

**BY ORDER OF THE COMMANDER
WRIGHT PATTERSON AIR FORCE
BASE**

**WRIGHT PATTERSON AIR FORCE
BASE INSTRUCTION 40-201**

28 MARCH 2023

Medical Command

**IONIZING RADIATION
SAFETY PROGRAM**



COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

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This installation implements AFMAN 40-201, *Radioactive Materials Management* and satisfies the requirement of AFMAN 48-148 section 2.10.4.3 which states that the Installation Radiation safety Officer (IRSO) shall 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.). It also describes necessary procedures for the implementation of an effective radiation safety program at Wright-Patterson Air Force Base (WPAFB). This instruction applies only to ionizing radiation sources. Non-ionizing radiation sources are not covered by this instruction.

SUMMARY OF CHANGES

This instruction has been revised in its entirety. Major changes include removal instructions quoted from other Air Force Instructions. It must be reviewed in its entirety.

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Chapter 1

PERMITEE RESPONSIBILITIES

1.1. If required by permit or federal regulations the permittee shall. Establish a Permit Radiation Safety Committee (PRSC) in accordance with the guidance in AFMAN 40-201.

1.2. Units owning a permit shall. Provide a primary and should provide an alternate permit RSO. (AFMAN 40-201, para 3.4.1.2.)

Chapter 2

PERMITS FOR THE POSSESSION OF RADIATION-PRODUCING DEVICES

2.1. The IRSO has reserved the authority to. Control the possession and use of radiation-producing devices such as x-ray machines and accelerators that are not under the jurisdiction of either the Nuclear Regulatory Commission (NRC) or the Radioisotope Committee (RIC).

Chapter 3

INSTRUMENTS

3.1. Instruments used for compliance with DAFIs/DAFMANS and Federal regulations are. Calibrated annually, or at a frequency specified in the applicable Air Force RAM permit, according to current revisions of the American National Standards Institute (ANSI). Use of withdrawn and replaced ANSI standards is inappropriate.

3.2. In accordance with AFMAN 40-201, para. 2.17.16.10 . “Radiation survey meters shall be capable of detecting the appropriate radiation type, measuring the energies of interest, and operationally checked with an appropriate check source prior to use.” In order to provide relevant data, all instruments must be sufficiently sensitive to make measurements at the required level. The “minimum detectable activity” (MDA) for the instrument should be a fraction (10 to 50 percent) of the criteria that must be met.

3.2.1. For portable instruments, it may not always be practical to reach an MDA that is 10 to 50% of the limits. In such cases, an MDA below the limit is acceptable.

3.2.2. The MDA for instruments used for surveys shall be documented. Survey documentation should also include the calibration date, instrument serial number, and background and efficiency.

3.3. Acceptable Levels of Surface Contamination.

3.3.1. In accordance with AFMAN48-148, para. 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.” However, the DODM states in paragraph 7.2b.2 that licensed activities are covered by other requirements. Therefore, each permit holder will specify screening levels either in the permit or the program manual.

3.3.2. In absence of other specified limits for acceptable levels of contamination in restricted areas within a permit manual, Table 1 NUREG 1556 Vol. 7 Rev. 1 should apply. Units using unfixed, but non-permitted radiation should limit contamination to within the levels specified by the program manual. See also section 5.3 for personnel contamination. No surface contamination above the levels in **Table 3.1** should be allowed to occur outside of restricted areas.

Table 3.1. Acceptable Surface Contamination Levels.

Nuclide ¹	Total (Fixed + Removable) ^{2, 3, 5}	Removable ^{2, 4, 5}
U-nat, ²³⁵ U, ²³⁸ U, and associated decay products	83.3 Bq/100 cm ² [5,000 dpm/100 cm ²]	16.7 Bq/100 cm ² [1,000 dpm/100 cm ²]
Transuranics, ²²⁶ Ra, ²²⁸ Ra, ²³⁰ Th, ²²⁸ Th, ²³¹ Pa, ²²⁷ Ac, ¹²⁵ I, ¹²⁹ I	1.7 Bq/100 cm ² [100 dpm/100 cm ²]	0.3 Bq/100 cm ² [20 dpm/100 cm ²]
Th-nat, ²³² Th, ⁹⁰ Sr, ²²³ Ra, ²²⁴ Ra, ²³² U, ¹²⁶ I, ¹³¹ I, ¹³³ I	16.7 Bq/100 cm ² [1,000 dpm/100 cm ²]	3.3 Bq/100 cm ² [200 dpm/100 cm ²]
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except ⁹⁰ Sr and others noted above.	83.3 Bq/100 cm ² [5,000 dpm/100 cm ²]	16.7 Bq/100 cm ² [1,000 dpm/100 cm ²]
<p>1. Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.</p> <p>2. As used in this table, disintegrations per minute (dpm) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.</p> <p>3. The amount of removable radioactive material per 100 cm² of surface area should be determined by wiping that area with filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.</p>		

Chapter 4

DOSIMETRY

4.1. Dosimetry shall be conducted IAW DAFMAN 48-125.

4.2. Self-reading dosimeters.

4.2.1. Self-reading dosimeters should be used for personnel entering high or very high radiation areas, or to keep track of workers who are expected to exceed ALARA investigation levels, per quarter (**Table 4.1**).

4.3. Investigative Action Levels.

4.3.1. These levels are not legal limits. IAW DAFMAN 48-125 they are referred to as Investigation Action Levels (IALs) which are set by the IRSO.

4.3.2. The IRSO has set the investigation at levels shown in **Table 4.1** Investigative Levels.

4.4. General guidelines for ALARA investigations:

4.4.1. Personnel dose less than Investigational Level. No further action will be taken in those cases where an individual's dose is less than **Table 4.1** values for the Investigational Level, except when deemed appropriate by the IRSO.

4.4.2. Personnel dose equal to or greater than Investigational. The IRSO will review the dose of each individual whose quarterly dose equals or exceeds Investigational Level.

Table 4.1. Investigative Levels.

Per Quarter	Radiation Workers (millirem)
Investigative levels	Level
Whole body (TEDE)*	125
Lens of eye	375
Skin of the whole body or skin of any extremity	1250
Note: * the whole body means, for purposes of external exposure, head, trunk (including male gonads), arms above the elbow, and legs above the knee.	

4.5. Bioassay.

4.5.1. If after implementing controls (engineering, administrative and personal protective equipment) work that could still result in an internal exposure of 2% of the annual limit on intake as a result of inhalation, ingestion, injection, or absorption of radioactive materials, bioassay with adequate sensitivity will be required.

4.5.2. Bioassays shall have adequate sensitivity to reach the goal of DAFMAN48-125 (2% of the ALI; 100 mrem). The frequency and strategy of the bioassay program is implemented by the IRSO and PRSO in consultation with USAFSAM. (DAFMAN 48-125, para 4.6.3.2)

4.5.3. The bioassay program is a component of the workplace occupational health program, and compliance is mandatory. (DAFI 48-145, para 2.27.1, DAFMAN 48-125, para 2.11.4.)

4.5.4. Bioassay dose is recorded on the worker's annual dose report. Workers may request bioassay results from the IRSO.

Chapter 5

RADIOACTIVE MATERIAL WORK PROCEDURES

5.1. Generic radiological controls for work procedures.

5.1.1. The hierarchy of controls used to protect personnel are.

5.1.1.1. First, Engineering Controls

5.1.1.2. Second, Administrative Controls

5.1.1.3. Third, Personnel Protective Equipment

5.1.2. Work procedures shall list all required personnel protective equipment (PPE) for activities involving radioactive materials.

5.1.2.1. When handling unsealed radioactive material, a minimum of a laboratory coat and disposable gloves should be required. Personnel Protective Equipment (PPE) required for work shall match the hazards (e.g. if contamination is found on the floor shoe protection needs to be added). Consult the most recent Bioenvironmental Engineering shop survey and certified PPE list for additional guidance, IAW AFI 48-145.

5.1.2.2. Radioactive material which has the potential to generate contamination above the limits contained in the radiological permit or program manual for the permit is considered unsealed from the standpoint of engineering work controls and PPE selection.

5.1.3. Before leaving an area with removable contamination and restricted areas where unsealed radioactive material is used, personnel should perform a whole-body frisk. Perform the frisk in the following order:

5.1.3.1. Head (pause at mouth and nose for approximately 5 seconds)

5.1.3.2. Neck and shoulders

5.1.3.3. Arms (pause at each elbow for approximately 5 seconds)

5.1.3.4. Chest and abdomen

5.1.3.5. Back, hips and seat of pants

5.1.3.6. Legs (pause at each knee for approximately 5 seconds)

5.1.3.7. Shoe tops

5.1.3.8. Shoe bottoms (pause at sole and heel for approximately 5 seconds)

5.1.3.9. Personnel and supplemental dosimeters.

5.1.3.10. Return the probe to its holder and leave the area. The probe should be placed on the side or face up to allow the next individual to monitor his/her hands before handling the probe.

5.1.4. Personnel should be considered contaminated if the frisk results in any detectable contamination. If contaminated, personnel should follow workplace specific decontamination procedures and consider seeking medical attention.

5.1.4.1. If removable contamination exceeding the limits in **Table 3.1** are detected outside restricted areas.

5.1.4.1.1. Notify the PRSO and the IRSO.

5.1.4.1.2. A detailed survey shall be performed to determine the extent of the removable contamination outside the restricted area (e.g. small localized area, tracked to other facilities).

5.1.4.1.3. Decontaminate the area.

5.1.4.1.4. Investigate the cause and take action to prevent re-occurrence.

5.1.4.1.5. Evaluation of possible exposure to unmonitored personnel should be performed.

5.1.5. At the time of establishment areas where unsealed radioactive material are stored or used shall be coordinated with the installation and Permit RSOs. No eating, drinking, smoking, or the application of cosmetics shall be permitted in these areas. In addition, exposed portions of the body such as the face should not be touched.

5.1.6. Include work area restrictions to include at a minimum do not store food, drink, or keep personal effects in areas where radioactive material are stored or used.

5.1.7. If issued, wear personnel monitoring devices at all times performing tasks that require dosimetry.

5.1.8. Store radioactive waste only in designated, labeled and properly shielded containers.

5.1.9. Do not pipette radioactive liquids by mouth.

5.1.10. Discard contaminated disposable PPE such as rubber gloves and boots into segregated radioactive waste disposal containers.

5.1.11. Individuals with open wounds shall not work with unsealed radioactive material without proper protection of the wound.

5.1.12. Items shall not be placed in ordinary trash unless they are first checked for radioactivity with a meter which is sensitive enough to release the material as non-contaminated given the limits of **Table 3.1**.

5.1.13. In areas where unsealed radioactive material is used, survey work areas after each use of unsealed radioactive material.

5.1.14. Each PRSO will determine acceptable removable contamination levels in restricted areas to minimize the potential for internal intakes. This will be documented in the program manual.

5.1.15. Contamination Survey

5.1.15.1. NUREG 1556 Volume 7 Revision 1 states: “Personnel should survey for contamination in locations where individuals are working with an unsealed form of radioactive material. These surveys shall be done at a frequency appropriate to the types and quantities of radioactive materials in use (see Table N-1) [Table 5.1 below]. If the activity used is greater than or equal to the smallest annual limit on intake (ALI) (for either inhalation or ingestion), as identified in 10 CFR Part 20, Appendix B, then documented surveys should be performed at least daily and records retained in accordance with 10 CFR 20.2103.” ALI values are contained in 10 CFR 20 Appendix B Radionuclide Table – Index of Radioisotopes. The Addendum to the Bioenvironmental Engineer’s Guide to Ionizing Radiation Appendix F Installation-Level Internal Dosimetry Program states: “Inhalation is the most common route of exposure in an occupational setting, followed by ingestion.” Therefore, the inhalation ALI shall be used.

Table 5.1. Frequency of Contamination Surveys.

	< 0.1 ALI	≥ 0.1 ALI < 1.0	≥ 1.0 ALI
In Use	Monthly	Weekly	Daily
Not in Use	Every 6 Months		

Chapter 6

RADIOACTIVE WASTE

6.1. When a waste container is ready for disposal contact the IRSO for instructions.

Chapter 7

TRAINING

7.1. The definition for “Radiation Worker” differs in AFMAN 40-201 and AFMAN 48-148. The definition from AFMAN 40-201 is more restrictive and adopted at Wright Patterson Air Force Base, as follows: “An individual engaged in activities licensed or regulated by the NRC (or RIC) and controlled by a licensee (or Permittee) or regulated entity, but does not include the licensee (or Permittee) or regulated entity, in accordance with 10 CFR Part 19.”

7.2. Section 4.3.1 of AFMAN 48-148 states. “General: 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.”

7.3. Determining training that is appropriate in breadth and depth to the radiation hazards present in the workplace shall be determined by the PRSO. The training program shall be reviewed and revised as necessary to reflect changes in practices in the workplace.

Chapter 8**EMERGENCY PROCEDURES**

8.1. Spills of radioactive material. Each permit program manual shall address emergency and spill response. NUREG 1556 Vol 7 Rev 1 should be used as guidance.

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Commander

Attachment 1**GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION*****References***

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

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

NUREG-1556 Vol. 7 Rev. 1, *Consolidated Guidance About Materials Licenses Program-Specific Guidance About Academic, Research and Development, and Other Licenses of Limited Scope*, February 2018

NUREG 1575 Supplement 1, *Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual*, January 2009

NUREG 1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*, July 1995

Nuclear Regulatory Commission Information notice 93-30, *NRC Requirements for Evaluation of Wipe Test Results; Calibration of Count Rate Survey Instruments*, April 1993

Abbreviations and Acronyms

ALARA—As Low As Reasonably Achievable

MDC—Minimum Detectable Concentration

NRC—Nuclear Regulatory Commission

RIC—Radioisotope Committee

IRSO—Installation Radiation Safety Officer

OSL—Optically Stimulated Luminescence dosimeter

Terms

Minimum Detectable Concentration/Activity (MDC, or MDA)—Is the smallest activity concentration measurement that is practically achievable with a given instrument and type of measurement procedure. It depends not only on the instrument characteristics, but also on many other specific factors involved in the measurement process, as well as the characteristics of the sample being measured. Because of this it cannot be considered a limit, but only an estimated level achievable under a given set of practical conditions. Because it cannot be considered a limit of detection it is really the estimated minimum detectable concentration. The MDC is a modern term and Minimum Detectable Activity (MDA) and MDC are essentially identical terms. Technically, the MDC is “the smallest concentration of radioactive material in a sample that will yield a net count (above system background) that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a ‘real’ signal. MARLAP NUREG 1576 Vol. 1 uses the terms MDA and MDC interchangeably in section 3B.3 “In radiochemistry, the minimum detectable value may be called the minimum detectable concentration (MDC), minimum detectable amount (MDA), or minimum detectable activity (also abbreviated as MDA.

Appropriately sensitive meter means—That the instrument will respond to the type of radiation emitted by the nuclide and has a minimum detectable concentration (MDC) that meets the limits of NUREG 1556 Vol. 7 Rev. 1 Table M-2. (for scan/frisking surveys the “Average” limits apply and for counting wipes the “Removable” limits apply) There may be exceptions to this, as an example frisking of some hard to detect nuclides using portable instruments may not be able to achieve an MDC at the limits of NUREG 1556 Vol. 7 Rev. 1 Table M-2. In this case compensatory measures should be implemented (e.g. taking swipes at a higher frequency to check for removable contamination by liquid scintillation or instrumentation with equivalent capabilities for I-125).

Spill means—Unintended release of radioactive material from its container irrespective of the form of the material is considered a spill. The material may be in powdered form, liquid, gas, or a solid mass. Spills pose a hazard because of the potential for: (1) contamination of the environment, (2) contamination of the skin of personnel, (3) ingestion or inhalation of RAM, and (4) production of a high radiation field which may result in a radiation dose exceeding permissible limits even if the individual does not become externally contaminated. A spill may result from a simple incident such as the dropping of a container or it may result from a more serious event such as a fire or explosion.