1 to 4E-4 per WLM. One WLM is approximately equal to an annual exposure of 4 pCi per liter of radon, if the radon decay products are in 50% equilibrium with the radon.