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OPR: AFIOH/SDRD

Certified by: HQ USAF/SG (Lt Gen Taylor.)

Supersedes AFI 48-125, 1 March 1999

Pages: 100

AFOEHL Report

90-211RD00253MRF,

December 1990

This manual implements AFPD 48-1, *Aerospace Medicine Program*, and interfaces with AFI 40-201, *Managing Radioactive Materials in the USAF*, and AFI 48-148, *Ionizing Radiation Protection*. It establishes and describes the Air Force Personnel Ionizing Radiation Dosimetry Program, applicable to US Air Force, US Air Force Reserve, and Air National Guard installations. It explains the purpose and gives instructions for operating an occupational radiation dosimetry program at the base level, to include monitoring in non-routine and contingency operations. The use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this publication does not imply endorsement by the Air Force. This publication requires the collection and or maintenance of information protected by the Privacy Act (PA) of 1974. The authority to collect and/or maintain the records prescribed in this publication is Executive Order 12196, *Occupational Safety and Health Programs for Federal Employees*, February 26, 1980. Forms affected by the PA have an appropriate PA statement. System of records notice F044 AF SGO *United States Air Force Master Radiation Exposure Registry* (November 18 2003, 68 FR 65042) applies. Ensure that all records created as a result of processes prescribed in this publication are maintained in accordance with AFMAN 37-123, (will become AFMAN 33-363) *Management of Records* and disposed of in accordance with the *Air Force Records Disposition Schedule (RDS)* located at <https://afrims.amc.af.mil/>. To recommend changes, conflicts, suggestions or recommendations, submit on AF IMT 847, **Recommendation for Change of Publication**, through channels, to AFMSA/SGPR, 110 Luke Avenue, Room 405, Bolling AFB, DC 20032-7050.

**SUMMARY OF CHANGES**

This manual replaces AFI 48-125, *The US Air Force Personnel Dosimetry Program*, 1 March 1999 and AFOEHL Report 90-211RD00253MRF, *USAF Personnel Dosimetry Instruction Manual*, December 1990. It updates all technical information and processes associated with management of the installation-level radiation dosimetry program.

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## 1. INTRODUCTION TO USAF PERSONNEL DOSIMETRY PROGRAM

1.1. **Objective:** This manual describes procedures essential for successful operation of the USAF Personnel Dosimetry Program, particularly at base level. It implements the external and internal radiation monitoring policies established in Title 10 Code of Federal Regulations Part 20 (10CFR20) and AFI 48-148, *Ionizing Radiation Protection*. In addition, this manual provides information to assist the Radiation Safety Officer (RSO) and Thermoluminescent Dosimetry (TLD) Program Monitor in forming educated decisions regarding dosimeters.

1.2. **Purpose:** Each person who routinely works with radioactive materials or ionizing radiation-producing machines could receive an occupational exposure to ionizing radiation. Occupational exposure includes exposures from sources external to the body (i.e., x-ray machines, various radioactive sources) and exposures from internally deposited radionuclides (i.e., ingested, inhaled or absorbed). Occupational radiation exposures do not include exposures to naturally occurring background radiation (i.e., cosmic or terrestrial sources) and/or exposures received as a patient undergoing medical diagnosis or treatment. The USAF Personnel Ionizing Radiation Dosimetry Program (hereafter referred to as the Dosimetry Program) is designed to monitor, when necessary, occupational radiation exposures. All Dosimetry Program-monitoring results are maintained permanently in the USAF Master Radiation Exposure Registry (MRER), which is maintained by the Air Force Institute for Operational Health, Surveillance Directorate, Radiation Surveillance Division, Radiation Dosimetry Branch (AFIOH/SDRD), 2350 Gillingham Drive, Bldg-140 Brooks City-Base TX 78235-5103.

### 1.3. Program Eligibility:

1.3.1. Military and civilian Air Force, Air Force Reserves and Air National Guard occupational radiation workers who require personnel radiation dosimetry monitoring as identified by the installation RSO. Air Force dosimetry services may be provided to contractor personnel if the contract states these and other occupational medicine services will be provided.

1.3.2. Military and civilian occupational radiation workers of other DoD agencies. Under terms of agreements between the Air Force Radiation Dosimetry Laboratory (AFIOH/SDRD) and the Radiation Dosimetry Centers of DoD sister services or agencies, all personnel monitoring results for individuals in this category will be stored in the USAF MRER and may be reported to the responsible Service or Agency dosimetry center.

1.3.3. Occupational radiation workers employed by Federal, State, or Local government agencies outside of the DoD. These individuals may receive personnel monitoring from AFIOH/SDRD on a fee-for-services basis under terms of agreements between AFIOH/SDRD and their agency radiation safety office.

### 1.4. Overview of Routine Operations:

1.4.1. **General:** The USAF Personnel Ionizing Radiation Dosimetry Program is operated at the base level by the installation RSO (usually a Bioenvironmental Engineer, a Senior Bioenvironmental Engineering Noncommissioned Officer, or a qualified Civilian employee) and a designated TLD Program Monitor [usually a Bioenvironmental Engineering Technician, AFSC (4BOX1)]. The RSO identifies personnel to be monitored, determines how many administrative areas are needed to cover the entire base, assigns a letter or number to designate those areas, determines the monitoring frequency (monthly or quarterly) and provides this information to AFIOH/SDRD. Each installation is assigned a unique base code that is used to identify the base in all Dosimetry Program records. AFIOH/SDRD registers individuals into the program according to

their base code. AFIOH/SDRD separates each base dosimeter issue into the designated monitoring areas and issues TLDs and extremity dosimeters for either a monthly or quarterly monitoring period as specified by the RSO. At the end of the monitoring period, the TLD Monitor retrieves issued dosimeters and issues a new set of dosimeters to the monitored individuals. The TLDs are removed from the whole body, collar and neutron hangers and are placed back into the shipping tray (if one was supplied). The TLDs and extremity dosimeters are packaged and returned to AFIOH/SDRD for processing. Dose equivalent reports are forwarded to the base RSO for review to confirm that the values reported are appropriate for the individual and the monitoring period and for use in managing the installation level radiation safety program. This cycle is repeated until the RSO removes the individuals from the program or cancels monitoring for that area or until the individual leaves the work area, through a permanent change of station, separation or retirement.

**1.4.2. Who is Monitored:** Monitoring is required for certain radiation workers based on job description and their potential for exposure (e.g., pregnant radiation worker likely to exceed 500 mrem during gestation, USAF radioactive material permit condition, etc.) and for anyone who is likely to exceed 10% of the annual external dose limit or 10% of the Annual Limits of Intake (ALI). Individuals who work with unsealed radioactive sources and are at risk of obtaining an internal exposure greater than 10% of the applicable ALI will be included in a bioassay program (see section 4.7.). The professional staff of AFIOH/SDRD is available to provide consultative assistance in determining whether monitoring is appropriate. It is important to remember that the decision to enroll individuals in the external or internal monitoring program is made by the installation RSO. AFIOH/SDRD will NOT decline to provide dosimetry services to a customer solely because arbitrary guidelines may appear to indicate that dosimetry is not required.

**1.4.3. Area Control Dosimeters:** AFIOH/SDRD provides area control dosimeters for each radiation exposure area and dosimeter type worn in that area. Area control dosimeters are used to measure background radiation accumulated during transit or storage of dosimeters and are handled in the same manner as the dosimeters issued to individuals. To provide an accurate measurement of an individual's occupational dose, the dose assessed using a five-year average daily background of control dosimeters is subtracted from the dose recorded on the issued dosimeter. Use of a five-year average daily background ensures accurate background subtraction for late returned badges. An area control dosimeter shall never be used for monitoring an individual. The area control dosimeter is always maintained in the TLD storage rack or designated TLD storage area used for issued dosimeters when they are not being worn and must be returned to AFIOH/SDRD at the end of the monitoring period along with the dosimeters issued during the monitoring period. Each area must have a control dosimeter for each dosimeter type (e.g., one whole body dosimeter, one neutron dosimeter, one extremity dosimeter, etc.).

**1.4.4. Storage of TLDs:** Any dosimeter, when not being worn, must be stored with its associated control dosimeter in an area as free from radiation sources as possible and away from excessive heat or moisture (i.e., on a dosimeter storage rack or in a storage area designated by the RSO). Dosimeters are to be used only in the designated work area. They are NOT to be stored in an individual's desk or placed onto the dash of a vehicle. Proper control and storage of dosimeters is important to ensure the dosimeters are not tampered with, can be returned for processing and can provide a dose representative of the working environment. Improper storage adversely affects the accuracy of dose assessment and may result in a need for an exposure investigation by the RSO.

1.4.5. Extra (Spare) Dosimeters: AFIOH/SDRD provides extra (spare) dosimeters with each routine shipment. Whenever a new person is identified as needing monitoring, the individual needs to be added to the USAF Personnel Dosimetry Program. Instead of waiting for a TLD or extremity dosimeter to be issued from AFIOH/SDRD, extra TLDs and extremity dosimeters that are provided with each shipment can be used to allow the individual to immediately start working. When using extra dosimeters, the Dosimetry Assignment Data Form (SDRD Listing 1523) must be properly annotated to provide all necessary information for AFIOH/SDRD to register the individual in the USAF Personnel Ionizing Radiation Dosimetry Program. All extra TLDs and extremity dosimeters, whether issued or not, are to be returned to AFIOH/SDRD at the end of the monitoring period. When extra dosimeters are not being used, they are stored in a designated area as free from radiation as possible and away from excessive heat or moisture. There is no preprinted wear location on SDRD Listing 1523 for extra dosimeters. The wear location must be designated when the dosimeter is issued. Customers may request an increase in their quarterly issue to maintain enough extra TLDs for emergency response operations. TLDs that are requested for this purpose must be handled in a manner consistent with all personnel TLDs. Should the spare TLD be issued to personnel for emergency response, that information should be annotated on the SDRD Listing 1523. **Note:** ALL EXTRA TLDs MUST BE RETURNED AT THE END OF THE MONITORING PERIOD.

1.4.6. Returning Dosimeters for Processing: Dosimeters should be returned to the TLD Program Monitor for processing within ten (10) days of the end of the monitoring period. After ensuring all TLDs are accounted for and the SDRD Listing 1523 is properly filled out, the dosimeters are placed back into the original shipping container if possible. Dosimeters should be packaged to ensure that all are received by AFIOH/SDRD in an orderly fashion to facilitate processing. When shipping TLDs from two different monitoring periods in the same package, it is important that dosimeters from each period be clearly separated and identified. The RSO retains a copy of the SDRD Listing 1523 for local files. Attach a "CAUTION – Do not X-ray or expose to radiation" label to the outside of the box and ship the package by the most expeditious and traceable means back to AFIOH/SDRD [e.g., express shipment (FedEx®, etc.), certified mail – return receipt requested, etc.]. Dosimeters should not be shipped by "standard" postal service. Also, dosimeters should not be shipped on Friday nor should they be marked for Saturday or other after duty hours delivery. **Note:** There is no need to return the printed labels that were supplied by AFIOH/SDRD.

## 1.5. Miscellaneous Considerations:

1.5.1. ALARA Investigation Levels: When evaluating doses for the As Low As Reasonably Achievable (ALARA) program, ALARA action investigation levels should not be lower than the analytical system's Lower Limit of Detection (LLD). AFIOH/SDRD had determined the appropriate LLD for dosimeters issued to field operations to be 0.1 mSv [10 millirem (mrem)].

1.5.2. Special Studies: Installations often use TLDs to conduct area surveys and for other special studies not directly measuring the radiation dose to uniquely identified individuals (See also Sections 7.4. and 7.5.). AFIOH/SDRD will supply appropriate dosimeters and associated controls as may be required to support special studies. **Note:** Issued whole body dosimeters are not to be used for this purpose.

1.5.3. Dosimetry for Visitors: Visitors entering high radiation areas (0.1 rem (1 mSv) in 1 hour at 30 centimeters from the radiation source) and very high radiation areas (500 rads (5 grays) in 1 hour at 1 meter from a radiation source) are required to be monitored. Visitors who may receive a

dose, which could exceed 10% of the public dose limits, should be afforded monitoring (See Section 7.3.). This can be accomplished by issuing TLDs, Personal Ion Chambers (PICs), or Electronic Personal Dosimeters (EPDs). Extra TLDs, supplied with each TLD shipment may be issued for monitoring visitors entering radiation areas. All TLDs issued for this purpose should be annotated on the SDRD Listing 1523 to include the required personnel information. Visitors who are issued TLDs or have a non-zero dose measured on a self-reading dosimeter must be registered in the USAF Personnel Dosimetry Program for the monitoring period in which the visit occurred. If a visitor's dose is measured with a self-reading dosimeter, the local RSO is to be notified and any non-zero dose results must be forwarded to AFIOH/SDRD in writing by the RSO for inclusion in the MRER. Only self-reading dosimeters having a current calibration in accordance with Precision Instrument and Equipment Laboratory (PMEL) requirements may be used for this purpose.

#### **1.6. Non-routine Operations (Emergency, Contingency & Weapons of Mass Destruction (WMD) Response Actions):**

1.6.1. General: Detailed information regarding this scenario will be covered in another AFM. Please refer to that document or contact the Radiation Dosimetry Laboratory for specific guidance.

## 2. RESPONSIBILITIES

**2.1. Deputy Assistant Secretary of the Air Force (Environment, Safety and Occupational Health) (SAF/IEE):** Provides oversight for all Air Force policy related to environment, safety, and occupational health.

**2.2. The Surgeon General (HQ USAF/SG):** Provides policy guidance for operating the Air Force Dosimetry Program and ensures the program complies with Federal rules and regulations, DoD and Air Force policy, and accepted scientific practice.

**2.3. Commander, Air Force Materiel Command (HQ AFMC/CC), through Command Surgeon Air Force Materiel Command (HQ AFMC/SG):** Funds and implements the Dosimetry Program, AFIOH/SDRD provides operational control.

**2.4. Commander, 311th Human Systems Wing (311 HSW/CC):** Provides the facilities, technical expertise and personnel for operating AFIOH/SDRD.

**2.5. Commander, Air Force Institute for Operational Health (AFIOH/CC), through AFIOH/SDRD:**

2.5.1. Establishes and maintains accreditation for the Dosimetry Program through the National Voluntary Laboratory Accreditation Program (NVLAP) administered by the National Institute of Standards and Technology (NIST) in the following categories at a minimum:

2.5.1.1. Whole body dosimeters. Low and high-energy photons (protection and accident ranges), beta particles, neutrons, and mixtures (NVLAP performance test categories I-VI, inclusive).

2.5.1.2. Extremity dosimeters. Low and high-energy photons, beta particles (NVLAP performance test categories I-C, II-A, III, and IV-C).

2.5.1.3. Neutron dosimeters. Neutrons and high-energy photons (NVLAP performance test categories II and VI).

2.5.2. Provides, processes and analyzes NVLAP accredited TLDs for external monitoring of personnel identified by the installation RSO as meeting criteria in Chapter 1., Paragraph 1.3.

2.5.3. Prepares and provides reports, listings or other documentation as may be necessary to ensure installation RSO has information necessary to effectively administer the installation level program.

2.5.4. Provides on-call technical assistance to the installation RSO, or other individuals as may be appropriate, on external radiation dosimetry and program operations.

2.5.5. Ensures all internal and external dosimetry results are incorporated into the MRER.

2.5.6. Briefs the USAF Radioisotope Committee quarterly on program status and statistical trends for the previous quarter.

2.5.7. Provides a written annual summary report and briefing to the USAF Radioisotope Committee at the 2nd quarter meeting which details program status and statistical trends for the previous calendar year.

2.5.8. Establishes and maintains a dosimetry record system to conform to the record keeping requirements of Title 10, Code of Federal Regulations, Part 20, Section 2106 (10 CFR 20.2106).

2.5.9. Ensures recording of non-occupational radiation doses delineates these records from occupational radiation doses via database codes and/or fields.

2.5.10. Establishes and operates the deployable Field Laboratory to Assess Radiation Exposure (FLARE) which provides an external ionizing radiation dosimetry capability to support peacetime and wartime ionizing radiation monitoring requirements. FLARE functions as a remote (transportable) extension of the fixed-base radiation Dosimetry Program. Flare was created to meet the requirements of STANAG 2473 and 2474 and well as Presidential directives for the protection of deployed personnel to hostile environments.

**2.6. Commander, Air Force Institute for Operational Health (AFIOH/CC), through the Radio-analytical Branch (AFIOH/SDRR):**

2.6.1. Establishes and maintains comprehensive radioanalytical capability necessary to assess potential internal deposition of radioactive material for Air Force personnel.

2.6.2. Processes and analyzes bioassay samples in accordance with scientifically established and approved analytical procedures.

2.6.3. Provides bioassay results and any documentation necessary for their interpretation to the requesting installation RSO and AFIOH/SDRD for incorporation into the MRER.

2.6.4. Maintains internal dosimetry records in accordance with the record keeping requirements of 10 CFR 20.2106.

2.6.5. Provides on-call technical support to the installation RSO or other field activities, as may be appropriate, on internal bioassay requirements and methods.

2.6.6. Provide notice to base bioenvironmental engineer/Installation RSO whenever changes to procedures, algorithms, or analytical methods may result in change to baseline results or impact data quality.

2.6.7. Ensures results are entered into the appropriate Occupational Health Management Information System (OH-MIS), when available.

**2.7. Installation Commander through the Installation RSO:** Ensures occupational radiation exposure received by installation personnel is kept ALARA and, when monitoring is provided or required, is properly assessed and documented.

**2.8. Medical Treatment Facility (MTF) Commander:**

2.8.1. Recommends to the installation commander that personnel be relieved from duties that could involve further radiation exposure when individuals have been, or are likely to be, exposed to ionizing radiation in excess of limits specified in 10CFR20 and AFI 48-148.

2.8.2. Accomplishes tests, as may be necessary, to medically evaluate an individual's exposure to radiation in the event of a potential overexposure.

2.8.3. Make a Radiation Safety Officer available to support the installation program and ensure RSO is properly qualified and trained to perform radiation safety duties.

2.8.4. Ensures pregnant individuals working in potential occupational radiation exposure environments and who could potentially exceed 500 mrem during their pregnancy are referred to the Installation RSO for enrollment in the Dosimetry Program on a monthly monitoring frequency. Civilian personnel can elect to not be enrolled in the Dosimetry Program, but are highly encour-

aged to enroll. If the civil service worker elects not to be monitored, reassignment to a non-radiation work environment is required to ensure the AF meets the legal limit of 500 mrem during gestation as stated in 10 CFR 20. **Note:** Pregnant individuals referred to the Installation RSO who are enrolled in the Dosimetry Program will be placed on a monthly badge exchange frequency (see Section 6).

## 2.9. Bioenvironmental Engineer (BEE)/ Installation RSO:

2.9.1. Conducts the Dosimetry Program at base level per AFI 48-148 and this Manual. **Note:** In some rare instances, program management may be assigned to other offices and individuals depending on the organizational structure and the availability of suitable radiation expertise.

2.9.2. Determines that individuals and work areas meet one or more of the monitoring conditions specified in paragraph **1.3.**

2.9.3. Determines the type of external monitoring required (i.e., body, head, extremity, beta/gamma/neutron), the length of the monitoring period, and the type and scope of any bioassay procedures (urine sampling, fecal sampling, etc).

2.9.4. Requests records of an individual's prior occupational radiation dose IAW 10 CFR 20.2104, prior to registering an individual in the Dosimetry Program.

2.9.5. Upon referral from Public Health (PH):

2.9.5.1. Conducts workplace evaluation and exposure assessment for pregnant employees.

2.9.5.2. Notifies PH of the scope of the radiation hazard and any recommended duty restrictions.

2.9.5.3. Ensures that pregnant radiation workers that have the potential to exceed 500 mrem during gestation are enrolled into the Dosimetry Program and placed on a monthly monitoring schedule, if required (See Section 6).

2.9.5.4. Ensures that pregnant radiation workers already enrolled in the Dosimetry Program and meet the above criteria are placed on a monthly badge exchange frequency.

2.9.5.5. Approves Dosimeter Storage locations.

2.9.6. Briefs personnel enrolling in the Dosimetry Program on the following:

2.9.6.1. Proper wear and storage of TLDs.

2.9.6.2. Procedures for collecting any required bioassay samples.

2.9.6.3. Hazards associated with ionizing radiation and methods to keep their exposure ALARA.

2.9.6.4. Additional briefing requirements for female occupational radiation workers:

2.9.6.4.1. Hazards associated with exposure to ionizing radiation during pregnancy.

2.9.6.4.2. Their responsibility to report to Public Health (PH) as soon as possible following confirmation of pregnancy, and the need to be placed on a monthly dosimeter exchange frequency.

2.9.7. Ensures Air Force personnel being monitored by other than AFIOH/SDRD or having bioassay samples analyzed by other than AFIOH/SDRR are aware of the requirement to provide cop-

ies of any monitoring results to the RSO and forwards copies to AFIOH/SDRD for inclusion in the MRER.

2.9.8. Establishes a program for monitoring visitors.

2.9.9. Reports and investigates abnormal and overexposures per this instruction (see chapters 9. and 10.).

2.9.10. Requests priority processing from AFIOH/SDRD for dosimeters issued to pregnant workers or used in planned special exposures.

2.9.11. Maintains and reviews forms and listings received from AFIOH/SDRD to ensure accuracy and completeness and promptly notifies AFIOH/SDRD of any changes as may be appropriate.

2.9.12. Provides and reviews (if possible) a copy of the appropriate AF Form 1527-1 to each person monitored (for more detail see Section 4.6.5.).

2.9.13. Ensures responders have at least one dosimeter per group of responders who are co-located, either a whole body, or whole body and neutron, depending on the type of radiation potentially present, along with an electronic personal dosimeter. Ensures first responders are knowledgeable of dose guidance in AFI 48-148.

**2.10. Public Health Office (PH):**

2.10.1. Assists preparation of pregnancy profile based upon physician recommendations and BEE environmental health assessment (including radiation exposure).

**2.11. Unit Commanders with Individuals in the USAF Personnel Dosimetry Program:**

2.11.1. Ensures the unit implements all the requirements of this AFM.

2.11.2. Responsible to ensure all personnel exposures are ALARA

**2.12. Supervisors of Individuals in the USAF Personnel Dosimetry Program:**

2.12.1. Responsible to ensure all personnel exposures are ALARA

2.12.2. Ensure badges are properly worn and handled per this AFM.

2.12.3. Refer newly assigned personnel and visitors who will enter into an area requiring the wear of TLDs to the Installation RSO for entry into the Dosimetry Program prior to starting work involving occupational exposure to ionizing radiation.

2.12.4. Promptly refer pregnant personnel to:

2.12.4.1. PH for establishment of a Pregnancy Profile and

2.12.4.2. Installation RSO for placement into the monthly monitoring program.

2.12.5. Review the Occupational Radiation Exposure Report (Current) (SDRD Listing 1499) and associated installation RSO comments and take necessary action to address errors or possible adverse trends.

2.12.6. Maintain Listing 1499 and provide dosimetry results to personnel upon request. Forms are maintained until the installation RSO has distributed the Annual Occupational Exposure History to Ionizing Radiation (AF Form 1527-1) or Cumulative Occupational Exposure History to Ionizing Radiation (AF Form 1527-2) to individuals covering the same monitoring period.

2.12.7. Cooperates in the assessment of assigned administrative doses due to individual loss, stolen, destroyed, or otherwise cannot account for personnel dosimeters.

**2.13. Individual Participants in the USAF Personnel Dosimetry Program:**

2.13.1. Responsible to ensure all personnel exposures are ALARA

2.13.2. Provide the installation RSO with all relevant personnel dosimetry information. Such information includes, but is not limited to, listing current or prior history of occupational radiation exposure.

2.13.3. Review dosimetry results provided by AFIOH/SDRD via Listing 1499, AF Form 1527-1 and (or) AF Form 1527-2 promptly upon receipt and report any errors noted to the installation RSO.

2.13.4. Comply with any requirements for bioassay sample collection.

2.13.5. Cooperates in the assessment of assigned administrative doses due to individual loss, stolen, destroyed, or otherwise cannot account for personnel dosimeters

2.13.6. Female military members shall, on becoming aware she is pregnant, notify her workplace supervisor, or primary care manager. The pregnant military member shall be enrolled in the Dosimetry Program on a monthly monitoring frequency, and depending upon her duties, may be temporarily reassigned.

2.13.7. Female non-military member should notify their workplace supervisor or primary care manager to ensure the safety of the fetus. **Note:** It is important to remember that a civilian or non-military woman's decision to declare her pregnancy is entirely voluntary. It is the fundamental responsibility of the pregnant non-military worker to decide when, and whether she will formally declare her pregnancy, via a signed letter. The pregnant non-military worker will be enrolled in the Dosimetry Program at her discretion.

2.13.8. Properly use issued dosimeters per instructions provided by the installation RSO and in this AFM. The Air Force may take Uniform Code of Military Justice disciplinary action against anyone who willfully engages in deliberate exposure, destruction, contamination, falsification or tampering with dosimeters, bioassay samples, or records of dosimetry results.

### 3. DESCRIPTION OF AIR FORCE DOSIMETERS.

3.1. **Air Force Whole Body and Collar Dosimeters:** Please refer to [Attachment 3](#) for additional technical and operational details.

3.1.1. Panasonic UD-802 Whole Body Dosimeter and 820 Hanger Combination – “Smoke Holder” (General Purpose Dosimeter): This is the general-purpose dosimeter used to measure radiation exposures to the whole body. The dosimeter is sensitive to beta, gamma, x-ray, and neutron radiation. This dosimeter must be worn by all personnel enrolled in the USAF Dosimetry Program regardless of other type(s) of dosimeters worn. If specialty dosimeters such as the collar or extremity dosimeters are not worn, the whole body dosimeter will also be used to determine the dose equivalents for the head, lens of the eye, and extremities. This dosimeter is clipped on the outer clothing in the front part of the body below the shoulders and above the hips. When worn with a collar dosimeter, the whole body dosimeter is always worn underneath any lead apron. When worn WITHOUT a collar dosimeter and a lead apron is worn, the whole body dosimeter is worn on the individual’s collar, outside any protective shielding. When a whole body dosimeter is not being worn, it is stored with the area control dosimeter. SDRD Listing 1523 designates this wear location as "BODY."

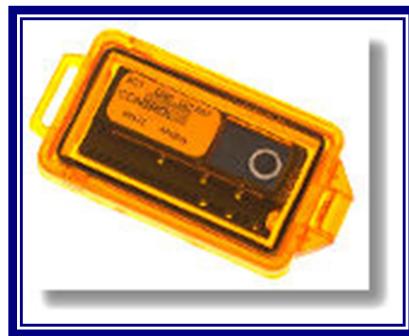
**Figure 1. Typical UD-802 Whole Body Dosimeter in Smoke (clear) Hanger**



3.1.2. Panasonic UD-802 Collar Dosimeter: A collar dosimeter is the primary device used to evaluate exposures to the head and lens of the eye and, when applicable, to facilitate calculating the effective dose equivalent under the special monitoring circumstances described in Chapter [4.](#). Consideration for wearing this dosimeter should be given to individuals engaged in fluoroscopic examinations, in the operation of portable medical x-ray equipment, in performing cardiac catheterizations, or who otherwise may wear protective lead aprons and for whom the whole body dosimeter may not provide an accurate assessment of dose to the head, neck, or lens of the eye. THE COLLAR DOSIMETER IS ALWAYS WORN OUTSIDE ANY SHIELDED PROTECTIVE COVERING. The collar dosimeter may be placed in a red hanger to facilitate verification of proper placement while worn in conjunction with a whole body dosimeter; however, if the collar dosimeter is the *only* dosimeter used then it shall be placed in the standard smoke hanger. A collar dosimeter should be worn as near to the thyroid as possible to determine the unshielded exposure to the head and lens of the eye. When a collar dosimeter is not being worn, it is stored with the area control dosimeters. SDRD Listing 1523 designates this wear location as "COLL." The RSO should contact AFIOH/SDRD for guidance in other circumstances such as a desire to provide collar dosimetry service.

3.1.3. Panasonic UD-802 Whole Body Dosimeter/811 Hanger Combination - "Amber Hanger" (Neutron Dosimeter): This dosimeter/hanger configuration is a specialized design that provides enhanced capability to measure doses due to exposure to neutrons. This is accomplished by the incorporation of a cadmium filter into the hanger. The cadmium filter improves the dosimeter's response to the wide range of neutron energies that may be operationally encountered. A neutron dosimeter is the primary device for determining the neutron dose equivalents to the whole body. THE NEUTRON DOSIMETER IS NEVER WORN WITHOUT A WHOLE BODY BADGE. Since the neutron dosimeter is an albedo device (i.e., it uses the scattered neutrons from the user's body to determine the dose equivalent), it must be worn flat against the body, at the mid-section of the individual, with the back of the dosimeter next to the body. Note: The back of the dosimeter is clearly indicated by the presence of a pre-printed identification label. When a neutron dosimeter is not being worn, it is stored with the area control dosimeters. SDRD Listing 1523 designates this wear location as "NBOD."

**Figure 2. Typical UD-802 Dosimeter in Amber Hanger**



3.2. **Air Force Extremity Dosimeters:** Please refer to [Attachment 3](#) for additional technical and operational details.

3.2.1. General Description: AFIOH/SDRD has characterized two extremity (ring) dosimetry systems – “EXT-RAD” and “DXT-RAD”, both developed by Thermo Electron Radiation Measurement and Protection. The DXT-RAD system uses ringlets. The active phosphor is assembled into a miniature ring which has an adjustable strap and is hot or cold sterilizable. The EXT-RAD system is an active phosphor chipstrate assembled into sealed pouches and worn in band-aid style rings. The EXT-RAD dosimeter is cold sterilizable. Both types of dosimeters are bar-coded, have human-readable identities and are reusable. The extremity dosimeter is the primary device to evaluate exposures to the hand and forearm of an individual. THE EXTREMITY DOSIMETER IS NEVER WORN WITHOUT A WHOLE BODY DOSIMETER. The ring should be worn on the finger that will receive the highest dose of radiation from the source and must be oriented so that the circular indentation is facing the radiation source. If the extremity dosimeter is worn with leaded gloves, it is worn under the shielded gloves. When an extremity dosimeter is not being worn, it is stored with the area control dosimeters. SDRD Listing 1523 designates this wear location as "RING".

3.2.2. Extremity Dosimeter response at Nonstandard Beta Energies: The dose calculation algorithms for the single element extremity dosimeters (DXT-RAD and EXT-RAD) do not automatically compensate for exposures to beta radiation at energies other than those used to characterize the dosimeter (i.e., 0.556 MeV  $^{90}\text{Sr}/^{90}\text{Y}$  and 0.267 MeV  $^{204}\text{Tl}$ ). **Because of this inherent limita-**

*tion in dosimeter design, it is important that the customer advise AFIOH/SDRD of the type and energy of beta radiation for which the dosimeter is to be evaluated so that appropriate correction factors can be applied.*

**Figure 3. Components of DXT-RAD Extremity Dosimeter**



**Figure 4. EXT-RAD "band-aid" Chipstrate Extremity Dosimeter**



**Figure 5. EXT-RAD Extremity Dosimeter in use**



**3.3. Air Force Electronic Personal Dosimeters (EPDs):** The use of these dosimeters is reserved for special circumstances like emergency response, and selected Occupation Codes. Please contact AFIOH/SDRD for further guidance *prior* to issue or use of this technology. **Note:** Currently the Radiation Dosimetry Laboratory is recommending these units as supplemental dosimetry to be used in conjunction with the TLD system.

3.3.1. When the Thermo Electron Mark 2 and N2 EPDs are used to assess a dose to personnel that dose must be provided to AFIOH/SDRD for inclusion in the MRER. AFIOH/SDRD does not issue EPDs to individual personnel.

3.3.2. AFIOH/SDRD/RCF will conduct all calibrations of Thermo Electron Mark 2 and N2 EPD technology in use within the AF.

3.3.2.1. EPDs used for First Responder Teams or readiness purposes require calibration on an annual basis

3.3.2.2. EPDs used for personnel monitoring on a regular basis will require a 6 month calibration cycle.

3.3.3. Thermo Electron's Electronic Personal Dosimeter – EPD Mk2: The EPD Mk2 is an electronic dosimeter that detects and measures beta and gamma radiation. The EPD Mk2 detects radiation and processes it to give an indication of penetrating dose, superficial dose and the dose rate. This information is displayed to the user via an LCD display on the top of the EPD. The EPD also has various dose and dose-rate alarms that can be set to alert the wearer of a potential radiological hazard.

3.3.3.1. Mk2 EPDs are preset by AFIOH/SDRD/RCF and should not be adjusted by the end-user. If custom alarm set points are required, please contact the Radiation Calibration Facility (RCF) to create a profile for your installation.

3.3.4. Thermo Electron's Electronic Personal Dosimeter – EPD N2: The EPD N2 works the same as the EPD Mk2 except it detects neutron and photon radiation instead of beta and photon.

3.3.4.1. N2 EPDs are currently used for Weapons of Mass Destruction First Responders exclusively. These EPDs are preset by AFIOH/SDRD/RCF and should not be adjusted by the end user.

#### **4. CONDUCTING AN INSTALLATION-LEVEL DOSIMETRY PROGRAM.**

**4.1. General:** Detailed guidance on managing installation-level Dosimetry Programs is contained in this Chapter.

**4.2. Monitoring Criteria:** Eligible persons (see paragraph 1.3.) shall be entered into the Dosimetry Program based on the requirements of AFI 48-148, Section 3.5.1.

4.2.1. Personnel monitoring may be provided to individuals not meeting any of the above criteria if the installation RSO determines that any of the following applies:

4.2.1.1. The type of radiation to which the individual could be exposed is detectable by the personnel monitoring program,

4.2.1.2. Provision of monitoring services would be helpful in demonstrating compliance with ALARA

4.2.1.3. Monitoring is desirable to evaluate potential exposure conditions to allay public concern.

4.2.2. Occupations Normally Not Requiring Monitoring: Monitoring is normally not required for individuals working exclusively with the following types of ionizing radiation sources:

4.2.2.1. Dental X-Ray: Historical data has shown doses to personnel working with or around intraoral x-ray machines to be at or below the LLD. This is primarily due to the well collimated x-ray beams, positioning of the tube head close to the patient which minimizes scatter and adherence to good safety procedures (i.e., utilizing the principles of time, distance and shielding). Dosimetry should be provided for individuals when operation exposures can potentially approach occupational limits; for example, during pregnancy of full-time dental radiology technicians, operation of equipment at a distance of less than 6 feet such as during mass casualty identification; or when panoramic units are operated without the protection of a shielded control room/booth.

4.2.2.2. Baggage X-Ray: Historical data has shown doses to personnel working with or around baggage x-ray units to be negligible provided unit shielding and safety interlocks are functional.

4.2.2.3. Explosive Ordnance Disposal (EOD) and Office of Special Investigation (OSI) Pulsed X-Ray Units: Historical data has shown doses to personnel working with or around pulsed x-ray units (non-fluoroscopic) used by EOD and OSI personnel to be negligible provided good safety procedures are followed (i.e., adherence to time, distance and shielding principles). Use of the EOD MK-32 X-ray system does not require personnel dosimetry; however other x-ray systems may require dosimetry monitoring and may need to be assessed, on a case-by-case basis. EOD and OSI occasionally will use a fluoroscopic type x-ray system. If this is the case, dosimetry may be necessary to assess exposure conditions.

#### **4.3. Monitoring Period:**

4.3.1. General: Most personnel enrolled in the Dosimetry Program have TLDs that are exchanged quarterly. Factors necessitating more frequent exchange i.e., monthly exchange, might include the prior exposure history of the unit for individuals performing similar duties, prior exposure history of the individual beginning work as an occupational radiation worker, the potential for accumulat-

ing radiation doses at a high or irregular rate, training of individuals, etc. The appropriate exchange frequency for personnel dosimeters is determined by the RSO.

#### 4.3.2. Normal Exchange Frequency:

4.3.2.1. Most occupational radiation exposure circumstances encountered within the USAF can be adequately monitored by using dosimeters exchanged on a quarterly basis. Using quarterly monitoring periods (i.e., 3-month) generally provides optimum accuracy for low dose rate environments.

4.3.2.2. Monitoring at shorter frequencies (e.g., monthly) may be appropriate under special circumstances, as detailed below:

4.3.2.2.1. Occupational radiation workers who are pregnant and have the potential to exceed 500 mrem during their pregnancy will be monitored monthly (see chapter 6.).

4.3.2.2.2. Certain operations having an exceptionally high radiation exposure potential (i.e., greater than 1.25 rem per quarter) may necessitate a monthly exchange frequency.

#### 4.4. **Determining Prior Occupational Dose:**

4.4.1. In accordance with AFI 48-148 and 10 CFR 20.2104, individuals enrolled in personnel monitoring programs should provide information regarding their current and past history of occupational radiation exposure at the time of enrollment.

4.4.2. For each individual who is likely to receive, in a year, an occupational dose requiring monitoring, the installation RSO shall:

4.4.2.1. Request the occupational internal and external radiation dose records that the individual received during the current year.

4.4.2.2. Attempt to obtain the records of cumulative occupational radiation dose.

4.4.3. It is ultimately the individual's responsibility to provide records of prior non-AF occupational dose to the installation RSO.

4.4.4. In complying with the requirements of this section, the installation RSO may:

4.4.4.1. Accept, as a record of the occupational dose that the individual received during the current year, a written signed statement from the individual, or from the individual's most recent employer for work involving radiation exposure, that discloses the nature and amount of any occupational dose the individual may have received during the current year *or*

4.4.4.2. Accept, as a record of the cumulative radiation dose, an up-to-date AF Form 1527-2 obtained from AFIOH/SDRD if the individual certifies by signature that the AF Form 1527-2 contains records of his or her complete radiation exposure history *or*

4.4.4.3. Accept, as a record of the cumulative radiation dose, an up-to-date NRC Form 4, Cumulative Occupational Exposure History, or equivalent, signed by the individual and countersigned by an appropriate official (along with office/title of responsibility: i.e. RSO, supervisor, contract monitor, etc.) of the most recent employer for work involving radiation exposure, or the individual's current employer; and

4.4.4.4. Obtain reports of the individual's dose equivalents from the most recent former employer for work involving radiation exposure or the individual's current employer by tele-

phone, telegram, electronic media or letter. Written verification of dose data will be requested if the authenticity of the transmitted report cannot be established.

4.4.5. The installation RSO, as required by this section, shall take into account an individual's prior exposure history and ensure any additional occupational radiation exposure received as a result of USAF or concurrent moonlighting operations does not exceed allowable occupational exposure limits as specified in 10CFR20 and AFI 48-148. Individuals, whose prior exposure history exceeds allowable occupational exposure limits for the current calendar year either as a result of AF or concurrent moonlighting activities, will be immediately removed from all duties involving occupational radiation exposure and will not be monitored by the Personnel Ionizing Radiation Dosimetry Program.

4.4.6. If the installation RSO is unable to obtain a complete record of an individual's current and previously accumulated occupational dose, the installation RSO shall assume:

4.4.6.1. In establishing administrative controls for the calendar current year, that the allowable dose limit for the individual is reduced by 12.5 mSv (1.25 rem) for each quarter records were unavailable and the individual was engaged in activities that could have resulted in occupational radiation exposure; and

4.4.6.2. That the individual is not available for planned special exposures.

**4.5. Exposures Incurred during Secondary (i.e., "moonlighting") Employment:** USAF occupationally exposed individuals, monitored under the USAF personnel Dosimetry Program, are prohibited from exceeding the dose limits specified in 10CFR20 and AFI 48-148, regardless of the source of exposure. Because of this, it is necessary to consider the radiation exposure an individual may receive from employment outside the USAF. **Note:** AF occupational radiation workers may not wear their AF issued TLDs while moonlighting.

4.5.1. NRC Form 4, Occupational Radiation Exposure History. Upon initial entry or re-entry in the USAF Personnel Ionizing Radiation Dosimetry Program, radiation workers are required to provide radiation exposure histories (NRC Form 4 or as stated in 10 CFR 20.2104, (c)) from previous employers prior to beginning work. This includes, but is not limited to, individuals who may have studied at civilian or military institutions for advanced degrees. The NRC Form 4 or its equivalent is used to record radiation exposures from previous employers outside of the USAF. This request is normally initiated by the RSO with the individual signing a statement allowing the release of Privacy Act information. **IAW AFI 48-148 all dose equivalent histories of previous employment outside the USAF must be forwarded to AFIOH/SDRD for inclusion in the MRER.**

4.5.2. NRC Form 5, Current Occupational Radiation Exposure. All Air Force employees involved in off-duty employment and registered in the USAF Personnel Dosimetry Program are required to provide current radiation exposure summaries. The NRC Form 5 or its equivalent is used to record radiation exposures to USAF personnel who have off-duty employment involving radiation exposures, and are provided dosimeters by an institution other than the USAF. **IAW AFI 48-148, the individual must furnish dose equivalent information from off-duty employment at least quarterly to the local RSO. The RSO must forward this information to AFIOH/SDRD for entry into the MRER.**

#### **4.6. Personnel Monitoring for Exposure to Radiation from an External Agency:**

4.6.1. All persons monitored by the USAF through AFIOH/SDRD, or working for the USAF but monitored by another agency, must be registered in the USAF Personnel Dosimetry Program.

4.6.2. AFIOH/SDRD sends dosimeters to the installation RSO or medical organization conducting the Dosimetry Program along with a Listing 1523 that contains information on all registered individuals.

4.6.3. At the end of each monitoring period, the installation RSO exchanges the dosimeters and ships the old dosimeters, along with the Listing 1523 for that monitoring period, to AFIOH/SDRD, 2350 Gillingham Drive, Bldg-140 Brooks City-Base TX 78235-5103. AFIOH/SDRD must receive the packages no later than the tenth working day of the month immediately following the last day of the monitoring period to facilitate processing and result reporting. Include all control and extra dosimeters with these shipments. Ensure Listing 1523 is not mutilated in any way and all original information is legible.

4.6.4. AFIOH/SDRD processes all dosimeters and the installation RSO, using the Radiation Dosimetry Web secure website, retrieves a Listing 1499 with the individual exposures for the monitoring period. For more information on the Radiation Dosimetry Web please contact AFIOH/SDRD.

4.6.4.1. The installation RSO reviews the Listing 1499 and distributes a copy to the supervisor of the monitored individuals.

4.6.4.2. The installation RSO evaluates any administrative doses assigned by AFIOH/SDRD on the Listing 1499 due to lost or damaged dosimeters, to determine the most likely dose received by the individual for the given monitoring period (See Chapter 5.).

4.6.5. AFIOH/SDRD annually provides the installation RSO, via the Radiation Dosimetry Web, with an AF Form 1527-1 for each individual entered on the Dosimetry Program for the previous calendar year. (For more information on the Radiation Dosimetry Web please contact AFIOH/SDRD.) The installation RSO provides these forms to each individual on the Dosimetry Program within 30 days of receipt. 10 CFR 19.13(c) states the installation RSO will establish a system (e.g., logbook, copy of AF Form 1527-1 signed by the individual, etc.) to document receipt of this information by the individual.

#### **4.7. Personnel Monitoring for Exposure to Radiation from Internally Deposited Radioactive Materials:**

4.7.1. *In vitro* (e.g., samples of breath, urine, feces, and organ) or *in vivo* bioassay methods (e.g., whole body counting) may be used to determine individual intakes of radioactive material. All radio-bioassays conducted to evaluate individual radiation exposure (radionuclide intake) shall be conducted per procedures contained in American National Standards Institute (ANSI) Standard HPS N13.30-1996 and Federal Guidance Report No. 11 (EPA-520/1-88-020, 1998).

4.7.2. The installation RSO identifies personnel and work areas requiring periodic bioassay monitoring, the type of bioassay procedures the installation requires, the frequency of bioassay procedures, and the length of the monitoring period. Specific guidance is available from AFIOH/SDRR. The installation RSO coordinates all bioassay programs and collections with AFIOH/SDRR before implementing them.

4.7.3. At the end of the monitoring period, the installation RSO:

4.7.3.1. Collects and packages the bioassay sample(s) following AFIOH/SDRR instructions. The installation RSO must coordinate the collection of bioassay samples with the servicing MTF Commander because bioassay sample collection is a clinical procedure.

4.7.3.2. Sends packaged samples, along with a completed AF Form 2753, Radiological Sampling Data, for each, to AFIOH/SDRR, 2350 Gillingham Drive, Bldg-140 Brooks City-Base TX 78235-5103.

4.7.3.3. AFIOH/SDRR processes samples, provides data interpretation and dose assessment and generates a report meeting the criteria of 10 CFR 20.2016. The report is sent to AFIOH/SDRD for inclusion in the MRER as the official USAF record of internal radiation dose. An information copy of the report is also sent to the installation RSO for appropriate filing and for distribution to the monitored individual.

#### **4.8. Wearing and Handling of Dosimeters:**

##### **4.8.1. General:**

4.8.1.1. Dosimeters are to be placed in the proper position on the body prior to entering a radiation area or handling radioactive materials. Dosimeters are to be removed upon leaving the radiation work place and stored in a location designated by the installation RSO.

4.8.1.2. Each dosimeter hanger is uniquely identified with a label provided by AFIOH/SDRD. If it is necessary to make any changes to this label, the original print must remain legible to properly account for the card and dosimeter.

4.8.1.3. Dosimeters must not be inscribed with any type of name, number or other identifying information. To ensure accurate dose assessments, dosimeters must not be covered with any foreign material such as duct tape, masking tape or labels not furnished by AFIOH/SDRD.

4.8.1.4. Each whole body dosimeter has a thin Mylar™ window designed to aid in evaluating exposures from low energy radiation. Dosimeters must be visually inspected before use to confirm this window is present and intact. Dosimeters with missing or damaged windows are not to be used and must be returned to the installation RSO for exchange.

4.8.2. Whole Body Dosimeters: This type of dosimeter is designed to measure radiation exposure to the whole body (or major portion of the whole body) and is to be worn on the front of the body between the neck and the waist level on the outside of clothing. The front surface of the dosimeter faces away from the body. Normally, whole body exposures to beta, gamma and x-radiation are assessed by use of a single whole body dosimeter.

4.8.2.1. When a lead apron or similar protective garment is used, a separate collar dosimeter shall be issued. Whole body dosimeters are worn on the outside of basic clothing but beneath the protective garment.

4.8.2.2. In certain situations, multiple dosimeters may be issued. These are generally used to assess localized exposures and must never be worn in lieu of the whole body dosimeter.

4.8.3. Collar Dosimeters: These dosimeters are used to assess the dose to the head, neck, and lens of the eye, and are used to supplement the whole body dosimeter that is worn beneath a protective lead apron.

4.8.4. Neutron Dosimeters: Specialized dosimeters are issued to monitor occupational exposures to neutron radiation. Neutron and whole body dosimeters are always worn simultaneously, in the same approximate location and in the same manner as whole body dosimeters. Examples of circumstances where neutron dosimeters may be required include: individuals working around medical or industrial accelerators that operate at greater than 13 MeV, work with radioactive materials that emit neutrons (e.g.,  $^{238}\text{Pu}/\text{Be}$  sources,  $^{252}\text{Cf}$  sources, or nuclear weapon systems), or work around operating nuclear reactors. The accuracy of neutron dosimetry is greatly enhanced when the energy spectrum of neutron radiation to which the individual is exposed is known. The base RSO should consult with the Health Physics Branch (AFIOH/SDRH) for assistance in characterizing site-specific neutron energy spectra.

4.8.5. Extremity Dosimeters: Extremity dosimeters (most commonly finger rings) will be worn by persons determined by the installation RSO as likely to exceed 10 percent of the applicable extremity dose limit in 10 CFR20 and AFI 48-148. Dosimeters must be worn underneath any protective garments (e.g., surgical gloves and leaded gloves), on the dominant hand and with the circular indentation facing toward the radiation source. Extremity dosimeters are always worn simultaneously with whole body dosimeters.

#### 4.9. Storing Dosimeters:

4.9.1. The installation RSO designates dosimeter storage areas remote from ionizing radiation sources. The number and location of these storage areas is determined by the installation RSO, as needed to support local programs.

4.9.2. Dosimeter storage areas must be free of oil, dust, or other contaminants.

4.9.3. Dosimeters must not be stored in areas of high temperature or moisture.

4.9.4. A designated control dosimeter must be placed in each dosimeter storage area for the entire monitoring period.

4.9.5. Dosimeters must not be stored in places not approved by the installation RSO.

#### 4.10. The Radiation Dosimetry Web Secure Website.

4.10.1. The Radiation Dosimetry Web is a secure website that can be accessed by the RSO, the TLD Monitor, and assigned Alternates. To obtain an application for a username and password, logon to <https://afioh.brooks.af.mil/portal/> and follow the instructions on the page. After completing the PDF form, fax it to the number listed on the bottom of the form and your logon instruction with username and password will be returned to you.

4.10.2. The following six common dosimetry customer service tasks should be accomplished using this system:

4.10.2.1. Base Information Change Request – Used to change information about your base, i.e., mailing address or delivery address, new RSO (or alternate where applicable), new TLD Monitor, new telephone or fax number, status of Dosimetry Program (active, inactive), etc.

4.10.2.2. Personnel Information Change Request – Used to add a person to the program, delete (deactivate) a person in the program, or request a change, i.e., new area, different dosimeters, etc.

4.10.2.3. Declaration of Pregnant Radiation Worker – self-explanatory (module of the Personnel Information Change Request).

4.10.2.4. Administrative Dose Change – Used to change the dose reported by the TLD or to change a dose that was assigned as a result of an unreturned TLD.

4.10.2.5. Special Requests – Used to order additional whole body, neutron, and extremity dosimeters, hangers, clips, etc.

4.10.2.6. Request Cumulative Occupational Exposure History to Ionizing Radiation (1527-2) – For radiation workers assigned to your base or location. If the radiation worker is not currently assigned to your base/location, or if the worker was assigned within the last 5 days, then you will not be able to generate a 1527-2 by using this service. This service is available interactively.

4.10.3. Routine Dosimetry Reports (1499-1, 1499-2, 1499-3) – These will be transmitted to you via this system. Reports will be in PDF format and will be available for viewing and printing only. The USAF Center for Radiation Dosimetry will no longer send a hard copy of reports. Authorized users will receive email notification that a dose report is ready for viewing and printing. *Reports will remain available for 30 days and then will automatically be deleted (reposts will be available upon request).*

4.10.4. Annual Dose Reports (1527-1) – These reports will also be sent via this system, as described above.

## 5. LOST, DAMAGED, OR NOT RECEIVED DOSIMETER PROCEDURES.

5.1. **General:** On occasion, dosimeters may be lost, temporarily misplaced or damaged.

5.1.1. If a TLD is found to be lost or damaged at the end of the monitoring period, the installation RSO should explain the occurrence and assign an appropriate dose equivalent for the monitoring period in a memorandum or via the Dosimetry Web System. The memorandum will need to be submitted with the rest of the TLD shipment from the base. This effort will simplify the TLD program for all parties concerned, saving on needless tracking and notifications.

5.1.2. If a TLD is not included in a received shipment from the field, AFIOH/SDRD assigns an interim administrative dose, sends a notification to the base and requests that the TLD be returned immediately, or an evaluation be made to determine the appropriate dose equivalent that should be recorded for the monitoring period for the affected individual. Within 30 days of receipt, the RSO must review these notices, assign an appropriate dose equivalent and report the dose equivalent to AFIOH/SDRD. **Note:** TLDs are a measure of radiation exposure to AF personnel. All necessary steps should be taken to ensure security and accountability of dosimeters shipped to your facility.

### 5.2. Determining the Administrative Dose for Lost or Damaged TLDs or Dosimeters:

5.2.1. The following steps should be used in assigning an administrative dose:

5.2.1.1. The base RSO reviews the radiation exposure records of the monitored individual and coworkers for the previous twelve months.

5.2.1.2. The first level supervisor prepares a statement of the worker's duties during the monitoring period and the worker signs the statement indicating concurrence.

5.2.1.3. The RSO reviews the above summary of duties and previous radiation exposures for the work area and assigns the best estimate of the dose equivalent.

5.2.1.4. The RSO can report to AFIOH/SDRD by filling out the proper form on the Radiation Dosimetry Web secure website. The RSO can also report to AFIOH/SDRD by letter or by returning the AFIOH/SDRD notification letter. If reporting via letter, the report should include:

5.2.1.4.1. The assigned dose equivalent and any explanation on how that value was determined.

5.2.1.4.2. The dosimeter number, type of dosimeter and monitoring period.

5.2.1.4.3. The name and social security account number of the individual.

5.2.1.4.4. The signed statement of concurrence. If an individual cannot sign a statement of concurrence, the RSO must note the reason. Copies of this report should be appropriately filed and/or a scanned copy should be included in the OHMIS. AFIOH/SDRD will also maintain a copy after the dose has been entered into the MRER as an assigned dose.

5.3. **Dosimeters Not Received By AFIOH/SDRD:** The TLD Program Monitor and the RSO must attempt to locate the dosimeter. If found, the TLD or extremity dosimeter must be forwarded to AFIOH/SDRD with a note indicating that the dosimeter or TLD was previously not returned to AFIOH/SDRD. If not found, follow the steps in the previous paragraph to assign the appropriate dose equivalent. If no response is received by AFIOH/SDRD within 30 days of the end of the monitoring period, a notification will be sent to the TLD Program Monitor/RSO, with copies sent to the MTF

Commander and the MAJCOM. Additional attempts are made to obtain the missing dosimeters at the 60- and 90-day overdue points. Bases may be assessed through a report of survey for the replacement cost of lost dosimeters. AFIOH/SDRD may also request the assistance of the Office of the Surgeon General (AFMOA/SGPR) and command channels to resolve problems involving persistent failure to return dosimeters for processing. In the most serious cases, the Office of the Surgeon General may, through command channels, direct that dosimetry service or radioactive material use permits issued by the USAF Radioisotope Committee be suspended.

## **6. PERSONNEL MONITORING FOR PREGNANT RADIATION WORKERS.**

**6.1. General:** AFI 48-148, Ionizing Radiation Protection, requires that the dose equivalent to an unborn child as a result of occupational exposure of the mother be as low as reasonably achievable, not exceed 5mSv (500 mrem) during the gestation period, and be less than 0.5 mSv (50 mrem) per month. AFIOH/SDRD supports this requirement by providing monthly badges and priority processing and notification of dosimetry results for identified pregnant workers that have the potential to exceed the aforementioned limits. If the person works in an area normally monitored quarterly, base program managers need to temporarily change her area registration to an area that is monitored monthly. In this case, storage of her dosimeter when not being worn must be kept with a monthly area control dosimeter. Otherwise her TLD may not get exchanged at the proper frequency or the area control will not be proper for her dosimeter. To obtain the most accurate results, both the control and the personnel monitor TLD need to be stored and processed together.

### **6.2. Installation Radiation Safety Officer (RSO):**

6.2.1. Evaluates the exposure potential for each pregnant worker and advises her attending physician accordingly.

6.2.2. Prescribes protective measures to include possible enrollment in the USAF Personnel Ionizing Radiation Dosimetry Program (if not already on the program, and providing potential exists to exceed 5 mSv (500 mrem) deep dose equivalent (DDE) over the gestation period), arranges placement on a monthly versus quarterly dosimetry exchange cycle and priority processing of dosimetry by AFIOH/SDRD, or reassignment to a non-radiation work environment. Although there are higher dose limits established for occupational radiation workers, in the special case of a pregnant radiation worker the aforementioned limit shall be applied.

6.2.3. Recommends work restrictions necessary to ensure adequate protection of the embryo/fetus. Assignment of pregnant workers to alternative duties for radiation protection purposes shall be without loss of all normal benefits associated with duties from which removed. Pregnant workers are normally removed from radiation related duties under the following circumstances:

6.2.3.1. Past monitoring (internal and external) indicates the worker will receive a whole body total effective dose equivalent (TEDE) of greater than 5 mSv (500 mrem) over the gestation period, or the potential for receiving this dose is considered excessive.

6.2.3.2. Work directly involving unsealed radionuclides unless authorized in writing by AFMOA/SGPR.

6.2.4. The installation RSO notifies AFIOH/SDRD of pregnant occupational radiation workers requiring monthly monitoring and priority reporting of results.

6.2.4.1. This notification should be done by using the Radiation Dosimetry Web secure website.

6.2.4.2. If notification via the website is not possible, it should be made by facsimile.

6.2.4.2.1. Facsimile reporting must include the individual's name, social security number (SSAN), the installation and work area code, the estimated date of conception and whether or not the worker had any past history of external or internal radiation exposure.

6.2.4.2.2. Since the facsimile will contain personal and medical information such as SSAN and medical conditions, the fax cover sheet must include the following disclaimer,

“FOR OFFICIAL USE ONLY. This electronic transmission may contain personal medical information protected by the Privacy Act of 1974 (see AFI 33-332) and the Health Insurance Portability and Accountability Act (HIPPA) (see DoD 6025.18-R) not intended for disclosure outside government channels and exempt from mandatory disclosure under the Freedom of Information Act, 5 U.S.C., 552. Exemption 6 may apply. Do not release outside of DoD channels without the consent of the originator's office. If you received this message in error, please notify the sender either by reply e-mail or phone, and delete all copies of this message.”

## 7. NON-ROUTINE DOSIMETRY.

### 7.1. Radiation Workers on Extended Temporary Duty (TDY):

#### 7.1.1. TDY for Periods of 90 Days or Less:

7.1.1.1. Individuals going TDY for 90 days or less will take their dosimeter and a designated transit control dosimeter with them. The accompanying control dosimeter may be issued from spare dosimeters provided to the home base. **Note:** TDY badges should be carried onto the aircraft; checked baggage may be subject to X-ray radiation at a level that could damage the TLDs.

7.1.1.2. Upon return from TDY, the individual will ensure the dosimeter and transit control are turned in for processing at the next exchange interval. In no instances will a dosimeter be kept for periods longer than 6 months.

#### 7.1.2. TDY for Periods Exceeding 90 Days:

7.1.2.1. TDY/Deployed Locations Having an Established Dosimetry Program: While TDY to a location with an established Dosimetry Program, individuals will obtain necessary dosimetry at the TDY location. If dosimetry support is provided by other than AFIOH/SDRD, the individual is responsible for ensuring copies of their dosimetry results are provided to AFIOH/SDRD for inclusion in the MRER.

7.1.2.2. TDY/Within CONUS: Locations Not Having an Established Dosimetry Program: Individuals on TDY for periods greater than 90 days to locations without an established Dosimetry Program will receive dosimetry support from their sponsoring organization for the duration of the TDY. Support will necessitate providing dosimetry controls and ensuring exchanges are made in a timely fashion. Gaining organizations anticipating ongoing requirements of this nature are encouraged to establish their own dosimetry programs.

7.1.2.3. TDY/OCONUS: Locations Not Having an Established Dosimetry Program. Individuals on TDY for periods greater than 90 days to locations without an established Dosimetry Program will receive dosimetry support from the nearest location with an established Dosimetry Program. AFIOH/SDRD will provide additional dosimetry support to the location providing the support to these individuals. These procedures should be established before member departs TDY for OCONUS locations.

### 7.2. Members or Employees of Other Services or Federal Agencies Who Are Occupationally Exposed to Ionizing Radiation From Air Force Operations:

7.2.1. Individuals employed by other military services or other Federal agencies may on occasion be occupationally exposed to ionizing radiation while working under Air Force jurisdiction. Examples of circumstances where this could occur include cooperative staffing of military medical treatment facilities, joint operations, etc.

7.2.2. Individuals having a primary employer other than the USAF who are occupationally exposed while under USAF jurisdiction (i.e., while working with radiation sources subject to licensing, permitting, or control of the USAF) shall be enrolled in the USAF personnel dosimetry system and shall utilize USAF-provided personnel monitoring.

7.2.3. The USAF MRER will maintain dosimetry results for individuals in circumstances of paragraph **7.2.2.** In addition, dosimetry results for these individuals will be reported to the individual's

primary employer using procedures established between AFIOH/SDRD and the counterpart organization in the other Federal agency.

7.2.4. AFIOH/SDRD will establish procedures to routinely request and obtain dosimetry results from the US Army and US Navy personnel dosimetry centers on any USAF personnel who have received personnel dosimetry services from those centers and will incorporate these results into the MRER as doses obtained outside the USAF.

### **7.3. Visitors (Occasionally-Exposed Individuals):**

7.3.1. The RSO may authorize visitors to enter a radiation area or high radiation area IAW AFI 48-148. Visitors entering defined "Radiation Areas" or "High Radiation Areas" or that are likely to incur a deep dose equivalent in excess of 0.10 mSv shall be afforded personnel monitoring devices (See also Section 1.5.3). The decision to provide either a direct reading dosimeter or TLD for entry into controlled areas should be based on the anticipated exposure potential during a single visit and the anticipated number of visits by an individual in a year. In no case shall a member of the public visiting controlled areas be permitted to receive a dose that exceeds the 1 mSv in a yr (100 mrem in a year) limits of 10CFR20 and AFI 48-148. If direct reading dosimeters are issued, the dosimeters must have been calibrated within the last year. In addition, a log of all direct reading dosimeter readings must be maintained by the workplace supervisor and include the following:

- 7.3.1.1. The date, time and purpose of the visit.
- 7.3.1.2. The visitor's printed name, SSAN, business address and phone.
- 7.3.1.3. The dosimeter's serial number and calibration date.
- 7.3.1.4. The dosimeter reading before and after the visit.
- 7.3.1.5. The dosimeter's net exposure reading and net exposure time.

7.3.2. The installation RSO shall review all visitor dosimeter logs quarterly.

7.3.3. The installation RSO ensures AFIOH/SDRD is provided a copy of all positive log readings for entry into the MRER within 10 calendar days of the end of the quarterly monitoring period.

7.3.4. When visitors enter an area where unsealed radioactive material is in use, the installation RSO will ensure appropriate protective clothing or equipment (e.g., respiratory protection, laboratory coats, shoe covers, gloves, etc.) are provided as needed to keep potential doses below the 0.1 mSv (100 mrem) TEDE control limit. **Note:** Visitors will not be assigned respiratory protection unless they have been enrolled in the base respiratory protection program and assigned a properly fit tested respirator.

### **7.4. Special Survey Dosimeters:**

7.4.1. The installation RSO may request special survey dosimeters (e.g., dosimeters used for area surveys, localized exposure determinations, conducting an exposure investigation) from AFIOH/SDRD.

7.4.2. Dosimeters routinely provided by AFIOH/SDRD will **not** be used for special surveys unless authorized by AFIOH/SDRD.

### **7.5. Planned Special Exposures: (as defined in 10 CFR 20)**

7.5.1. Planned special exposures will **not** be accomplished unless prior approval is granted by AFMOA/SGPR. Requests for planned special exposures will be signed by the installation commander and include the following:

7.5.1.1. Justification for the planned special exposure.

7.5.1.2. Radiological Work Plan to include precautions to be taken to keep exposures received ALARA.

7.5.1.3. Name, SSAN and cumulative record of lifetime radiation exposure history (NRC Form 4 or equivalent) for each individual involved.

7.5.2. Following approval by AFMOA/SGPR, the installation RSO notifies AFIOH/SDRD of the planned special exposure and provides the individual's name, SSAN, work code and expected date of the planned exposure.

7.5.3. Upon being notified by the installation RSO, AFIOH/SDRD:

7.5.3.1. Ensures individuals are entered into the Dosimetry Program.

7.5.3.2. Provides dosimeters specifically for use during the planned special exposure.

7.5.3.3. Provides AF Form 1527-2 for each individual before and after the planned special exposure.

7.5.3.4. AFIOH/SDRD and SDRR provide priority processing of planned special exposure dosimeters and bioassay samples, respectively. AFIOH/SDRD provides consolidated external and internal results via facsimile to the installation RSO, along with a new AF Form 1527-2.

7.5.3.5. The installation RSO provides these results to all individuals involved in the planned special exposure within 15 calendar days of determining the dose.

## 8. ABNORMAL EXPOSURES.

8.1. **Abnormal Exposures:** Any dosimeter and/or bioassay result exceeding any of the values in Table 9-1 represent an "abnormal exposure."

**Table 1. Abnormal Exposure Criteria**

The More Restrictive Of	VALUE	
	Monthly Dosimeter	Quarterly Dosimeter
Total Effective Dose Equivalent	> 4.17 mSv (0.417 rem)	> 12.5 mSv (1.25 rem)
Deep dose equivalent to pregnant radiation worker	> 0.5 mSv (0.05 rem)	N/A
Sum of deep dose equivalent and committed dose equivalent to any individual organ or tissue other than the lens of the eye	> 41.7 mSv (4.17 rem)	> 125 mSv (12.5 rem)
Eye dose equivalent	> 12.5 mSv (1.25 rem)	> 37.5 mSv (3.75 rem)
Shallow dose equivalent to skin or extremity	> 41.7 mSv (4.17 rem)	> 125 mSv (12.5 rem)
Internal deposition of any radionuclide	>10% of Annual Limit on Intake (ALI)	>25% of ALI

8.2. **Abnormal Exposure Suspected by Base:** Any dosimeter suspected of receiving an abnormal exposure will be forwarded to AFIOH/SDRD together with a control dosimeter and an identifying letter detailing the circumstances involved in the suspected exposure. The control dosimeter should be taken from that monitoring period's unused stock of extras unless the exposure is believed to have occurred while the dosimeter was stored in its normal location on a rack with the standard control dosimeter. Whenever an abnormal exposure is suspected, the standard control dosimeter will be submitted along with the suspected exposed dosimeter and a control dosimeter from that monitoring period's unused stock of extras and the standard control dosimeter replaced from the unused stock of extras. If you have no unused stock of dosimeters, contact AFIOH/SDRD for further instructions. Suspected abnormally exposed TLDs will receive priority processing at AFIOH/SDRD and the dose results will be reported back to the RSO as soon as they are available.

8.3. **Abnormal Exposure Observed by AFIOH/SDRD Upon Processing a Dosimeter:** The RSO is to conduct an investigation into the abnormal exposure and submit a written report within 30 calendar days on the findings of the investigation, IAW AFI 48-148. Finalized reports must be sent to AFIOH/SDRD and the MAJCOM BEE. An advance copy of the investigation report should be sent to the MAJCOM BEE as well as AFIOH/SDRD by FAX (DSN 240-5368) or Commercial (210) 536-5368 or via email.

8.4. **Notification of Abnormal Exposures:**

8.4.1. AFIOH/SDRD notifies the installation RSO by telephone, within 72 hours, and follows-up with a facsimile memorandum of apparent abnormal exposures. The memorandum:

- 8.4.1.1. Identifies the dosimeter and/or bioassay sample number.
- 8.4.1.2. Includes the name, SSAN, occupational code of the individual involved.
- 8.4.1.3. Gives a dose equivalent estimate based on the dosimeter results, bioassay concentrations, or both.
- 8.4.1.4. Provides instructions to accomplish the required investigation IAW AFI 48-148.

8.5. **Exception:** When a Personnel assigned dosimeter is not returned to AFIOH/SDRD, an Administrative Dose equal to the corresponding dose in table 9-1, is automatically assigned for the given exchange frequency. These doses are not a valid representation of the individual's exposure and therefore will not be treated as an abnormal exposure. The sole purpose of these types of dose assessments is to notify RSOs that actions must be taken to correct the individual's records to more accurately reflect personnel exposure.

8.6. **Investigation:** The installation RSO initiates a formal investigation to determine:

- 8.6.1. Circumstances surrounding the abnormal exposure.
- 8.6.2. The validity of the dose received.
- 8.6.3. The portion of the body exposed.
- 8.6.4. Any corrective actions required preventing recurrence.

8.7. **Written Report:**

8.7.1. The installation RSO submits a written report on the findings of the investigation to AFIOH/SDRD and the MAJCOM BEE within 30 calendar days of being notified about the possible abnormal exposure. The report includes:

- 8.7.1.1. Name, SSAN, occupational code and AFSC of the individual involved.
- 8.7.1.2. Description of circumstances surrounding the abnormal exposure.
- 8.7.1.3. Estimates of each individual's dose equivalent to include a detailed discussion of how this value was determined.
- 8.7.1.4. If it is determined that the individual's dosimeter was inadvertently exposed to radiation while not being worn, the following information needs to be determined to assist in estimating the appropriate dose to be assigned for this monitoring period:
  - 8.7.1.4.1. During the monitoring period, did the individual's activities differ from normal activities or those of fellow workers during the same monitoring period? If so, in what way did they differ (e.g., did the workload increase or decrease significantly)?
  - 8.7.1.4.2. Was the individual involved in any activities, which might have caused the dosimeter to indicate a higher or lower dose than normal?
  - 8.7.1.4.3. If the individual wore pocket dosimeters, what was the indicated exposure during the monitoring period?
  - 8.7.1.4.4. What is the individual's past dose history?

- 8.7.1.4.5. What dose did the individual receive during normal periods of work?
  - 8.7.1.4.6. Provide any available evidence used in concluding the investigation. The letter could potentially be used for medical and legal purposes so, therefore, must be complete.
  - 8.7.1.4.7. Corrective actions taken to prevent recurrence. Appropriate corrective actions might include: Instruction on the proper wear and uses of the dosimeter, ensuring the adequacy of the radiation protection program, surveying and correcting faulty equipment, moving the dosimeter storage area to an area free of radiation sources, etc.
  - 8.7.1.4.8. Statement signed by the individual involved either supporting or contesting the investigation report.
  - 8.7.1.4.9. Results of any medical examinations (if appropriate).
- 8.7.2. AFIOH/SDRD evaluates the written report and requests any additional information from the installation RSO as may be necessary to fully document the dose received and updates the MRER. Upon notification by AFIOH/SDRD that the MRER has been updated the installation RSO should acquire an AF Form 1527-2 for the individual in question or request one from AFIOH/SDRD. AFIOH/SDRD retains all supporting documentation for the dose assigned.
- 8.7.3. The installation RSO will ensure copies of reports validating the occurrence of an abnormal exposure are forwarded to AFMOA/SGPR and to the applicable Command Bioenvironmental Engineer.
- 8.7.4. AFIOH/SDRD ensures the MRER is updated accordingly.

## **9. POTENTIAL OVEREXPOSURES.**

**9.1. General:** Any dosimeter and/or bioassay result that exceeds the applicable dose limits specified in 10CFR20 and AFI 48-148 shall be considered to represent a "potential overexposure."

**Table 2. Potential Overexposure Criteria**

<b>The More Restrictive Of</b>	<b>VALUE</b>
Total Effective Dose Equivalent	> 0.05 Sv (5.0 rem)
Total effective dose equivalent to pregnant radiation worker during course of pregnancy	> 0.005 Sv (0.500 rem)
Sum of deep dose equivalent and committed dose equivalent to any individual organ or tissue other than the lens of the eye	> 0.5 Sv (50 rem)
Eye dose equivalent	> 0.15 Sv (15 rem)
Shallow dose equivalent to skin or extremity	> 0.5 Sv (50 rem)
Internal deposition of any radionuclide	> of applicable ALI

### **9.2. Potential Overexposure Identified by Base:**

9.2.1. An installation RSO who is notified by an individual, or suspects a potential overexposure may have occurred, immediately notifies AFIOH/SDRD, the MAJCOM BEE and AFMOA/SGPR by telephone and follows-up with a facsimile letter explaining the circumstances. This includes, but is not limited to, potential overexposures as a result of accidents or terrorist events, both in garrison or deployed.

9.2.2. Following notification by the RSO, AFIOH/SDRD immediately provides facsimile instructions for performing an investigation, to include any bioassay requirements, and requests the installation RSO return any dosimeters and (or) bioassays in progress at the time immediately to AFIOH/SDRD for priority processing.

9.2.3. AFIOH/SDRR provides priority processing for all bioassay samples collected in overexposure investigations and immediately reports the results to the installation RSO by telephone and facsimile letter.

9.2.4. Written Report: The installation RSO provides a written report of the investigation findings through the MAJCOM BEE to AFIOH/SDRD within 7 calendar days of being notified of the potential over exposure. Copies of this report are provided to AFMOA/SGPR and the individual.

**9.3. Removal from Duties:** Individuals that have possibly received an overexposure will be removed from duties involving radiation exposure as recommended by the RSO to the individual's supervisor, pending completion of the final investigation report. This removal from duty is not to be considered adverse personnel action. If the final investigation report concludes the individual received an overexposure, AFMOA/SGPR concurrence must be obtained before the exposed individual is allowed to return to radiation related duties.

### **9.4. Potential Overexposure Identified by AFIOH:**

#### **9.4.1. Notification:**

9.4.1.1. When a dosimeter or bioassay indicates an overexposure may have occurred, AFIOH/SDRD immediately notifies the installation RSO by telephone and follows with a facsimile letter within 2 hours. Facsimile copies of this letter are also provided to AFMOA/SGPR.

9.4.1.2. Following telephone notification by AFIOH/SDRD, the installation RSO immediately contacts the unit commander and requests the individual be removed from all duties involving potential radiation exposure until an investigation of the incident can be completed. The installation RSO also notifies the MTF commander who, in turn, notifies the installation commander, as appropriate. Notification should also be made to the appropriate MAJCOM BEE.

9.4.2. Investigation: The installation RSO investigates suspected overexposures in the same manner as abnormal exposures (see paragraph 8.6.). An overexposure may represent a potentially or overtly injurious dose of ionizing radiation. These investigations demand swifter action, more detailed reporting procedures, possible medical follow-up and comprehensive documentation.

9.4.3. Written Report: The installation RSO provides a written report of the investigation findings through the MAJCOM BEE to AFIOH/SDRD within 7 calendar days of being notified of the potential over exposure. Copies of this report are provided to AFMOA/SGPR. All reports should include the following information:

9.4.3.1. Name, SSAN, occupational code and AFSC of individual involved.

9.4.3.2. Description of circumstances surrounding the potential overexposure.

9.4.3.3. Estimates of each individual's total effective dose equivalent to include a detailed discussion of how this value was determined.

9.4.3.4. Root cause of the exposure: Factors to be considered might include; deliberate exposure of the dosimeters, dosimeter worn while the individual concerned received diagnostic or therapeutic radiation exposure as a patient, improper action on the part of the individual in question, inadequate protective measures, faulty operation of equipment, or use of the dosimeter for other than personnel monitoring, etc.

9.4.3.5. If it is determined that the individual's dosimeter is erroneous, for whatever reason, the following information should be considered in estimating the appropriate administrative dose to be assigned for the monitoring period. Your report should provide any evidence available used in developing this estimate.

9.4.3.5.1. During the monitoring period, did the individual's activities differ from normal activities or those of fellow workers during the same monitoring period? If so, in what way did they differ (e.g., did the workload increase or decrease significantly)?

9.4.3.5.2. Was the individual involved in any activities, which might have caused the dosimeter to indicate a higher or lower dose than normal?

9.4.3.5.3. If the individual wore a pocket dosimeter, what was the indicated exposure during the monitoring period?

9.4.3.5.4. What is the individual's past dose history?

9.4.3.5.5. What dose did the individual receive during normal periods of work?

9.4.3.5.6. Corrective actions taken to prevent recurrence. Appropriate corrective actions might include; instruction on the proper wear and uses of dosimeters, ensuring the adequacy of the radiation protection program, surveying and correcting faulty equipment, moving the dosimeter storage area to an area free of radiation sources, etc.

9.4.3.5.7. Statement signed by the individual involved either supporting or contesting the investigation report.

9.4.3.5.8. Results of any medical examinations (if appropriate).

**9.5. Termination of Investigation:** AFIOH/SDRD will review reports involving doses considered as a potential or true overexposure. AFMOA/SGPR evaluates the reports of potential overexposures and either approves termination of the incident or requests additional information. Following termination, AFIOH/SDRD updates the MRER. Upon notification by AFIOH/SDRD that the MRER has been updated the installation RSO should acquire an AF Form 1527-2 for the individual in question or request one from AFIOH/SDRD. The installation RSO ensures the individual is given a copy of the revised AF Form 1527-2.

**10. WEIGHTED EFFECTIVE DOSE EQUIVALENT (EDE) WHEN SHIELDED PROTECTIVE APRON IS WORN.**

10.1. **Applicable Population:** Occupational radiation workers certified by the RSO as working exclusively with radiation sources not subject to regulation of the US Nuclear Regulatory Commission, and wearing both a whole body badge beneath shielded protective clothing and a collar badge worn outside the shielded protective clothing.

10.2. **General Protocol:** Fluoroscopy procedures are the largest source of occupational radiation dose in medicine. Fluoroscopic and special procedures may account for 90% of the total collective dose accrued by occupational exposed persons working in general radiography. The radiation dose to personnel performing these procedures is non-uniform, with relatively high doses to the head, neck, and extremities, with much lower doses to the trunk and other regions protected by shielding (lead aprons). A special calculation protocol is necessary to provide a more realistic estimate of the effective dose received by individuals working in these highly specialized radiographic/fluoroscopic work environments. Numerous approaches and models have been proposed to address the issue that the deep dose equivalent recorded for personnel during such procedures by a single monitoring badge worn on the neck above an apron will overestimate the Effective Dose Equivalent ( $H_E$ ) by factors of 8 to 23, while a single monitoring badge worn at the waist under an apron will underestimate  $H_E$  by factors of 1.2 to 60. X-rays having energies within the range of kilovoltages commonly used in diagnostic radiology (60 to 120 kVp), the calculated values of  $H_E$  range from 0.93 to 0.95 for 0.5 mm lead aprons and from 0.99 to 1.48  $H_E$  for 0.3 mm lead aprons. This approximation is given by:

$$EDE = (1.5 \times WB) + (0.04 \times WBCL)$$

Where:

EDE = Effective Dose Equivalent

WB = Dose measured by the whole body badge worn under the lead apron

WBCL = Dose measured by the whole body badge worn on the collar, outside the lead apron

10.3. **Applicability Criteria:** Weighting of deep dose equivalent may be applied if ALL of the following conditions are met:

10.3.1. During the monitoring period, the individual works ONLY with machine produced radiation sources.

10.3.2. During monitoring period, the individual NEVER works with radiation sources regulated by the US Nuclear Regulatory Commission (NRC), radioactive material permitted under the USAF Radioisotope Committee, Section 91b radioactive materials permitted by HQ AFSC, or exposures from intrinsic radiation from nuclear weapons.

10.3.3. During the monitoring period, the individual is NOT enrolled in the pregnant radiation worker-monitoring program (generally indicated as "Area PF" by the RSO).

10.3.4. The whole body badge is worn on the front of the body, between the waist and shoulders, underneath the lead apron.

10.3.5. The collar badge is worn on the front of the body, at collar or neck level, outside the lead apron.

10.3.6. Placement of the two badges is not interchanged during the monitoring period.

10.3.7. If ANY of the above conditions are ***not*** met, the dose of record is the highest dose recorded for any dosimeter during that monitoring period.

10.4. **Example of Dose Recording:** When weighting is applied, the results obtained from both badges must be recorded on the individual's dose record together with the calculated EDE. However, only the calculated EDE is added to the cumulative deep dose total for the quarter, year to date, or life-time. An example of the application of this weighting protocol is shown in the following table:

**Table 3. Sample of Weighting Calculation**

Dosimeter Type	Deep Dose Equivalent mSv (rem)	Lens Dose Equivalent mSv (rem)	Shallow Dose Equivalent mSv (rem)
Chest Badge	0.2 (0.020)	0.2 (0.020)	0.25 (0.025)
Collar Badge	2.5 (0.250)	2.6 (0.260)	2.75 (0.275)
*EDE <sub>(Calc.)</sub>	0.4 (0.040)	-	-

\*EDE<sub>(Calc.)</sub> = (1.5 X Deep(chest)) + (0.04 X Deep (collar)) In this example, the dose equivalent of record for Deep, Lens and Shallow are 0.4 mSv (0.040 rem), 2.6 mSv (0.260 rem) and 2.75 mSv (0.275 rem), respectively, because the weighting calculation applies only to deep dose equivalent.

## 11. FORMS, LISTINGS, RECORDS AND REPORTS.

### 11.1. General:

11.1.1. USAF Master Radiation Exposure Registry (MRER): The MRER provides a centralized, permanent record of exposure for all personnel currently and previously registered in the USAF Personnel Ionizing Radiation Dosimetry Program (See Chapter 12. for a detailed description of the MRER). The information contained in the MRER serves as the source for the generation of dose equivalent reports to be included in an individual's medical records. The MRER is medical information and contains Privacy Act information that must be protected in accordance with AFI 37-132, Air Force Privacy Act Program.

11.1.2. Records Maintenance: All records of exposure to ionizing radiation (e.g., SDRD Listing 1499-1, SDRD Listing 1499-2, AF Form 1527, etc.) are to be maintained in accordance with this manual, the requirements of 10 CFR 20.2106, DODI 6055.8, AFI 48-148 and HPS N13.6-1999.

11.1.3. **SDRD Listing 1523** – Dosimetry Assignment Data - , serves as a shipping list of dosimeters provided to a base for a specified monitoring period. It is automatically prepared based on information provided to AFIOH/SDRD by the base RSO for individuals and areas. Information included on the SDRD Listing 1523 includes:

11.1.3.1. **Date Prepared:** The date the listing was prepared (shown in the upper left corner of each page).

11.1.3.2. **Page # of #:** The page number and total number of pages in the listing (each area begins on a separate page).

11.1.3.3. **Base Code/Client Code:** A unique alpha-numeric code, established to identify each base.

11.1.3.4. **Area:** The designation of the monitoring area for data included on this report. This can be up to two characters and is established by the RSO, except that a separate area identified as "PF" is reserved for pregnant radiation workers. This listing shows the two character abbreviation and the plain-text description of the area as provided by the RSO.

11.1.3.5. **For the Period of:** The normal starting date for use of the dosimeters included in this shipment. **Dosimeters should not be used before the indicated start date without the specific permission of AFIOH/SDRD.** Unless specifically indicated by the RSO in the details section, it will be presumed that the individual to whom the dosimeter is issued began wearing the dosimeter on this date.

11.1.3.6. **To:** The normal ending date for use of the dosimeters included in this shipment. **Dosimeters should not be used beyond the indicated ending date without the specific permission of AFIOH/SDRD.** Unless specifically indicated by the RSO in the details section, it will be presumed that the individual to whom the dosimeter is issued discontinued wearing the dosimeter on this date.

11.1.3.7. **Name:** Name of individual to whom the dosimeter is to be issued (or other special designator such as "spare," "control," etc.).

11.1.3.8. **SSAN:** The social security number of the individual to whom the dosimeter is to be issued. When the dosimeter is to be used as a "control," this field will read "CONTROL-B" (whole body), "CONTROL-N" (neutron), or "CONTROL-F" (ring).

11.1.3.9. **DOB:** Date of birth of the individual to whom the dosimeter is to be issued.

11.1.3.10. **Sex:** Gender of the individual to whom the dosimeter is to be issued.

11.1.3.11. **OCC Code:** The three-character occupation code describing the type of occupational radiation exposure ([Attachment 4](#) to this manual is a listing of Occupation Codes).

11.1.3.12. **Pack ID #:** A control number assigned by AFIOH/SDRD to uniquely identify the dosimeter(s) to be assigned to each individual.

11.1.3.13. **Badge ID:** The unique numeric identification number shown on each dosimeter to be assigned to an individual.

11.1.3.14. **Wear LOC:** Wear location for this dosimeter.

11.1.3.14.1. CNTL=Control Dosimeter

11.1.3.14.2. BODY=Whole Body

11.1.3.14.3. NBOD=Neutron whole Body

11.1.3.14.4. COLL=Collar Dosimeter

11.1.3.14.5. RING=Extremity Dosimeter (ring)

11.1.3.15. **Start Date (MM/DD/YY):** The date the dosimeter was issued by the RSO to the individual being monitored. If all dosimeters are issued on the same day, one entry with a line down to the bottom of the listing will be adequate. When adding an individual to the program, the date the individual was issued the dosimeter must be indicated.

11.1.3.16. **End Date:** The date the dosimeter was collected by the RSO from the individual being monitored. At the end of the monitoring period, there should be an entry for each dosimeter that was issued and collected. As the dosimeters are collected, place a check next to the date collected to confirm receipt.

11.1.3.17. **Remarks: (Add/Del/Change):** Indicate any action required by AFIOH/SDRD to be taken on the form. If adding an individual to the program, write "ADD" in this column. Ensure that the AREA in which the individual needs to be added is also included in comment. (i.e., ADD to Area PF). If deleting an individual from the program, then there are two possible entries into this column. If the individual has worn the TLD during this monitoring period, specify DELETE/WORN (DW) in this column. If the individual has NOT worn their TLDs during this period, indicate DELETE/NOT WORN (DNW) in this column. If any of the personnel or dosimetry data must be changed, write "CHANGE" in this column, along with the proper information that the change needs to reflect (i.e., "CHANGE" last name to Doe). This field is also used to indicate anything that may be pertinent for the records of the individual being monitored. For example, if the dosimeter was not returned, write "NOT RETURNED," "TDY," "LOST," etc. in this column. If the monitoring was for a visitor (i.e., one time monitoring), write "ONE TIME" in this column. If the individual is deleted from the program due to a permanent change of station, write "PCS" in this column.

**Figure 6. SDRD Listing 1523, Dosimetry Assignment Data**

02/16/2000	<b>Dosimetry Assignment Data</b>										7 of 9
This form is covered by the privacy act statement as given in DD Form 2605											
Base: 0253	Area: R	RADIATION DOSIMETRY BRANCH									For The Period Of: 10/01/1999
HUMAN SYSTEMS CENTER/EMB											To: 12/31/1999
2909 NORTH ROAD BROOKS AFB TX 78235-5336											
Name	SSN	Dob	Sex	OCC	Pack ID#	Badge Id	Wear Loc	Start Date	Collection Date	Remarks: Add/Del/Change	
RADIATION ,	CONTROL-B					0506968	CNTL	10/1/99	12/31/99		
	CONTROL-N					0505999	CNTL	10/1/99	12/31/99		
					097	12756	BODY	10/1/99	12/31/99		
					097	12756	NBOD	10/1/99	12/31/99		
					097	12757	BODY	10/1/99	12/31/99		
					097	12757	NBOD	10/1/99	12/31/99		
					089	12758	BODY	10/1/99	12/31/99		
					089	12758	NBOD	10/1/99	12/31/99		
					097	12759	BODY	10/1/99	12/31/99		
					097	12759	NBOD	10/1/99	12/31/99		
					097	12760	BODY	10/1/99	12/31/99		
					097	12760	NBOD	10/1/99	12/31/99		
					097	12761	BODY	10/1/99	12/31/99		
					097	12761	NBOD	10/1/99	12/31/99		
					097		0509197	NBOD	10/1/99	12/31/99	
					097		0517370	BODY	10/1/99	12/31/99	

### 11.1.4. SDRD Listing 1499-1 , Current Occupational Radiation Exposure Report:

**Figure 7. SDRD Listing 1499-1**

OCCUPATIONAL RADIATION EXPOSURE REPORT (CURRENT) Date generated: 24-JAN-2003												
This form is covered by the privacy act statement as given in DD form 2005												
TO: 88 ABW/EMB / RADIATION SAFETY BASE CODE: 0206 AREA: 3A WRIGHT-PATTERNS OH 45433-5332 This report is furnished to you under the provisions of the Nuclear Regulatory Commission regulation 10 CFR 19.13. You should preserve this report for further reference.											METHOD RECORD	TYPE ROUTINE
(ALL RESULTS IN REM) EXTERNAL TOTALS THIS MONITORING PERIOD												
PERSONAL DATA				EYE DOSE EQUIV (DEEP)	HEAD DOSE EQUIV EQUIV	EXTREM DOSE EQUIV CD SKIN	SHALLO DOSE EQUIV EQUIV	DEEP DOSE EQUIV WHOLE BODY B/G/X	DOSE EQUIV SOURCE NEUT	ALL TEDE	D E C	
NAME LAST, FIRST, MI	SEX M	SSAN 3 008	OCC CODE FROM TO SAMPLE #	MONITORING PERIOD TLD, OR SAMPLE #	PACK, EQUIV (DEEP)	0.064 0.066 0.017 NA 0.017	0.018 ----- 0.018 ----- 0.066	0.000 0.000 0.000 NA 0.000	0.000 0.000 0.000 0.000 0.116	0.000 0.000 0.000 0.000 0.116	0.000 0.000 0.000 0.000 0.116	
Investigation action level (IAL): _____ Radiation Safety Officer (RSO) signature: _____												
AO -- Abnormal/Overexposure DA -- Damaged dosimeter LO -- Lost dosimeter NR -- Not received dosimeter SE -- Setup error (old badg)												
* An asterisk appearing after the occupation code denotes that this individual's occupation uses the Air Force's Master Materials License Number 42-23539-01AF.												
AL LISTING 1499-1 (15-NOV-1990)												

This listing serves as a summary report for AFIOH/SDRD issued dosimetry. The automated record shows the results for all individuals assigned to a given base code and area. Information included on the SDRD Listing 1499-1 includes:

11.1.4.1. **TO:** The mailing address for the base code and area.

11.1.4.2. **BASE CODE/CLIENT CODE:** A unique alpha-numeric code, established to identify each base.

11.1.4.3. **AREA:** The designation of the monitoring area for data included on this report. This can be up to two characters and is established by the RSO, except that a separate area identified as "PF" is reserved for pregnant radiation workers.

11.1.4.4. **METHOD:** How the results in this report were determined – **RECORD** for results measured from reading dosimeters or **CALC** for results calculated from other data such as a dose estimate report prepared by the RSO.

11.1.4.5. **TYPE:** Type of exposure – **ROUTINE** for regular monitoring cycle, **SPECIAL** for dosimeters processed outside the normal monitoring cycle as might occur in the case of a suspected abnormal exposure, potential overexposure or for a planned special exposure.

11.1.4.6. **PERSONAL DATA:**

11.1.4.6.1. **NAME (Last, First, MI):** The name of the individual to whom the dosimeter was assigned.

11.1.4.6.2. **SEX:** Gender of the individual to whom the dosimeter was assigned.

11.1.4.6.3. **SSAN:** The social security account number of the individual to whom the dosimeter was assigned.

11.1.4.6.4. **OCC CODE:** The three-character occupation code describing the type of occupational radiation exposure ([Attachment 5](#) to this manual is a listing of Occupation Codes). Reported results should be compared with the AF-wide summary by OCC Code to verify that an individual's exposure remains within the established ALARA constraints.

11.1.4.7. **MONITORING PERIOD (FROM, TO):** The start and end dates the dosimeter was assigned to this individual (YYYYMMDD).

11.1.4.8. **PACK, TLD, OR SAMPLE #:** A unique number identifying the physical dosimeter assigned to the individual during this monitoring period.

11.1.4.9. **EXTERNAL TOTALS THIS MONITORING PERIOD (ALL RESULTS IN REM):** The results measured from processing the dosimeters assigned to each individual.

11.1.4.9.1. **EYE DOSE EQUIV:** Absorbed dose (rem) from radiation of sufficient energy to penetrate an absorber providing attenuation equivalent to 300 mg/cm<sup>2</sup> (approximately that afforded by the lens of the eye).

11.1.4.9.2. **HEAD DOSE EQUIV (DEEP):** Absorbed dose (rem) to the head, neck, and thyroid from radiation of sufficient energy to penetrate an absorber providing attenuation equivalent to 1,000 mg/cm<sup>2</sup> (i.e., sufficient to reach deep tissue and blood forming organs such as bone marrow).

11.1.4.9.3. **EXTREM DOSE EQUIV:** The absorbed dose (rem) to the maximally exposed extremity (hands and forearms) from radiation of sufficient energy to penetrate an absorber providing attenuation equivalent to 7 mg/cm<sup>2</sup> (approximately that afforded by the dead layer of the skin).

11.1.4.9.4. **SHALLOW DOSE EQUIV:** The absorbed dose (rem) to the skin of the whole body from radiation of sufficient energy to penetrate an absorber providing attenuation equivalent to 7 mg/cm<sup>2</sup> (approximately that afforded by the dead layer of the skin).

11.1.4.9.5. **DEEP DOSE EQUIV:** The absorbed dose (rem) to the whole body from radiation of sufficient energy to penetrate an absorber providing attenuation equivalent to 1,000 mg/cm<sup>2</sup> (i.e., sufficient to reach deep tissue and blood forming organs such as bone marrow). When applicable, dose attributable to neutrons is listed separately from the total deep dose equivalent.

11.1.4.9.6. **ALL SOURCE TEDE:** The total effective dose equivalent (rem) to the individual from all sources for the monitoring period indicated. TEDE is defined as the sum of the deep dose equivalent [ $(H_D)$ (for external exposures)] and the committed effective dose equivalent (for internal exposures), expressed in units of either rem or Sv. The term TEDE does not apply to components of the individual's dose attributed to eye dose equivalent, extremity dose equivalent, or to shallow dose equivalent.

11.1.4.10. **DEC:** Digital Explanation Code – describes any unique circumstances related to the reported exposure. Commonly used codes include the following:

DEC	Description
AO	Abnormal/Overexposure Reading
AD	RSO Assigned Dose
LO	Dosimeter Lost (Old DEC Category)
DM	Dosimeter Damaged (Old DEC Category)
NR	Dosimeter Not Received
TS	Thyroid Shield Worn (Unshielded Dose Equivalents Shown)
ES	Eye Shield Worn (Unshielded Dose Equivalents Shown)
TE	Thyroid and Eye Shields Worn (Unshielded Dose Equivalents Shown)

## 11.1.5. SDRD LISTING 1499-2 , Summary of Occupational Radiation Exposure

Figure 8. SDRD Listing 1499-2

OCCUPATIONAL RADIATION EXPOSURE REPORT (SUMMARY)												
Date generated: 24-JAN-2003												
This form is covered by the privacy act statement as given in DD form 2005												
TO: 88 ABW/EMB WRIGHT-PATTERSON OH 45433-5332 RADIATION SAFETY BASE CODE: 0206 AREA: 3A This report is furnished to you under the provisions of the Nuclear Regulatory Commission regulation 10 CFR 19.13. You should preserve this report for further reference.											METHOD RECORD	TYPE ROUTINE
PERSONAL DATA				(ALL RESULTS IN REM) EXTERNAL TOTALS THIS YEAR								
NAME	LAST, FIRST, MI	SEX	SSAN	OCC CODE	DATE OF BIRTH	EYE DOSE EQUIV	HEAD DOSE EQUIV	EXTREM (DEEP) DOSE EQUIV	SHALLO DOSE EQUIV SKIN	DEEP DOSE EQUIV	WHOLE BODY B/G/X NEUT	ALL SOURCE TEDE
I	HAN M	1	3 008		196712	0.248	0.254	0.275	0.275	0.297	0.000	0.358
	IC M	5:	2 032*		196507	0.246	0.251	0.000	0.000	0.000	0.000	0.251
I	M	5:	..50 010		196310	0.780	0.793	0.069	0.069	0.075	0.000	0.793
Investigation action level (IAL): _____ Radiation Safety Officer (RSO) signature: _____												
* An asterisk appearing after the occupation code denotes that this individual's occupation uses the Air Force's Master Materials License Number 42-23539-01AF.												
AL LISTING 1499-2 (15-NOV-1990)												

This listing is prepared for each dosimetry account by area and indicates the dose received by each individual monitored under the USAF Personnel Dosimetry Program from the beginning of the calendar year to the date of the report. The date the form is prepared appears at the top of the form. ALL RESULTS ARE PRINTED IN REM UNLESS INDICATED OTHERWISE. A dash indicates the particular category is not applicable for the monitored individual.

## 11.1.6. PART D: LIFETIME CUMULATIVE TOTALS (ALL RESULTS IN REM).

## 11.1.7. PART D (1): INTERNAL.

11.1.8. **ITEM 18 - Committed Effective Dose Equivalent:** Indicates the sum of all committed effective dose equivalent assessments for all significantly irradiated organs or tissues during the lifetime of the employee.

## 11.1.9. PART D (2): EXTERNAL.

11.1.10. **ITEM 19 - Eye Dose Equivalent:** Indicates the external dose equivalent for the lens of the eye for the lifetime of the employee.

11.1.11. **ITEM 20 - Head Dose Equivalent (Deep):** Indicates the external dose equivalent for the head for the lifetime of the employee.

11.1.12. **ITEM 21 - Extremity Dose Equivalent:** Indicates the external dose equivalent to the extremities for the lifetime of the employee. If the dose equivalent results are reported on SDRD Listing 1499-1 by extremity dosimeter location and not the highest extremity value, the lifetime total is the sum of all the entries for the extremity location that received the highest dose during each monitoring period. No code is used to indicate dosimeter location.

11.1.13. **ITEM 22 - Shallow Dose Equivalent Skin:** Indicates the external dose equivalent for the skin during the lifetime of the employee.

11.1.14. **ITEM 23a - Deep Dose Equivalent Whole Body B/G/X-RAY:** Indicates the external dose equivalent for the whole body due to beta, gamma, and x-rays for the lifetime of the employee. This total value is included in Item 22.

11.1.15. **ITEM 23b - Deep Dose Equivalent Whole Body Neutron:** Indicates the external dose equivalent for the whole body due to neutrons for the lifetime of the employee. This total value is included in Item 22.

11.1.16. **PART D (3): ALL SOURCES.**

11.1.17. **ITEM 24 - Total Effective Dose Equivalent:** Indicates the sum of the committed effective dose equivalent (Item 18) and the total whole body deep dose equivalent (Items 23a and 23b).

11.1.18. **AF Form 1527-1 , Annual Report of Individual Occupational Exposure to Ionizing Radiation:**

Figure 9. AF Form 1527-1

Annual Occupational Exposure History to Ionizing Radiation								AIR FORCE CENTER FOR RADIATION DOSIMETRY				
This form is for use in place of certain reports required by NRC licensees, OSHA and state regulations. It reflects data provided to or by your account and contains information for NRC Form 5 and other equivalent forms.								Institute for Environment, Safety, Occupational Health Risk Analysis (IERA) Surveillance Directorate (SD) Radiation Surveillance Division (SDR) Dosimetry Branch (SDRD)				
NAME	SSAN	SEX	DATE OF BIRTH	LAST BASE				STATE	LAST ISSUE AREA	DATE		
				0253 BROOKS AFB				TX	R	29 Apr 99		
Monitoring Period	Base Code	Base Name	Area	Occ	DDE	LDE	SDE,WB	SDE,ME	Method	Type	DEC	Comments
1/1/98	3/31/98	0253 BROOKS AFB	R	89	0.010	0.010	0.010	0.010	R	R		
4/1/98	6/30/98	0253 BROOKS AFB	R	89	0.000	0.000	0.000	0.000	R	R		
7/1/98	9/30/98	0253 BROOKS AFB	R	89	0.000	0.000	0.000	0.000	R	R		
10/1/98	12/31/98	0253 BROOKS AFB	R	89	0.000	0.000	0.000	0.000	R	R		
Annual Intakes			Total Annual Doses (in rem)									
Radionuclide	Class	Mode	Intake in pCi									
Deep Dose Equivalent			(DDE) 0.010									
Eye Dose Equivalent To The Lens Of The Eye			(LDE) 0.010									
Shallow Dose Equivalent, Whole Body			(SDE,WB) 0.010									
Shallow Dose Equivalent, Max Extremity			(SDE,ME) 0.010									
Committed Effective Dose Equivalent			(CEDE)									
Committed Dose Equivalent, Max Organ			(CDE)									
Total Effective Dose Equivalent			(TEDE) 0.010									
Total Organ Dose Equivalent			(TODE) NC									
<b>METHOD</b> R - Record E - Estimate ND - No Record <b>TYPE</b> R - Routine Exposure PSE - Planned Special Exposure <b>DEC CODES</b> AD - RSO Assigned Dose DA - Damaged Dosimeter ES - Eye Shield NR - Not Recorded O - Outside Employment TE - Thyroid/Eye Shield TS - Thyroid Shield XD - Administrative Dose											<b>MODE OF INTAKE</b> H - Inhalation      G - Ingestion B - Absorption    J - Injection <b>CLASS</b> D - Days            O - Others W - Weeks          V - Vapor Y - Years	
This report is furnished to you under the provisions of the Nuclear Regulatory Commission regulation 10 CFR part 19. You should preserve this report for further reference.												
SIGNATURE - CERTIFYING OFFICIAL OR RADIATION SAFETY OFFICER (RSO)				DATE		SIGNATURE - MONITORED INDIVIDUAL				DATE		
THIS FORM IS PROTECTED BY THE PRIVACY ACT OF 1974												

AF FORM 1527-1

This form is prepared annually for each individual who has been monitored for occupational exposure to ionizing radiation and is entered in the USAF Personnel Dosimetry Program. AF Form 1527-1 is provided in lieu of NRC Form 5 and includes all external and internal dosimetry results for the previous monitoring year to include results of all AF-provided monitoring and all non-AF monitoring reports submitted to AFIOH/SDRD for entry to the MRER. In this way, the RSO can better evaluate the total radiation dose received by the individual. The RSO can access the form using the Radiation Dosimetry Web secure website. The RSO prints, reviews and distributes the reports to the individuals monitored at the base. **All results are in rem unless indicated otherwise.** Information included in AF Form 1527-1 includes:

#### 11.1.18.1. IDENTIFICATION DATA:

11.1.18.1.1. **Name, SSAN, Sex, Date of Birth:** Self-explanatory.

11.1.18.1.2. **Last Base:** The base code and plain-text identification of the last installation from which the individual received monitoring service during the year.

11.1.18.1.3. **State :** Self-explanatory.

11.1.18.1.4. **Last Issue Area:** The last monitoring area from which the individual received monitoring service during the year.

11.1.18.1.5. **Date:** The date the Form 1527-1 was generated.

#### 11.1.18.2. EXTERNAL DOSIMETRY RESULTS:

11.1.18.2.1. **Monitoring Period:** Start and end date.

11.1.18.2.2. **Base Code/Client Code:** Alpha-numeric code at which the individual monitoring occurred.

11.1.18.2.3. **Base Name:** Plain-text identification of the installation.

11.1.18.2.4. **Area:** Working area (as defined by the RSO) for which the individual monitoring was provided.

11.1.18.2.5. **OCC:** Occupation Code applicable to this monitoring period (see [Attachment 4](#)).

11.1.18.2.6. **DDE:** The absorbed dose (rem) to the whole body from radiation of sufficient energy to penetrate an absorber providing attenuation equivalent to 1,000 mg/cm<sup>2</sup> (i.e., sufficient to reach deep tissue and blood forming organs such as bone marrow). When applicable, dose attributable to neutrons is included the total deep dose equivalent.

11.1.18.2.7. **LDE:** Absorbed dose (rem) from radiation of sufficient energy to penetrate an absorber providing attenuation equivalent to 300 mg/cm<sup>2</sup> (approximately that afforded by the lens of the eye).

11.1.18.2.8. **SDE, WB:** The absorbed dose (rem) to the skin of the whole body from radiation of sufficient energy to penetrate an absorber providing attenuation equivalent to 7 mg/cm<sup>2</sup> (approximately that afforded by the dead layer of the skin).

11.1.18.2.9. **SDE, ME:** The absorbed dose (rem) to the maximally exposed extremity (hands and forearms) from radiation of sufficient energy to penetrate an absorber providing attenuation equivalent to 7 mg/cm<sup>2</sup> (approximately that afforded by the dead layer of the skin).

11.1.18.3. **METHOD:** Basis for reported result – “R” (record), “E” (estimate), “ND” (no record).

11.1.18.4. **TYPE:** Circumstances of exposure (Routine or Planned Special Exposure).

11.1.18.5. **DEC:** Digital Explanation Code – describes any unique circumstances related to the reported exposure. Commonly used codes include the following:

DEC	Explanation
AD	RSO assigned dose
AO	Abnormal or Over Exposure
DA	Damaged dosimeter
ES	Eye shield
NR	Dosimeter not returned
OU	Exposure from outside (i.e., non AF) Employment
TE	Thyroid and Eye shield
TS	Thyroid Shield
XD	Administratively assigned dose

11.1.18.6. **COMMENTS:** Self-explanatory.

11.1.18.7. **INTERNAL DOSIMETRY:** For each identified radionuclide, the report identifies the intake class, mode of intake and calculated internal deposition (in  $\mu\text{Ci}$ ). Internal dose commitments to individual organs/organ types are identified as follows:

Code	Organ
GON	Gonads
BST	Breast
RBM	Red bone marrow
LNG	Lung
THY	Thyroid
BON	Bone surface
RDM	Remainder

11.1.18.8. **SUMMARY FOR YEAR [Total Annual Doses (in rem)]:**

11.1.18.8.1. ***Deep Dose Equivalent (DDE):***

11.1.18.8.2. ***Eye (Lens), Dose Equivalent (LDE):***

11.1.18.8.3. ***Shallow Dose Equivalent, Whole Body (SDE, WB):***

11.1.18.8.4. ***Shallow Dose Equivalent, Maximally Exposed Extremity (SDE, ME):***

11.1.18.8.5. ***Committed Effective Dose Equivalent (CEDE):*** 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 ( $H_{E,50}$ ) these organs or tissues have received.  $H_{T,50}$  is the committed (organ) dose equivalent to an individual organ from a current uptake that will be delivered over the 50 years following the uptake. CEDE applies specifically to the dosimetry of internally deposited radionuclides.

11.1.18.8.6. ***Committed Dose Equivalent (Max Organ) (CDE):*** The maximum dose equivalent to an organ or tissue of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

11.1.18.8.7. ***Total Effective Dose Equivalent (TEDE):*** The sum of the deep dose equivalent [ $(H_d)$  (for external exposures)] and the committed effective dose equivalent (for internal exposures), expressed in units of either rem or Sv.

11.1.18.8.8. ***Total Organ Dose Equivalent (TODE):*** The total organ dose equivalent for the maximally exposed organ. The TODE is the sum of the deep dose equivalent (DDE) and the committed dose equivalent (CDE), expressed in units of rem or Sv.

11.1.18.9. **CERTIFICATION:** The bottom of each AF Form 1527-1 includes spaces for the dated signatures of the RSO and the monitored individual.

The monitored individual will be provided with a copy of the signed AF Form 1527-1, a copy will be placed in the individual's health record (if available) and a copy retained in the files of the base RSO.

The RSO makes reasonable (i.e., at least two) attempts to provide a copy of the AF Form 1527-1 to each monitored individual and establishes a system (e.g., logbook, annotation on retained copy, etc.) to document each individual's receipt of the form. As a minimum, documentation should include the date provided, individual's name and signature verifying receipt, and initials or signature of the installation RSO or person providing the form. The installation RSO shall retain the AF Form 1527-1 IAW AFI 48-148, section 3.5.5.1. For individuals who have moved from the installation (e.g., permanent change of station, retirement, separation), one attempt will be made to send their AF Form 1527-1 to their last known forwarding address. **Note:** This form contains individual identification information and must be protected against unauthorized disclosure as required by the Privacy Act of 1974.



**Figure 11. AF Form 1527-2 (last page)**

Cumulative Occupational Exposure History to Ionizing Radiation								AIR FORCE CENTER FOR RADIATION DOSIMETRY							
This form is for use in place of certain reports required by NRC licensees, OSHA and state regulations. It reflects data provided to or by your account and contains information for NRC Form 6 and other equivalent forms.								Institute for Environment, Safety, Occupational Health Risk Analysis (IERA) Surveillance Directorate (SD) Radiation Surveillance Division (SDR) Dosimetry Branch (SDRD)							
NAME	SSAN	SEX	DATE OF BIRTH	LAST BASE	STATE	LAST ISSUE AREA	DATE								
		M		0100 LACKLAND AFB	TX	NM	08 Dec 98								
Monitoring Period	Base Code / Name	Area	Occ	DDE	LDE	SDEWB	SDEME	CEDE	CDE	TEDE	TODE	METHOD	TYPE	DEC	
7/1/97	9/30/97 0100 LACKLAND AFB	MP	97	0.014	0.014	0.014	0.000			0.014		R	R		
10/1/97	12/31/97 0100 LACKLAND AFB	MP	97	0.013	0.017	0.019	0.000			0.013		R	R		
1/1/98	3/31/98 0100 LACKLAND AFB	MP	97	0.000	0.000	0.013	0.080			0.000		R	R		
4/1/98	6/30/98 0100 LACKLAND AFB	MP	97	0.027	0.027	0.027	0.000			0.027		R	R		
7/1/98	9/30/98 0100 LACKLAND AFB	MP	97	0.000	0.000	0.000	0.000			0.000		R	R		
3/1/99	3/31/99 0100 LACKLAND AFB	NM	97	0.000	0.000	0.000	0.000			0.000		R	R		
SUMMARY (REM):								1.371	1.371	7.829	7.717	1.371			
<b>Lifetime total (all sources). as recorded in MRER</b>								<b>Last page of 1527-2</b>							
DEC CODES		METHOD		ABBREVIATIONS											
AD - RSO Assigned Dose DA - Damaged Dosimeter ES - Eye Shield NR - Dosimeter Not Received OU - Outside Employment SE - Setup Error (Old Badges) TE - Thyroid/Eye Shield TS - Thyroid Shield XD - Administrative Do se		R - Record E - Estimate ND - No Record		DDE - Deep Dose Equivalent LDE - Lens Dose Equivalent SDE, WB - Shallow Dose Equivalent (Whole Body) SDE, ME - Shallow Dose Equivalent for Maximally Exposed Extremity CEDE - Committed Effective Dose Equivalent CDE - Committed Dose Equivalent for Maximally Exposed Organ TEDE - Total Effective Dose Equivalent (DDE + CEDE)											
BIOMASSURE - CERTIFY OFFICIAL OR RADIATION SAFETY OFFICER (RSO)		DATE		BIOMASSURE - MONITORED INDIVIDUAL								DATE			
THIS FORM IS PROTECTED BY THE PRIVACY ACT OF 1974															

AF Form 1527-2

AF Form 1527-2, Cumulative Occupational Exposure History to Ionizing Radiation, is similar to AF Form 1527-1 except that it includes all information in the MRER related to the lifetime occupational radiation exposure history for an individual, including moonlighting and other sources of exposure external to AF practices.

Using the Radiation Dosimetry Web secure website, the RSO can generate this form. Otherwise, this form is prepared by AFIOH/SDRD upon written request of the individual, the RSO, or (with written concurrence of the individual) a third party such as a post-AF employer, the Department of Veterans Affairs, etc.

The contents of the form and explanation of fields are the same as shown above for AF Form 1527-1 except that, immediately following the last entry, a summary line is added showing the lifetime radiation exposure for the individual in terms of DDE, LDE, SDE-WB, SDE-ME, CEDE, CDE, TEDE, and TODE (as applicable).

**11.1.20. AF Form 2753, Radiological Sampling Data:** The installation RSO uses this form to submit bioassay samples to AFIOH/SDRR for analysis. The installation RSO prepares AF Form 2753 before submitting samples to AFIOH/SDRR for analysis, forwards the original copy of AF Form 2753 to AFIOH/SDRR with the bioassay sample, and maintains a copy until results (i.e., updated 1527-1) are received from AFIOH/SDRR.

**11.1.21. NRC Form 4:** The installation RSO makes a reasonable effort to collect previous dosimetry histories for individuals having either past or present non-USAF employment. USAF person-

nel moonlighting in jobs where they are monitored for radiation exposure make arrangements to routinely (e.g., based on monitoring period, but no less than quarterly) provide these results to the installation RSO. The installation RSO ensures these results are forwarded to AFIOH/SDRD for incorporation into the MRER. The individual bears ultimate responsibility for ensuring any non-USAF dosimetry results become part of the MRER.

## 11.2. Statistical Summaries of Dosimetry Results:

### 11.2.1. Annual Personnel Radiation Exposure Summary (RCS: HAF-SGP (A)9232).

11.2.1.1. Prior to 1 April of each calendar year, AFIOH/SDRD will submit a personnel radiation exposure summary report to AFMOA/SGPR as required by Air Force Policy Directive (AFPD) 40-2, Attachment 1.

11.2.1.2. Any data that would make identification of specific individuals possible will be contained in an attachment to the report.

11.2.1.3. This report shall include the following as a minimum:

11.2.1.3.1. Zero average (all results), non-zero average (only non-zero results) and maximum annual TEDE dose for all occupational codes. Codes associated with NRC or radioactive material-related activities should be denoted for ease of reference. Results should be presented in a bar-chart format and compared to the previous year and the previous 5 years.

11.2.1.3.2. Zero average, non-zero average and maximum annual CEDE dose for all occupational codes. Results should be presented in a bar-chart format and compared to the previous year and the previous 5 years. Codes associated with NRC or radioactive material-related activities should be denoted for ease of reference.

11.2.2. **Annual Exposure Summary Report by Occupation Code:** Annually, AFIOH/SDRD will prepare a summary report of AF-wide radiation exposure data for the previous year showing the range and median recorded dose for each occupation code. This report will be distributed to all bases for use in evaluating exposures considered abnormal with respect to the applicable ALARA constraint.

## **12. THE USAF MASTER RADIATION EXPOSURE REGISTRY (MRER).**

**12.1. General:** In accordance with 10 CFR 19 and 20, the Air Force is required to maintain permanent dosimetry records for all persons entered into the Dosimetry Program. The MRER is a computer database maintained by AFIOH/SDRD. The MRER provides a historical record of dose equivalent data for all persons presently or formerly registered in the program. Depending on the age of the data, some internal dosimetry results may not be in the MRER, but are instead maintained by AFIOH/SDRR. AFIOH/SDRD is the sole custodian of the MRER. The MRER will also provide an individual's historical dose due to military operations not considered in their occupational exposure history.

### **12.2. Responsibilities:**

#### **12.2.1. AFIOH/SDRD (The USAF Radiation Dosimetry Laboratory):**

12.2.1.1. Permanently maintains records of all dosimetry, internal and external, for individuals entered into the Dosimetry Program.

12.2.2. Installation RSO (Dosimetry Account Custodian): The installation RSO reviews all records associated with the Dosimetry Program and report any corrections to AFIOH/SDRD via the Radiation Dosimetry Web, annotation on the Listing 1523 or via written correspondence. Correction of individual dose data in the MRER will only be made upon receipt of written request signed by the individual or after the RSO submits the correct form using the secure website.

12.2.3. Individual: The individual is responsible for reviewing his/her dosimetry results and providing any corrections in writing to AFIOH/SDRD through the installation RSO.

### **12.3. Forms and Reports Generated from Data in the MRER:**

12.3.1. SDRD 1527-1, Annual Report of Individual Exposure to Ionizing Radiation.

12.3.2. SDRD 1527-2, Cumulative Report of Individual Exposure to Ionizing Radiation.

### **12.4. Requests for Radiation Exposure History (AF Form 1527-2):**

12.4.1. Required Information: The RSO can generate this report using the Radiation Dosimetry Web, or the RSO, monitored individual, and other authorized organizations can request an AF Form 1527 in writing. These written requests must include:

12.4.1.1. The individual's name showing the last name, first name and middle initial.

12.4.1.2. The social security account number.

12.4.1.3. The individual's date of birth by day, month, year.

12.4.1.4. The approximate dates the individual was monitored by the Air Force. If the individual entered the service before 1 Jul 62, the location and dates of assignment and the previous Air Force Serial (Service) Number assigned must also be provided.

12.4.2. Authorization for Release: Because of Privacy Act requirements, a signed release statement must accompany requests for AF Form 1527 from the individual whose history is being requested. All requests from outside the Air Force for deceased individuals must be processed through the Department of Veterans Affairs or a Base RSO.

**Attachment 1****GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION*****References*****NATO Standardization Agreements (STANAG)**

STANAG 2743 - *ACE Policy for Defensive Measures against Low Level Radiological Hazards during Military Operations*, 31 March 1999.

STANAG 2474 - *NBC/MED (Edition 1)(Ratification Draft 1) – Determination and Recording of Ionising Radiation Exposure for Medical Purposes*, 13 March 2001.

**Presidential Directive**

52 Fed. Reg. 2,822, (24 January 1987) - *Radiation Protection Guidance to Federal Agencies for Occupational Exposure*.

**Department of Defense Instruction**

DoDI 6055.8 - *Occupational Radiation Protection Program*, 6 May 1996

**Air Force Publications**

AFPD 40-2 - *Radioactive Materials (Non-Nuclear Weapons)*, 8 April 1993.

AFPD 48-1 - *Aerospace Medicine Program*, 22 July 1993.

AFI 40-201 - *Managing Radioactive Materials in the USAF*, 01 September 2000.

AFI 48-148 – *Ionizing Radiation Protection*, 20 October 2000.

AFMAN 37-123 (will become AFMAN 33-363) *Management of Records*, 31 August 1994.

**Applicable Portions of the Code of Federal Regulations**

10 CFR, Parts 19 and 20.

29 CFR § 1910.1096

**Nuclear Regulatory Commission Regulatory Guides**

8.02 - *Guide for Administrative Practices in Radiation Monitoring*

8.04 - *Direct-Reading and Indirect-Reading Pocket Dosimeters*

8.07 - *Instructions for Recording and Reporting Occupational Radiation Exposure Data*

8.09 - *Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program*

8.10 - *Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable*

8.13 - *Instruction Concerning Prenatal Radiation Exposure*

8.14 - *Personnel Neutron Dosimeters*

8.15 - *Acceptable Programs for Respiratory Protection*

8.18 - *Information Relevant to Ensuring that Occupational Radiation Exposures at Medical Institutions Will Be As Low As Reasonably Achievable*

8.20 - *Applications of Bioassay for I-125 and I-131*

8.22 - *Bioassay at Uranium Mills*

8.26 - *Applications of Bioassay for Fission and Activation Products*

8.29 - *Instruction Concerning Risks from Occupational Radiation Exposure*

8.32 - *Criteria for Establishing a Tritium Bioassay Program*

8.34 - *Monitoring Criteria and Methods To Calculate Occupational Radiation Doses*

8.35 - *Planned Special Exposures*

8.36 - *Radiation Dose to the Embryo/Fetus*

10.01 - *Compilation of Reporting Requirements for Persons Subject to NRC Regulations*

### **Environmental Protection Agency (EPA) Publication**

EPA-520/1-88-ORD – Federal Guidance Report No. 11 – *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, September 1988.

### **Health Physics Society (HPS) Standards**

HPS N13.6-1999 – *Practice for Occupational Radiation Exposure Records Systems*, May 1999.

HPS N13.11-1993 – *Personnel Dosimetry Performance – Criteria for Testing*, September 1993.

HPS N13.11-2001 – *Personnel Dosimetry Performance – Criteria for Testing*, June 2001.

HPS N13.32-1995 – *Performance Testing of Extremity Dosimeters*, August 1995.

HPS N13.41-1997 – *Criteria for Performing Multiple Dosimetry*, December 1996.

HPS N13.42-1997 – *Internal Dosimetry for Mixed Fission Activation Products*, February 1997.

HPS N13.30-1996 – *Performance Criteria for Radiobioassay*.

### **International Atomic Energy Agency (IAEA) Publications**

Safety Series No. 115 (Safety Standards) – *International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources*, 2000.

Safety Series No. 120 (Safety Fundamentals) – *Radiation Protection and the Safety of Radiation Sources*, 2000.

Safety Standards Series No. RS-G-1.1 (Safety Guide) – *Occupational Radiation Protection*, 2000.

Safety Standards Series No. RS-G-1.2 (Safety Guide) – *Assessment of Occupational Exposure Due to Intakes of Radionuclides*, 2000.

Safety Standards Series No. RS-G-1.3 (Safety Guide) – *Assessment of Occupational Exposure Due to External Sources of Radiation*, 2000.

**International Commission on Radiological Protection (ICRP) Publications**

33 – *Protection Against Ionizing Radiation from External Sources Used in Medicine*. Annals of the ICRP 9 (1) 1982.

34 – *Protection of the Patient in Diagnostic Radiology*. Annals of the ICRP (2/3) 1982.

35 – *General Principles of Monitoring for Radiation Protection of Workers*. Annals of the ICRP 2 (4) 1982.

36 – *Protection Against Ionizing Radiation in the Teaching of Science*. Annals of the ICRP 10 (1) 1983.

41 – *Non-stochastic Effects of Ionizing Radiation*. Annals of the ICRP 14 (3) 1984.

44 – *Protection of the Patient in Radiation Therapy*. Annals of the ICRP 15 (2) 1985.

51 – *Data for Use in Protection Against External Radiation*. Annals of the ICRP 17 (2/3) 1987.

52 – *Protection of the Patient in Nuclear Medicine*. Annals of the ICRP 17 (4) 1987.

53 – *Radiation Dose to Patients from Radiopharmaceuticals*. Annals of the ICRP 18 (1-4) 1987.

*Addendum 1 to ICRP Publication 53 – Radiation Doses to Patients from Radiopharmaceuticals*. Annals of the ICRP 22 (3) 1991.

54 – *Individual Monitoring for Intakes of Radionuclides by Workers: Design and Interpretation*. Annals of the ICRP 19 (1-3) 1988.

57 – *Radiological Protection of the Worker in Medicine and Dentistry*. Annals of the ICRP 20 (3) 1989.

62 – *Radiological Protection in Biomedical Research*. Annals of the ICRP 22 (3) 1991.

64 – *Protection from Potential Exposure: A Conceptual Framework*. Annals of the ICRP 23 (1) 1993.

**National Council on Radiation Protection and Measurements (NCRP) Reports**

32 – *Radiation Protection in Educational Institutions* (1966).

36 – *Radiation Protection in Veterinary Medicine* (1970).

37 – *Precautions in the Management of Patients Who Have Received Therapeutic Amounts of Radionuclides* (1970).

54 – *Medical Radiation Exposure of Pregnant and Potentially Pregnant Women* (1977).

59 – *Operational Radiation Safety Program* (1978).

65 – *Management of Persons Accidentally Contaminated with Radionuclides* (1980).

68 – *Radiation Protection in Pediatric Radiology* (1981).

69 – *Dosimetry of X-Ray and Gamma-Ray Beams for Radiation Therapy in the Energy Range 10 keV to 50 MeV* (1981).

73 – *Protection in Nuclear Medicine and Ultrasound Diagnostic Procedures in Children* (1983).

82 – *SI Units in Radiation Protection and Measurements* (1985).

84 – *General Concepts for the Dosimetry of Internally Deposited Radionuclides* (1985).

87 – *Use of Bioassay Procedures for Assessment of Internal Radionuclide Deposition* (1987).

- 93 – *Ionizing Radiation Exposure of the Population of the United States* (1987).
- 94 – *Exposure of the Population in the United States and Canada from Natural Background Radiation* (1988) (Supersedes NCRP Report No. 25).
- 95 – *Radiation Exposure of the U.S. Population from Consumer Products and Miscellaneous Sources* (1988) (Supersedes NCRP Report No. 56).
- 98 – *Guidance on Radiation Received in Space Activities* (1989).
- 100 – *Exposure of the U.S. Population from Diagnostic Medical Radiation* (1989).
- 101 – *Exposure of the U.S. Population from Occupational Radiation* (1989).
- 102 – *Medical X-Ray Electron Beam and Gamma-Ray Protection for Energies Up to 50 MeV (Equipment Design, Performance and Use)* (1989) (Supersedes NCRP Report No. 33).
- 105 – *Radiation Protection for Medical and Allied Health Personnel* (1989) (Supersedes NCRP Report No. 48).
- 107 – *Implementation of the Principle of As Low As Reasonably Achievable (ALARA) for Medical and Dental Personnel* (1990).
- 114 – *Maintaining Radiation Protection Records* (1992).
- 115 – *Risk Estimates for Radiation Protection* (1993).
- 116 – *Limitation of Exposure to Ionizing Radiation* (1993) (Supersedes NCRP Report No. 91).
- 121 – *Principles and Application of Collective Dose in Radiation Protection* (1995).
- 122 – *Use of Personal Monitors to Estimate Effective Dose Equivalent and Effective Dose to Workers for External Exposure to Low-LET Radiation* (1995).
- 124 – *Sources and Magnitude of Occupational and Public Exposures from Nuclear Medicine Procedures* (1996).
- 127 – Operational Radiation Safety Program (1998)
- 133 – Radiation Protection for Procedures Performed Outside the Radiology Department (2000)
- 134 – Operational Radiation Safety Training (2000)
- 145 – *Radiation Protection in Dentistry* (2003).

#### **National Institute of Standards and Technology (NIST) Publications**

Handbook No. 150 – *National Voluntary Laboratory Accreditation Program – Procedures and General Requirements*, March 2001.

Handbook No 150-4 – *National Voluntary Laboratory Accreditation Program – Ionizing Radiation Dosimetry*, August 1994.

Special Publication 812 – *Criteria for the Operation of Federally-Owned Secondary Calibration Laboratories (Ionizing Radiation)*, October 1991.

Technical Note 1297 – *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*, September 1994.

***Abbreviations and Acronyms*****AF**—Air Force**AFI**—Air Force Instruction**AFIOH**—Air Force Institute for Operational Health**AFIOH/SDRR**—Air Force Institute for Operational Health /Radioanalytical Services Branch**AFIOH/SDRD**—Air Force Institute for Operational Health/Radiation Dosimetry Branch (formerly Det 1, HSC/OEBD).**AFM**—Air Force Manual**AFPD**—Air Force Policy Directive**AFSC**—Air Force Specialty Code**AFMC**—Air Force Materiel Command**AFMOA/SGPR**—Air Force Medical Operations Agency/Radiation Protection Division**ALARA**—As Low As Is Reasonably Achievable**ANSI**—American National Standards Institute**BE**—Bioenvironmental Engineering**BEE**—Bioenvironmental Engineer**Bq**—Becquerel**CC**—Commander**cm**—centimeter (length)**cm<sup>2</sup>**—square centimeter (area)**CDE**—Committed Dose Equivalent**CEDE**—Committed Effective Dose Equivalent**CFR**—Code of Federal Regulations**Ci**—Curie**DAC**—Derived Air Concentration**DDE**—Deep Dose Equivalent**DOE**—The United States Department of Energy**DOELAP**—DOE Laboratory Accreditation Program**DoD**—The United States Department of Defense**DoDI**—Department of Defense Instruction**DTRA**—Defense Threat Reduction Agency**EOD**—Explosive Ordnance Disposal

**EPA**—US Environmental Protection Agency

**EPD**—Electronic Personnel Dosimeter

**HSC**—Human Systems Center

**HQ**—Headquarters

**HQ AFMC/CC**—Commander, Headquarters Air Force Materiel Command

**HQ USAF/SG**—Headquarters, United States Air Force Surgeon General

**ICRP**—International Commission on Radiological Protection

**LDE**—Lens Dose Equivalent

**mg**—milligram

**mrem**—milliRoentgen Equivalent Man

**MRER**—Master Radiation Exposure Registry

**mSv**—milliSievert

**MTF**—Medical Treatment Facility

**NVLAP**—National Voluntary Laboratory Accreditation Program

**NCRP**—National Council on Radiation Protection and Measurements

**NIST**—National Institute of Standards and Technology

**NRC**—US Nuclear Regulatory Commission or its duly authorized representatives.

**OSI**—Office of Special Investigation

**PCS**—Permanent Change of Station

**PDO**—Publication Distribution Office

**PH**—Public Health

**rad**—radiation absorbed dose

**RPO**—Radiation Protection Officer

**rem**—Roentgen Equivalent Man

**RSO**—Radiation Safety Officer

**SDE**—Shallow Dose Equivalent

**SG**—Surgeon General

**SSAN**—Social Security Account Number

**TDY**—Temporary Duty

**TLD**—Thermoluminescent Dosimeter

**US**—United States

**USAF**—United States Air Force

**U.S.C.**—United States Code

**WMD**—Weapons of Mass Destruction

**Terms**

**Absorbed dose**—The energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the rad and the gray (Gy); (1 rad = 0.01 Gy).

**Act**—The Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.), as amended.

**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 (administratively assigned dose)**—An arbitrary 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 which cannot be evaluated due to other factors. Numerically, the values assigned are as shown in **Table A1.1**. Administratively assigned doses must be investigated by the installation RSO as "Abnormal Exposures" following the procedure detailed in Chapter 9. of this Manual.

**Table A1.1. Administrative Dose Assigned for Lost, Damaged, or Not Returned Dosimeters.**

	Monthly Dosimeter	Quarterly Dosimeter
Shallow dose equivalent to skin or extremity	4,170 mrem	12,500 mrem
Total Effective Dose Equivalent	417 mrem	1,250 mrem

**Adult**—An individual 18 or more years of age.

**Airborne radioactive material**—Radioactive material dispersed in the air in the form of dusts, fumes, particulates, mists, vapors, or gases.

**Airborne radioactivity area**—A room, enclosure, or area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations (1) in excess of the Derived Air Concentrations (DAC), specified in appendix B, to Secs. 20.1001-20.2401, or (2) To such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours.

**ALARA (As Low As Is Reasonably Achievable)**—The NRC defines ALARA as “Making every reasonable effort to maintain exposures to radiation as far below established dose limits as is practical consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to 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 and licensed materials in the public interest.”

**Albedo**—Refers to detecting neutron radiation scattered by the wearer's body.

**Annual limit on Intake (ALI)**—The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller 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 (ALI values for intake by ingestion and by inhalation of selected radionuclides are given in Table 1, Columns 1 and 2, of appendix B to Secs. 20.1001-20.2401), 10 CFR 20.

**Background radiation**—Radiation from cosmic sources, naturally occurring radioactive materials, 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 NRC.

**Becquerel (Bq)**—The SI unit of radioactivity equivalent to one nuclear transformation per second. One curie is  $3.7 \times 10^{10}$  (37 billion) Bq.

**Bioassay (radiobioassay)**—The determination of kinds, quantities or concentrations, and in some cases, the locations of radioactive material in the human body, whether by direct measurement (in vivo counting) or by indirect analysis and evaluation of materials excreted or removed from the human body.

**Byproduct material**—(1) Any radioactive material (except special nuclear material) yielded in, or made radioactive by, exposure to the radiation incident to the process of producing or utilizing special nuclear material; and (2) the tailings or wastes produced by the extraction or concentration of uranium or thorium from ore processed primarily for its source material content, including discrete surface wastes resulting from uranium solution extraction processes. Underground ore bodies depleted by these solution extraction operations do not constitute "byproduct material" within this definition.

**Calendar quarter**—A period of time of not less than 12 consecutive weeks nor more than 14 consecutive weeks. The first calendar quarter shall begin in January or begin with the dosimetry issue cycle closest to January. Subsequent calendar quarters shall begin within 12 or 14 weeks of that date so that no day is included in both quarters or omitted from a quarter.

**Class (or lung class or inhalation class)**—A classification scheme for inhaled material according to its rate of clearance from the pulmonary region of the lung. Materials are classified as D, W, or Y, which applies to a range of clearance half-times: for Class D (days), less than 10 days; for Class W (weeks), from 10 to 100 days; and for Class Y (years), greater than 100 days.

**Collective dose**—The sum of the individual doses received in a given period of time by a specified population from exposure to a specified source of radiation.

**Commission**—(See Nuclear Regulatory Commission).

**Committed Dose Equivalent (CDE) ( $H_{T,50}$ )**—The dose equivalent to organs or tissues of reference (T) 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 (CEDE) ( $H_{E,50}$ )**—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 ( $H_{E,50}$ ) these organs or tissues, where  $H_{T,50}$  is the committed (organ) dose equivalent to an individual organ from a current uptake, that will be delivered over the 50 years following the uptake. CEDE applies specifically to the dosimetry of internally deposited radionuclides.

$$\text{CEDE} = H_{E,50} = \sum W_T H_{T,50}$$

**Constraint (dose constraint)**—A value above which specified actions are required.

**Control dosimeter**—A dosimeter that measures the background radiation accumulated during the transit and storage of personnel dosimeters.

**Controlled area**—An area outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any reason.

**Critical organ**—That organ which will sustain the greatest absorbed dose and whose associated damage by a radionuclide entering the human body will result in greatest potential impairment to the body due to the organ's radiosensitivity.

**Deep-Dose Equivalent (DDE) ( $H_D$ )**—Applies to external whole-body exposure. The dose equivalent at a tissue depth of 1 cm (1000 mg/cm<sup>2</sup>) beneath the outer surface of the skin.

**Derived Air Concentration (DAC)**—The concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work (inhalation rate 1.2 cubic meters of air per hour), results in an intake of one ALI. DAC values are given in Table 1, Column 3, of Appendix B to Secs. 20.1001-20.2401 of 10 CFR 20.

**Derived Air Concentration-hour (DAC-hour)**—The product of the concentration of radioactive material in air (expressed as a fraction or multiple of the derived air concentration for each radionuclide) and the time of exposure to that radionuclide, in hours. A licensee may take 2,000 DAC-hours to represent one ALI, equivalent to a committed effective dose equivalent of 5 rem (0.05 Sv) dose (radiation dose).

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

**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 grays multiplied by the  $Q$ ; 1 Sv = 100 rem. Its purpose is to have a single unit, regardless of the type of radiation, describing the radiation effect on man. See also Deep Dose Equivalent, Eye-Dose Equivalent, and Shallow-Dose Equivalent.

**Digital Explanation Code (DEC)**—An informational code assigned by AFIOH/SDRD to indicate special circumstances concerning the dose equivalent that is being reported. Valid codes are listed in paragraph **11.1.4.** of this Manual.

**Dosimeter**—A device that detects and measures accumulated ionizing radiation dose received by occupationally exposed individuals. The Dosimetry Program uses thermoluminescent dosimeters (TLDs). Examples of other types of dosimeters include film badges, pocket ionization chambers, Electronic Personnel Dosimeters (EPD) and CR-39 fast neutron detectors.

**Dosimetry processor**—An individual or organization that processes and evaluates individual monitoring equipment in order to determine the radiation dose delivered to the individual.

**Effective Dose Equivalent (EDE), ( $H_E$ )**—The sum of the products of the dose equivalent to the organ or tissue ( $H_T$ ) and the weighting factors ( $w_T$ ) applicable to each of the body organs or tissues that are irradiated ( $H_E = \sum w_T H_T$ ).

**Embryo/fetus**—The developing human organism from conception until the time of birth.

**Entrance or access point**—Any location through which an individual could gain access to radiation areas or to radioactive materials. This includes entry or exit portals of sufficient size to permit human entry, irrespective of their intended use.

**Exposure**—Being exposed to ionizing radiation or to radioactive material.

**External dose**—The portion of the dose equivalent received from radiation sources outside the body.

**External emitter**—A radionuclide or ionizing radiation producing device located external to the body.

**Extremity**—The hand, elbow, arm below the elbow, foot, knee, or leg below the knee.

**Extremity Dose Equivalent**—The external dose equivalent to the extremities assessed at a tissue depth of 7 millimeters ( $7 \text{ mg/cm}^2$ ). This limit, set by 10 CFR 20 as the allowable dose to the skin of the whole body or the skin of the extremities, is 50 rem (0.5 Sv) in a year.

**Extremity Dosimeter**—A monitoring device used to determine the dose equivalent delivered to the extremities of the body (knees and the rest of the legs below the knees and the elbows and the rest of the arms below the elbows). AFIOH/SDRD currently uses only the ring dosimeter (sometimes called a "finger ring") for extremity monitoring.

**Eye Dose Equivalent**—The external dose equivalent assessed at a tissue depth of 0.3 centimeters ( $300 \text{ mg/cm}^2$ ). This total value must not exceed 37.5 mSv (3.75 rem) per quarter or 150 mSv (15 rem) in one year.

**Generally applicable environmental radiation standards**—Standards issued by the EPA under the authority of the Atomic Energy Act of 1954, as amended, that impose limits on radiation exposures or levels, or concentrations or quantities of radioactive material, in the general environment outside the boundaries of locations under the control of persons possessing or using radioactive material.

**Government agency**—Any executive department, commission, independent establishment, corporation wholly or partly owned by the United States of America which is an instrumentality of the United States, or any board, bureau, division, service, office, officer, authority, administration, or other establishment in the executive branch of the Government.

**Gray**—Unit of absorbed dose that is equivalent to 100 rad.

**Head Dose Equivalent**—The external dose equivalent to the head assessed at a tissue depth of 10 millimeters ( $1000 \text{ mg/cm}^2$ ). This total value must not exceed 12.5 mSv (1.25 rem) per quarter. 10 CFR 20 limits this to 50 mSv (5 rem) in one year and with a maximum of 30 mSv (3 rem) in any quarter.

**High radiation area**—An area accessible to individuals in which radiation levels from radiation sources external to the body could result in an individual receiving a dose equivalent in excess of 1 mSv (0.1 rem) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

**Individual**—Any human being.

**Individual monitoring**—(1) The assessment of dose equivalent by using devices designed to be worn by an individual; (2) The assessment of committed effective dose equivalent by bioassay (see Bioassay) or by determination of the time-weighted air concentrations to which an individual has been exposed, i.e., DAC-hours; or (3) The assessment of dose equivalent by the use of survey data.

**Individual monitoring devices (individual monitoring equipment)**—Devices designed to be worn by a single individual for the assessment of dose equivalent such as film badges, thermoluminescent dosimeters (TLDs), pocket ionization chambers, and personal (“lapel”) air sampling devices.

**Intake**—The amount of radioactive material taken into the body by inhalation, absorption through the skin, injection, ingestion, or through wounds.

**Internal dose**—That portion of the dose equivalent received from radioactive material taken into the body.

**Internal emitter**—A radionuclide that is deposited in the body.

**Investigation Action Level**—(1) A dose equivalent value or radionuclide intake activity set by the installation RSO that requires further investigation when exceeded. Levels are normally tailored to each using section’s historical dosimetry data in order to promptly identify and correct adverse trends; (2) The CEDE from radioactive material taken into the human body or dose equivalent from an external radiation source to which the worker is occupationally exposed which justifies further investigation. Such an investigation generally includes a review of the circumstances associated with the apparently abnormal internal or external personnel dose equivalent, assessment of the consequences and mitigation or prevention of such a personnel dose equivalent of similar magnitude in the future. (Definition taken from NRC guidance.)

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

**Lens-dose equivalent ( $H_E$ )(LDE)**—The dose equivalent to the lens of the eye from external exposure of the lens of the eye to some ionizing radiation source. It is measured at an eye lens tissue depth of 0.3 cm (300 mg/cm<sup>2</sup>).

**License**—A license issued under the regulations in Parts 30 through 36, 39, 40, 50, 60, 61, 70, or 72 of Title 10, Code of Federal Regulations.

**Licensed material**—Source material, special nuclear material, or byproduct material received, possessed, used, transferred or disposed of under a general or specific license issued by the Nuclear Regulatory Commission.

**Licensee**—The holder of a license.

**Limits (dose limits)**—The permissible upper bounds of radiation doses.

**Lost or missing licensed material**—Licensed material whose location is unknown. It includes material that has been shipped but has not reached its destination and whose location cannot be readily traced in the transportation system.

**Master Radiation Exposure Registry (MRER)**—The USAF’s sole permanent record keeping registry of occupational ionizing radiation exposures for all personnel (past and present) enrolled in the Dosimetry Program. The US Air Force Radiation Dosimetry Laboratory (AFIORH/SDRD) maintains the MRER.

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

**Minor**—An individual less than 18 years of age.

**Monitoring (radiation monitoring, radiation protection monitoring)**—The measurement of radiation levels, concentrations, surface area concentrations or quantities of radioactive material and the use of the results of these measurements to evaluate potential exposures and doses.

**National Voluntary Laboratory Accreditation Program (NVLAP)**—A program administered by the National Institute of Standards and Technology (NIST) for the accreditation of ionizing radiation dosimetry processing laboratories. Accreditation is based on three rounds of open blind performance testing and site visits conducted by NVLAP National Technical Experts and is repeated every two years. Separate standards applicable to whole body and extremity dosimetry are detailed in NIST Handbook 150, NIST Handbook 150-4 and standards published by the Health Physics Society.

**Neutron Dosimeter**—A monitoring device that has special filtration to enable it to distinguish between fast and thermal neutrons.

**Nonstochastic effects**—Health effects, the severity of which varies with the dose and for which a threshold is believed to exist. Radiation-induced cataract formation is an example of a nonstochastic effect (also called a deterministic effect).

**Occasionally-exposed individual**—An individual whose work is not normally performed in a restricted area and whose duties do not normally involve exposure to ionizing radiation or radioactive material. Such individuals may, however, have reason to enter a restricted area in the performance of their duties. Examples are messengers, deliverymen, and maintenance workers.

**Occupational dose**—The dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to radiation and/or radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person. Occupational dose does not include doses received from background radiation, from any medical administration the individual has received, from voluntary participation in medical research programs, or as a member of the public.

**Occupational Exposure**— Routine exposure of Department of Defense (DoD) personnel to radiation associated with DoD operations during performance of their official duties. Occupational exposure does not include exposures from natural background radiation or those as a patient of practitioners of the healing arts.

**Overexposure (quarterly or annual)**—Any accumulated or one-time ionizing radiation exposure exceeding the limits specified in 10 CFR 20.

**Permit**—A written authorization to possess and use radiation sources issued by AFMOA/SGPR under the provisions of the NRC Air Force Master Material License.

**Permittee**—The holder of a permit issued by the Air Force Radioisotope Committee authorizing possession and/or use of radioactive material. The permittee is typically a squadron commander, or higher or civilian equivalent

**Person**—Any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, Government agency other than the NRC or the DOE subject to the licensing and related regulatory authority of the NRC and/or the USAF Master Material License.

**Public dose**—The dose received by a member of the public from exposure to radiation and/or radioactive material released by a licensee, or to any other source of radiation under the control of the licensee. Public dose does not include occupational dose or doses received from background radiation, from any medical administration the individual has received, or from voluntary participation in medical research programs.

**Quality Factor (Q)**—The numerical quantity shown in Table A3-1 chosen to modify the absorbed dose for the biological effectiveness of the type of ionizing radiation producing the absorbed dose.

**Table A1.2. Radiation Quality Factors**

Type of Radiation	Quality Factor( <i>Q</i> )	Absorbed dose equal to a unit dose equivalent <sup>a</sup>
X-, gamma, or beta	1	1
Alpha particles, multiple-charged particles, fission fragments and heavy particles of unknown charge	20	0.05
Neutrons of unknown energy	10	0.1
High-energy protons	10	0.1
<sup>a</sup> Absorbed dose in rad equal to 1 rem or the absorbed dose in gray equal to 1 sievert.		

**Quality Factor (Neutron) (Neutron Quality Factor)**—If it is more convenient to measure the neutron flux rate than to determine the neutron dose equivalent rate in rems per hour or Sieverts per hour, as provided in 10 CFR 20, 1 rem (0.01 Sv) of neutron radiation of unknown energies may, for purposes of the regulations in 10 CFR 20, be assumed to result from a total flux of 25 million neutrons per square centimeter incident upon the body. If sufficient information exists to estimate the approximate energy distribution of the neutrons, the licensee may use the flux rate per unit dose equivalent or the appropriate Q value from Table A3-1 to convert a measured tissue dose in rads to dose equivalent in rems.

**Table A1.3. Neutron Quality Factors**

Neutron Energy (MeV)	Quality Factor (Q) <sup>a</sup>	Flux per unit Dose equivalent <sup>b</sup> (neutrons cm <sup>-2</sup> rem <sup>-1</sup> )	Neutron Energy (MeV)	Quality Factor (Q) <sup>a</sup>	Flux per unit Dose equivalent <sup>b</sup> (neutrons cm <sup>-2</sup> rem <sup>-1</sup> )
(Thermal) 2.5 X 10 <sup>-8</sup>	2	980 X 10 <sup>6</sup>	5	8	23 X 10 <sup>6</sup>
1 X 10 <sup>-7</sup>	2	980 X 10 <sup>6</sup>	7	7	24 X 10 <sup>6</sup>
1 X 10 <sup>-6</sup>	2	810 X 10 <sup>6</sup>	10	6.5	24 X 10 <sup>6</sup>
1 X 10 <sup>-5</sup>	2	810 X 10 <sup>6</sup>	14	7.5	17 X 10 <sup>6</sup>
1 X 10 <sup>-4</sup>	2	840 X 10 <sup>6</sup>	20	8	16 X 10 <sup>6</sup>
1 X 10 <sup>-3</sup>	2	980 X 10 <sup>6</sup>	40	7	14 X 10 <sup>6</sup>
1 X 10 <sup>-2</sup>	2.5	1010 X 10 <sup>6</sup>	60	5.5	16 X 10 <sup>6</sup>
1 X 10 <sup>-1</sup>	7.5	170 X 10 <sup>6</sup>	1 X 10 <sup>2</sup>	4	20 X 10 <sup>6</sup>
5 X 10 <sup>-1</sup>	11	39 X 10 <sup>6</sup>	2 X 10 <sup>2</sup>	3.5	19 X 10 <sup>6</sup>
1	11	27 X 10 <sup>6</sup>	3 X 10 <sup>2</sup>	3.5	16 X 10 <sup>6</sup>
2.5	9	29 X 10 <sup>6</sup>	4 X 10 <sup>2</sup>	3.5	14 X 10 <sup>6</sup>

<sup>a</sup> Value of quality factor (Q), at the point where the dose equivalent is maximum in a 30-cm diameter cylinder tissue-equivalent phantom.

<sup>b</sup> Monoenergetic neutrons incident normally on a 30-cm diameter cylinder tissue-equivalent phantom.

**Quarter**—A period of time equal to one-fourth of the year observed by the licensee (approximately 13 consecutive weeks), providing that the beginning of the first quarter in a year coincides with the starting date of the year and that no day is omitted or duplicated in consecutive quarters.

**Radiation Absorbed Dose or Rad**—The special unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs/gram or 0.01 joule/kilogram (0.01 Gray).

**Radiation (ionizing radiation)**—Alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. Radiation, as used in 10 CFR 20, does not include non-ionizing radiation, such as radio- or microwaves, or visible, infrared, or ultraviolet light.

**Radiation area**—An area accessible to individuals in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in 1 hour at 30 cm from the radiation source or from any surface that the radiation penetrates.

**Radiation monitoring**—Evaluating or measuring radiation levels and amounts or concentrations of radionuclides in air, water, or other materials to evaluate potential exposures and doses to personnel.

**Radiation Safety Officer (RSO) (Also referred to as Radiation Protection Officer (RPO))**—An individual, normally a Health Physicist, Bioenvironmental Engineer, Department of the Air Force civilian, or a qualified Bioenvironmental Engineering Craftsman designated in writing by the installation commander to manage the radiation safety program for the installation or using activity. This person may or may not be the RSO responsible for activities conducted under a given USAF Radioactive Materials Permit.

**Radiation sources**—Material, 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.

**Radionuclide**—A radioactive species of atom characterized by its mass number (A), atomic number (Z), and nuclear energy state provided that the mean life of that state is long enough to be observable.

**Reference Man**—A hypothetical aggregation of human physical and physiological characteristics arrived at by international consensus. These characteristics may be used by researchers and public health workers to standardize results of experiments and to relate biological insult to a common base.

**Roentgen Equivalent Man or rem**—The special unit of any of the quantities expressed as dose equivalent. The dose equivalent in rems is equal to the absorbed dose in rads multiplied by the quality factor [(1 rem = 0.01 Sievert) and (1 rem = 1,000 millirem)].

**Respiratory protective device**—An apparatus, such as a respirator, used to reduce the individual's intake of airborne radioactive materials.

**Reference Level**—A dose received in any monitoring period that, if continued at the same rate, would exceed the limits specified in AFI 48-148 or 10 CFR Part 20.

**Restricted area**—An area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. 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.

**Shallow-dose Equivalent ( $H_s$ )**—The external exposure of the skin or an extremity which is taken as the dose equivalent at a tissue depth of 0.007 cm (7 mg cm<sup>2</sup> – the average depth of the germinal cell layer) averaged over an area of 1 cm<sup>2</sup>.

**Sum Committed Dose Deep Dose Equivalent**—A dose equivalent category used on SDRD Listings 1499-1 and 1499-2 showing the total of the committed dose equivalent to a tissue and the whole body deep dose equivalent. This value is limited by 10 CFR 20 to 500 mSv (50 rem) in one year for any organ or issue and is a summation of the internal committed dose equivalent and the external deep dose equivalent. This term is a synonym for Total Effective Dose Equivalent (TEDE).

**Sievert (Sv)**—The SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in Sieverts is equal to the absorbed dose in Grays multiplied by the quality factor (1 Sv = 100 rems). One millisievert (mSv) is 0.001 Sv [(0.1 rem) or (100 mrem)].

**Site boundary**—That line beyond which the land or property is not owned, leased, or otherwise controlled by the licensee.

**Source material**—(1) Uranium or thorium, or any combination of uranium or thorium in any physical or chemical form; or (2) ores that contain by weight one-twentieth of 1 percent (0.05 percent), or more, of uranium, thorium, or any combination of uranium and thorium. Source material does not include special nuclear material.

**Special nuclear material (SNM)**—(1) Plutonium, uranium-233, uranium enriched in the isotope 233 or in the isotope 235 and any other material that the NRC, pursuant to the provisions of section 51 of the Act, determines to be special nuclear material, but does not include source material; or (2) any material artificially enriched by any of the foregoing, but does not include source material.

**Stochastic effects**—Health effects which 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.

**Survey**—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.

**Termination**—The end of employment with USAF and ANG involving personnel radiation monitoring.

**Thermoluminescent dosimeter (TLD)**—A type of dosimeter that uses powdered or solid phosphor materials (e.g.,  $\text{Li}_2\text{B}_4\text{O}_7$ , LiF,  $\text{CaSO}_4$ ) to record radiation exposures. When heated, the phosphor emits light proportional to the amount of radiation energy absorbed. This type of dosimeter consists of a card and a holder (badge).

**TLD Holder**—A device used to hold the four TLD elements in the whole body, neutron and collar dosimeter.

**TLD Hanger**—A term used to describe the device used to attach a TLD holder on an individual.

**Total effective dose equivalent (TEDE)**—The sum of the deep dose equivalent ( $H_d$ ) (for external exposures) and the committed effective dose equivalent (for internal exposures) expressed in units of either rem or Sv.

**Total organ dose equivalent (TODE)**—The total organ dose equivalent for the maximally exposed organ. The TODE is the sum of the deep dose equivalent (DDE) and the committed dose equivalent (CDE) expressed in units of rem or Sv.

**Unrestricted area**—An area, access to which is neither limited nor controlled for purposes of radiation protection.

**User**—An individual delegated with the authority to use, operate, or store radiation sources and devices.

**Very high radiation area**—An area, accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving an absorbed dose in excess of 500 rad (5 Gray) in 1 hour at 1 meter from a radiation source or from any surface that the radiation penetrates.

[**Note:** At very high doses received at high dose rates, units of absorbed dose (e.g., rad and Gray) are appropriate, rather than units of dose equivalent (e.g., rem and Sievert)].

**Visitor**—A person who does not normally work in an USAF controlled radiation area, but who may be authorized to enter the area by the installation RSO providing suitable dosimetry and/or protective equipment is available.

**Week**—Seven consecutive days starting on Sunday.

**Weighting factor  $w_T$ , for an organ or tissue (T)**—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. For calculating the effective dose equivalent, the values of  $w_T$  are shown in [Table A1.4](#).

**Table A1.4. Organ Dose Weighting Factors**

<i>Organ or Tissue</i>	$w_T$
Gonads	0.25
Breast	0.15
Red bone marrow	0.12
Lung	0.12
Thyroid	0.03
Bone Surfaces	0.03
Remainder	0.30 <sup>1</sup>
Whole Body	1.00 <sup>2</sup>

<sup>1</sup> 0.30 results from 0.06 for each of 5 “remainder” organs (excluding the skin and the lens of the eye) that receive the highest doses.

<sup>2</sup> For the purpose of weighting the external whole body dose (for adding it to the internal dose) a single weighting factor,  $w_T = 1.0$ , has been specified. The use of other weighting factors for external exposure will be approved on a case-by-case basis until such time as specific guidance is issued.

**Whole body**—For purposes of external exposure, the head, trunk (including male gonads), arms above the elbow, or legs above the knee.

**Year**—The period of time beginning in January used to determine compliance with the provisions of this part. The licensee may change the starting date of the year used to determine compliance by the licensee provided that the change is made at the beginning of the year and that no day is omitted or duplicated in consecutive years.

**Attachment 2****CHECKLISTS FOR CONDUCTING BASE-LEVEL PERSONNEL IONIZING RADIATION DOSIMETRY PROGRAM OPERATIONS**

<i>Checklist - Adding an Individual to the AF Dosimetry Program</i>				
Enter YES, NO, N/A or ✓ when completed (as appropriate)	Yes	No	N/A	✓
Ask the individual whether he/she has had previous exposure to ionizing radiation prior to registering into the program.				
If yes and the previous exposure was during assignment to another Air Force installation, request an AF Form 1527-2 from AFIOH/SDRD				
If yes, and the previous exposure was during civilian employment, request a NRC Form 4, Occupational Radiation Exposure History (or equivalent), from the individual's employer prior to allowing the person to work in a radiation area. <b>Note:</b> If a release statement is signed, this information may be obtained directly from the previous employer but must be forwarded to AFIOH/SDRD upon receipt for addition to the MRER.				
Inform the individual that if a job outside the Air Force is desired, he/she must provide a NRC Form 5, Current Occupational Radiation Exposure (or equivalent), for each monitoring period they are employed.				
To add the individual to the base radiation Dosimetry Program, write the following information onto the SDRD listing 1523:				
Area.				
Name (last, first, middle initial).				
SSAN.				
Date of Birth (month, day, year).				
Gender (M/F).				
TLD type (e.g., UD-802AT, etc.)				
TLD ID number.				
Wear location (e.g., finger, collar, body, nbod (for neutron dosimeter), etc.).				
Occupational Code (see <a href="#">Attachment 5</a> ).				
Date of issue.				
<b>NOTE:</b> When the individual requires multiple badges, it is only necessary to provide the information above once for subsequent badges.				
Using the Radiation Dosimetry Web secure website, complete a Personnel Information Change request for each individual being added to the base radiation Dosimetry Program.				

<i><b>Checklist - Adding an Individual to the AF Dosimetry Program (continued)</b></i>				
Enter YES, NO, N/A or ✓ when completed (as appropriate)	Yes	No	N/A	✓
<b>If registering a foreign national into the program:</b>				
For the <b>initial</b> registration, enter "FORNAT" in the SSAN column of the listing.				
For previously registered Foreign Nationals, enter the "mock" SSAN assigned by AFIOH/SDRD for ID purposes in the SSAN column.				
Send a message or fax the above information to AFIOH/SDRD, or complete the Personnel Information Change form using the Radiation Dosimetry Web secure website				
Mark the listing to indicate an "add" to the program.				
<i>If the individual is a one time user (e.g., a visitor, student, special study, etc.) show this as "one time" in the remarks.</i>				
Confirm that all entries on the SDRD listing 1523 are correct and easy to be read (especially fields for the name, SSAN, and TLD number).				
Issue an extra dosimeter to the individual				
At the end of the monitoring period, submit all dosimeters for individual(s) added to the program to AFIOH/SDRD.				

<i><b>Checklist - Deleting an Individual From the AF Dosimetry Program</b></i>				
Enter YES, NO, N/A or ✓ when completed (as appropriate)	Yes	No	N/A	✓
Did the individual wear the dosimeter during the monitoring period?				
If yes, write "delete" in the remarks section on the SDRD Listing 1523.				
If no, write "delete" and "not worn" in the remarks section on the SDRD Listing 1523.				
Send a message or fax to AFIOH/SDRD with the following information, or complete the Personnel Information Change form using the Radiation Dosimetry Web secure website:				
Base code.				
Name of monitored individual to be deleted.				
SSAN (as printed on SDRD Listing 1523).				
Base area.				
At the end of the monitoring period, submit all dosimeters for individual(s) deleted from the program to AFIOH/SDRD.				

<i><b>Checklist - Changing Registry Information Concerning an Individual Enrolled in the AF Dosimetry Program</b></i>				
Enter YES, NO, N/A or ✓ when completed (as appropriate)	Yes	No	N/A	✓
Place a circle around the field needing changes on the SDRD Listing 1523 (DO NOT OBLITERATE PRE-PRINTED DATA).				
Clearly show all changes on the listing as a "change" in the appropriate column.				
Transmit the change request by mail or fax to AFIOH/SDRD including the following information, or <b>complete the Personnel Information Change form using the Radiation Dosimetry Web secure website:</b>				
Base code.				
Name (as printed on SDRD Listing 1523).				
SSAN (as printed on SDRD Listing 1523).				
Area code (as printed on SDRD Listing 1523).				
Old or incorrect information.				
New or correct information.				
To <i>increase</i> the number of dosimeters for an individual, enter the new dosimeter number information on the SDRD Listing 1523.				
To <i>decrease</i> the number of dosimeters for an individual, enter "not needed" in the remarks column on the line with the concerned dosimeter on the SDRD Listing 1523.				
To <i>change</i> information appearing on the SDRD Listing 1523 or to move an individual from one area to another, circle the data to be changed and write the new information underneath the preprinted entry.				
<b><i>NOTE: If more than one line is printed on the SDRD Listing 1523 for an individual, only ONE line needs to be changed.</i></b>				
Confirm that all entries on the SDRD Listing 1523 are correct and easy to read (especially fields for the name, SSAN, and TLD number).				

<i><b>Checklist - Assembling Whole Body, Collar and Neutron Dosimeters</b></i>				
<b>Enter YES, NO, N/A or ✓ when completed (as appropriate)</b>	<b>Yes</b>	<b>No</b>	<b>N/A</b>	<b>✓</b>
Remove the TLDs from the shipping tray (if provided).				
Determine the hanger type from the SDRD Listing 1523 and its corresponding ID label.				
<b>SMOKE COLORED HANGERS</b> - Whole body dosimeters or collar dosimeters (when worn alone), including badges worn beneath a shielded lead apron.				
<b>AMBER COLORED HANGERS</b> - Neutron dosimeters.				
<b>RED COLORED HANGERS</b> - Collar badges (worn at collar level outside the shielded lead apron) when worn in conjunction with a whole body dosimeter.				
(The preprinted label will specify the location to be worn and corresponding TLD number for each individual.)				
Use a small screwdriver to open the hanger.				
Visually inspect the hanger for damage. Damaged hangers must NOT be issued.				
Confirm that the Mylar™ window is intact.				
Confirm that the black gasket is intact.				
Confirm that the hanger hinge mechanism is operating properly.				
Place the opened hanger on a table with the part of the hanger with the word "front" closest to you. (This side has a small peg towards the hinge of the badge.)				
Place the TLD holder in the hanger in such a way that the TLD type number (e.g., UD-802AT, etc.) is facing to the left. (The TLD holder will only go in one way.)				
Locate the correct preprinted label.				
Confirm that the TLD number and ID label match the SDRD Listing 1523 entry.				
Place the label onto the TLD holder with the printed side facing up so that the label can be easily read.				
Close the hanger. You should hear a click. Do not force the hanger to close.				
If the hanger is difficult to close:				
Reposition the TLD and try again.				
Confirm that the black gasket is properly installed in the hanger.				
Continue this procedure until all TLDs and labels are assembled in the proper holders.				

<i><b>Checklist - Reviewing SDRD Dose Equivalent Report (SDRD Listing 1499-1 and/or SDRD Listing 1499-2)</b></i>				
<b>Enter YES, NO, N/A or ✓ when completed (as appropriate)</b>	<b>Yes</b>	<b>No</b>	<b>N/A</b>	<b>✓</b>
Have you received the SDRD Listings 1499-1 and 1499-2 covering specific monitoring periods?				
RSO reviews listings for administratively assigned dose equivalents and abnormal dose equivalent results.				
RSO reviews listings for compliance with 10 CFR 20 and AFI 48-148.				
Total Effective Dose Equivalent <0.417 rem (4.17 mSv) monthly or <1.250 rem (12.5 mSv) quarterly.				
Deep dose equivalent to pregnant radiation worker <0.05 rem (0.5 mSv monthly) or < 5 mSv (0.5 rem) for duration of pregnancy.				
Eye dose equivalent <1.250 rem (12.5 mSv) monthly or <3.750 rem (37.5 mSv) quarterly.				
Shallow dose equivalent to skin or extremity <4.17 rem (41.7 mSv) monthly or <12.5 rem (125 mSv) quarterly.				
Internal deposition of any radionuclide < 10% of ALI (monthly) or < 25% of ALI (quarterly).				
Sum of deep dose equivalent and committed dose equivalent to any individual organ or tissue other than the lens of the eye 12.500 rem (125 mSv). Are any personnel on a routine monthly bioassay monitoring program?				
ALARA Constraint < action level for all within the same occupation code in the previous calendar year as shown in the table published annually by AFIOH/SDRD.				
Confirm that totals for the year, as reflected on the SDRD Listing 1499-2, equal the sum of each monitoring period starting with 1 Jan of that year.				
RSO signs the forms as being reviewed and indicated the action investigation level for the specific area on the form.				
RSO provides the area monitor or supervisor with a copy of these listings.				
Area monitor or supervisor reviews listings with the individuals upon receipt to ensure all information is accurate and complete.				

<b><i>Checklist - Reviewing Individual Dose Report (AF Form 1527-1 and/or AF Form 1527-2)</i></b>				
<b>Enter YES, NO, N/A or ✓ when completed (as appropriate)</b>	<b>Yes</b>	<b>No</b>	<b>N/A</b>	<b>✓</b>
Confirm receipt of an annual AF Form 1527-1 for each individual currently in the program.				
If adding an individual to the program, request an AF Form 1527-2 from AFIOH/SDRD or through Radiation Dosimetry Web secure website.				
Request an AF Form 1527-2 from AFIOH/SDRD for each individual in the program who is retiring or separating from the Air Force during the year or through Radiation Dosimetry Web secure website.				
Upon receipt, check individual's monthly/quarterly entries for the current year against the SDRD Listings 1499-1 and 1499-2 received during the year.				
Monitored individual signs the form indicating concurrence with information.				
RSO signs the form indicating concurrence with the information presented.				
For any discrepancies, corrections, additions or deletions that can be substantiated,				
Note all changes on the form prior to posting in the individual's medical record.				
Notify AFIOH/SDRD of the needed changes so the MRER can be updated.				
Obtain an updated form from AFIOH/SDRD or through Radiation Dosimetry Web secure website..				
Place the AF Form 1527-1 or 1527-2 into the individual's medical record.				
Remove and destroy any old SDRD Forms 1527-1 or 1527-2 that are in the individual's medical record.				

<i><b>Checklist - Dosimeters Lost or Not Returned to the RSO by the Area Monitor</b></i>				
<b>Enter YES, NO, N/A or ✓ when completed (as appropriate)</b>	<b>Yes</b>	<b>No</b>	<b>N/A</b>	<b>✓</b>
Contact the area monitor to assist in accounting for the dosimeter(s).				
Circle the dosimeter number on the SDRD Listing 1523 to show some type of problem with the dosimeter.				
Indicate in the remarks column on the listing the reason for not collecting the dosimeter (e.g., TDY, leave, PCS, lost, etc.).				
Initiate a review of the dose equivalent records to be ready to assign a dose equivalent once the notification is received from AFIOH/SDRD.				
If a dosimeter that was not collected from a previous period is recovered, transfer all monitoring information on the old SDRD Listing 1523 to the current period, and enter the actual collection date.				
Action to take if a dosimeter previously reported as lost is recovered:				
Complete all information on the SDRD Listing 1523 as though adding a person to the program.				
Show the dosimeter as "recovered" in the remarks column.				
If a dosimeter is not worn, circle the dosimeter number, return it at the end of the monitoring period and write "not used" in the remarks column of SDRD Listing 1523.				

<i><b>Checklist - Issuing Dosimeters</b></i>				
<b>Enter YES, NO, N/A or ✓ when completed (as appropriate)</b>	<b>Yes</b>	<b>No</b>	<b>N/A</b>	<b>✓</b>
Divide all the dosimeters into groups according to area.				
Check each assembled whole body, neutron, collar, or extremity dosimeter label against the SDRD Listing 1523.				
Confirm that there is an entry for each individual.				
Confirm that the TLD holder or finger label number matches with the person's name.				
Confirm that the label and SDRD Listing 1523 show the same wear location.				
Provide dosimeters to the area monitor within two (2) duty days before the end of the previous monitoring period.				
Area monitor issues dosimeters to the individual listed on the dosimeter label.				
Instruct area monitor that:				
A. Under no circumstance is a dosimeter to be opened at the using activity.				
B. Dosimeters must not be collected from individuals without an exchange dosimeter being available.				
C. Any dosimeter with a suspected high exposure must be returned as soon as possible for analysis.				
D. Any damaged dosimeter must be returned to the TLD monitor for exchange.				
Confirm that individuals store dosimeters in the proper non-use storage location.				
Confirm that control dosimeters are maintained in the designated dosimeter storage location(s).				
Confirm that individuals are wearing the dosimeters in the proper locations as indicated.				
Are any dosimeters exchanged before the end of the monitoring period for which they are intended?				

<b><i>Checklist - Lost, Damaged, or Not Received Dosimeters</i></b>				
Enter YES, NO, N/A or ✓ when completed (as appropriate)	Yes	No	N/A	✓
RSO reviews the previous twelve months of monitoring data for the individual and co-workers in the area involved.				
Area monitor or supervisor prepares a statement describing the worker's activities over the monitoring period involved, including workload, changes in procedures, etc.				
Monitored worker signs the statement indicating concurrence with the dose estimate or submits an alternative signed statement of non-concurrence.				
After reviewing the summary of duties and previous exposure history, RSO determines a dose equivalent to be assigned for the period involved.				
<i>Fill out the correct form using the Radiation Dosimetry Web secure website, or forward a letter to AFIOH/SDRD showing:</i>				
The dose equivalent to be assigned.				
Dosimeter number, type and monitoring period.				
Name and SSAN of the individual.				
Statement signed by the individual (if available for signature) to show concurrence with the assigned dose.				
File a copy of the assigned dose equivalent determination in the workplace case file.				
File a copy of the assigned dose equivalent determination in the individual's health record.				
Complete all actions within 30 calendar days from the receipt of the notification.				

<b><i>Checklist - Monitoring of Pregnant Radiation Workers</i></b>				
RSO notifies AFIOH/SDRD by fax or immediate telephone message of all pregnant radiation workers for the base or completes a Personnel Information Change form using the Radiation Dosimetry Web secure website.				
Enter YES, NO, N/A or ✓ when completed (as appropriate)	Yes	No	N/A	✓
For each notification, provide the following information:				
Individual's name.				
SSAN.				
Base name and base code.				
Estimated date of conception.				
Confirm that all pregnant radiation workers are monitored on a monthly monitoring cycle.				
Indicate on the SDRD Listing 1523 under the remarks column that the individual is pregnant.				
If the individual works in an area normally monitored quarterly:				
Change the area to "PF" monthly to ensure proper dosimeter exchange and control.				
Advise the pregnant radiation worker that even though her dosimeter may be maintained on a different control board due to the change to monthly monitoring, she can still work in her normal work setting by retrieving and returning her dosimeter, when not being worn, to that control board.				
Change the area back to the worker's normal area when the pregnancy is terminated.				

<i><b>Checklist - Receipt and Inspection of Dosimeters</b></i>				
<b>COMPLETE THE FOLLOWING PROMPTLY UPON RECEIPT OF A SHIPMENT OF DOSIMETERS FROM AF DOSIMETRY</b>				
<b>Enter YES, NO, N/A or ✓ when completed (as appropriate)</b>	<b>Yes</b>	<b>No</b>	<b>N/A</b>	<b>✓</b>
Carefully open the shipping container and visually inspect for damage to its contents.				
Confirm receipt of all the necessary materials:				
Shipping tray(s) with TLDs.				
Preprinted identification labels.				
SDRD Listing 1523.				
Extremity dosimeters, if needed.				
Verify that there are enough dosimeters, including extras, for the base monitoring requirements.				
<b>NOTES:</b>				
<p><i>The shipping trays are arranged by:</i></p> <p><i>First area control TLDs for each dosimeter</i></p> <p><i>First area beta/gamma/x-ray TLDs</i></p> <p><i>First area neutron TLDs</i></p> <p><i>(Sequence is repeated for each area until all areas are complete)</i></p> <p><i>Extra base beta/gamma/x-ray TLDs</i></p> <p><i>Extra base neutron TLDs</i></p> <p><i>Extremity dosimeters (packaged separately)</i></p>				
Verify that there are control TLDs and control extremity dosimeters for each monitored area.				
Store the original shipping container so that it can be used at the end of the monitoring period.				

<i><b>Checklist - Requesting a Report of Radiation Exposure History (AF Form 1527-2)</b></i>																																																																										
Radiation Safety Officer (RSO) prepares a letter of request containing:																																																																										
<b>NOTE: The RSO may also obtain the Radiation Exposure History (AF Form 1527-2) of any individual currently stationed at his/her base through the Radiation Dosimetry Web secure website.</b>																																																																										
<table border="1"> <thead> <tr> <th>Enter YES, NO, N/A or ✓ when completed (as appropriate)</th> <th>Yes</th> <th>No</th> <th>N/A</th> <th>✓</th> </tr> </thead> <tbody> <tr> <td>Name of individual (last, first, MI).</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Social Security Account Number (SSAN) of individual.</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Date of Birth of individual.</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Signature of individual authorizing release of personal information.</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Signature of RSO requesting the report.</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Address to which the report is to be sent.</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Telephone number (commercial and DSN) of RSO (or individual) requesting the report.</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>FAX number of RSO (or individual) requesting the report.</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>E-mail address of RSO or individual requesting the report (REPORT WILL NOT BE SENT BY E-MAIL).</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Send Request by mail or FAX to:</td> <td colspan="4"> <i>USAF Radiation Dosimetry Laboratory AFIOH/SDRD 2350 Gillingham Drive, Bldg-140 Brooks City-Base TX 78235-5103 Fax: (210) 536-5368 or DSN FAX: 240-5368</i> </td> </tr> <tr> <td colspan="5"><b>TO PROTECT THE PRIVACY OF INDIVIDUALS RECEIVING MONITORING SERVICE, REQUESTS RECEIVED BY E-MAIL OR TELEPHONE WILL NOT BE HONORED.</b></td> </tr> <tr> <td colspan="5">ADIOH/SDRD will research available AF records of internal and external ionizing radiation exposure and will send a report to the address specified in the request within 30 calendar days of receipt.</td> </tr> <tr> <td colspan="5">Any individual who has received AF radiation monitoring service may request a copy of their history of exposure to ionizing radiation directly from ADIOH/SDRD by following the same procedure as shown in the above checklist. The signature of the base RSO is NOT required for requests from individuals; however, a statement of release and signature is required from the individual.</td> </tr> </tbody> </table>					Enter YES, NO, N/A or ✓ when completed (as appropriate)	Yes	No	N/A	✓	Name of individual (last, first, MI).					Social Security Account Number (SSAN) of individual.					Date of Birth of individual.					Signature of individual authorizing release of personal information.					Signature of RSO requesting the report.					Address to which the report is to be sent.					Telephone number (commercial and DSN) of RSO (or individual) requesting the report.					FAX number of RSO (or individual) requesting the report.					E-mail address of RSO or individual requesting the report (REPORT WILL NOT BE SENT BY E-MAIL).					Send Request by mail or FAX to:	<i>USAF Radiation Dosimetry Laboratory AFIOH/SDRD 2350 Gillingham Drive, Bldg-140 Brooks City-Base TX 78235-5103 Fax: (210) 536-5368 or DSN FAX: 240-5368</i>				<b>TO PROTECT THE PRIVACY OF INDIVIDUALS RECEIVING MONITORING SERVICE, REQUESTS RECEIVED BY E-MAIL OR TELEPHONE WILL NOT BE HONORED.</b>					ADIOH/SDRD will research available AF records of internal and external ionizing radiation exposure and will send a report to the address specified in the request within 30 calendar days of receipt.					Any individual who has received AF radiation monitoring service may request a copy of their history of exposure to ionizing radiation directly from ADIOH/SDRD by following the same procedure as shown in the above checklist. The signature of the base RSO is NOT required for requests from individuals; however, a statement of release and signature is required from the individual.				
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<i><b>Checklist - Returning TLDs to AFIOH/SDRD for Processing</b></i>				
Enter YES, NO, N/A or ✓ when completed (as appropriate)	Yes	No	N/A	✓
<b>WITHIN TWO (2) CALENDAR DAYS FOLLOWING THE END OF THE MONITORING PERIOD</b>				
Assemble the whole body, neutron and collar dosimeters and collect the extremity dosimeter rings for the next monitoring period.				
Contact each area monitor to make arrangements for exchange.				
Collect all dosimeters from all areas.				
Each area monitor has returned the dosimeters?				
Each area monitor has returned all area controls?				
Each area monitor has accounted for all dosimeters that were not returned?				
Check all returned dosimeters against SDRD Listing 1523 by checking off each entry on the listing as you find it.				
Request each area monitor to assist in accounting for missing dosimeters.				
Designate all "not returned" TLD badges and extremity dosimeters on SDRD Listing 1523.				
Remove the TLDs from the hangers using the reverse procedure for dosimeter assembly.				
Discard all labels in a manner designed to ensure that privacy act information is handled properly. You do not need include labels in shipping trays or shipping packages. (Exception: late return badges not being returned with the original shipment.)				
Screen TLDs with radiation monitoring instrumentation to ensure no exterior contamination is present before shipping.				
Place all TLDs into the shipping tray(s), or shipping container (Example: Zip-Loc™ bag). Badges should sit upright in tray and not at an angle. Badges shipped in trays need to be secure with rubber bands. DO NOT USE TAPE TO SECURE BADGES IN TRAY(S) (When shipping two or more monitoring periods, keep each monitoring period separate in the same package. Special surveys for the monitoring period also need to be separated from monthly and quarterly badges. Individual TLDs do not need to be in order.)				
Place the shipping tray(s) back into the original shipping boxes that have been saved since the beginning of the monitoring period or package appropriately to ensure the TLDs are protected and returned in an orderly fashion.				
Place the extremity dosimeters into a separate package for return in the shipping container (Example: Zip-Loc™ bag).				
<b>RSO REVIEWS THE SDRD Listing 1523 BEFORE SHIPPING</b>				
All additions, deletions and changes have been shown on the listing.				
All written information has been provided to AFIOH/SDRD by phone, message, or faxed prior to the end of the monitoring period?				

<b><i>Checklist - Returning TLDs to AFIOH/SDRD for Processing (continued)</i></b>				
Enter YES, NO, N/A or ✓ when completed (as appropriate)	Yes	No	N/A	✓
Listing marked to show the wear of a protective eyewear, thyroid shield or lead apron?				
Shipping tray(s) and extremity dosimeter package been placed into the shipping container?				
Original SDRD Listing 1523 in the shipping box?				
Copy of SDRD Listing 1523 retained for your files?				
<b>FINAL PREPARATION FOR SHIPMENT</b>				
Add additional cushioning material (not vermiculite) as needed to fill the shipping box.				
Seal all edges of the shipping box with reinforced tape.				
Attach or make your own address label.				
Attach the "caution" label to the shipping box next to the address label.				
Send the shipment to AFIOH/SDRD by the most expeditious <i>AND TRACEABLE</i> means (normally FedEx® or Certified Mail – Return Receipt Requested).				
Package shipped to AFIOH/SDRD within five (5) calendar days after the end of the monitoring period? ( <b>NOTE:</b> The required shipping date may be changed to avoid shipping on a Friday, Saturday or Sunday)				
<b>SHIPPING LABEL:</b> Send shipment to: <i>USAF Radiation Dosimetry Laboratory AFIOH/SDRD 2350 Gillingham Drive, Bldg-140 Brooks City-Base TX 78235-5103</i>				

<i><b>Checklist - Returning TLDs to AFIOH/SDRD for Processing (continued)</b></i>				
Enter YES, NO, N/A or ✓ when completed (as appropriate)	Yes	No	N/A	✓
<b>SPECIAL INSTRUCTIONS FOR MULTIPACK</b>				
<b>TLD HOLDER MULTIPACK IDENTIFICATION</b> <b>NUMBERS:</b> When TLDs are shipped to the field, they are shipped in a particular order. If an individual is registered in the USAF Personnel Dosimeter Program and wears different types of dosimeters (i.e., collar, whole body, neutron, and/or extremity dosimeters), the SDRD Listing 1523 will assign all these devices to the individual and assign one number to the entire collection (i.e., the multipack identification number). Although several devices are assigned within the pack, the subsequent SDRD Listings 1499-1 and 1499-2 will provide the dose equivalent results on a single line identified by this multipack identification number. <b>ALL DOSIMETERS USED IN THE MULTIPACKS MUST BE RETURNED FOR PROPER DOSE EQUIVALENT ASSESSMENT. ONE MISSING DOSIMETER WILL RESULT IN AN INTERIM ADMINISTRATIVE DOSE TO BE ASSIGNED AGAINST THE ENTIRE PACK.</b>				

<i><b>Checklist - Evaluating Doses Exceeding Reference Levels</b></i>				
Base RSO evaluates the suspected abnormal exposure if dose exceeds limits of Chapter <b>10.</b> or <b>11.</b>				
Enter YES, NO, N/A or ✓ when completed (as appropriate)	Yes	No	N/A	✓
Immediately forward the following items to AFIOH/SDRD:				
Any TLD holder and/or extremity dosimeter suspected of receiving an abnormal exposure.				
An unused TLD (of the same type) to serve as the area control dosimeter.				
A memo request for Priority Processing including pertinent facts surrounding the exposure such as: Individual's Name and SSAN. Base Code and Area Code. The actual dates of monitoring.				
Initiate an investigation as outlined in Chapters <b>9.</b> or <b>10.</b> of this manual.				

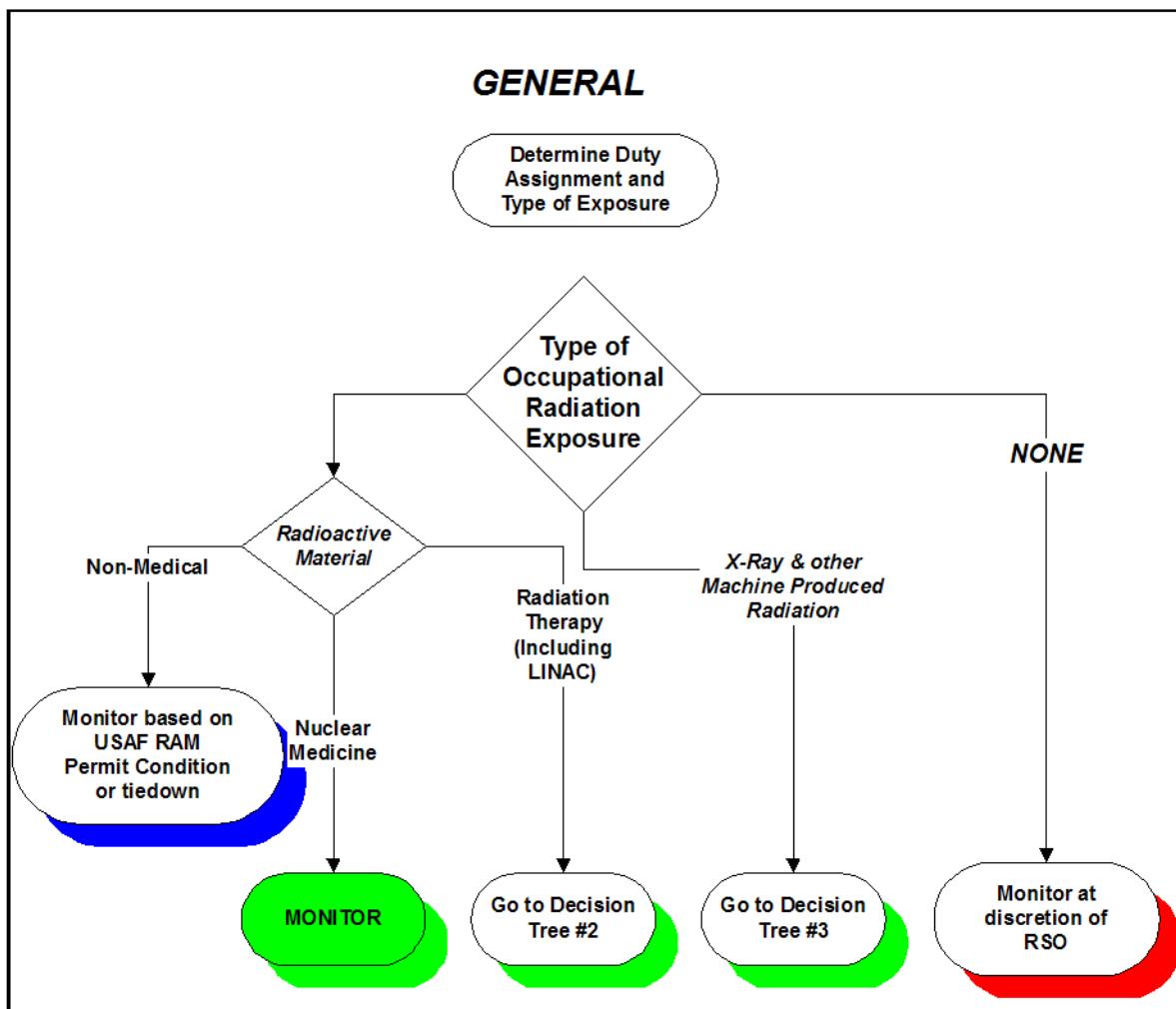
**Attachment 3****"DECISION TREES"**

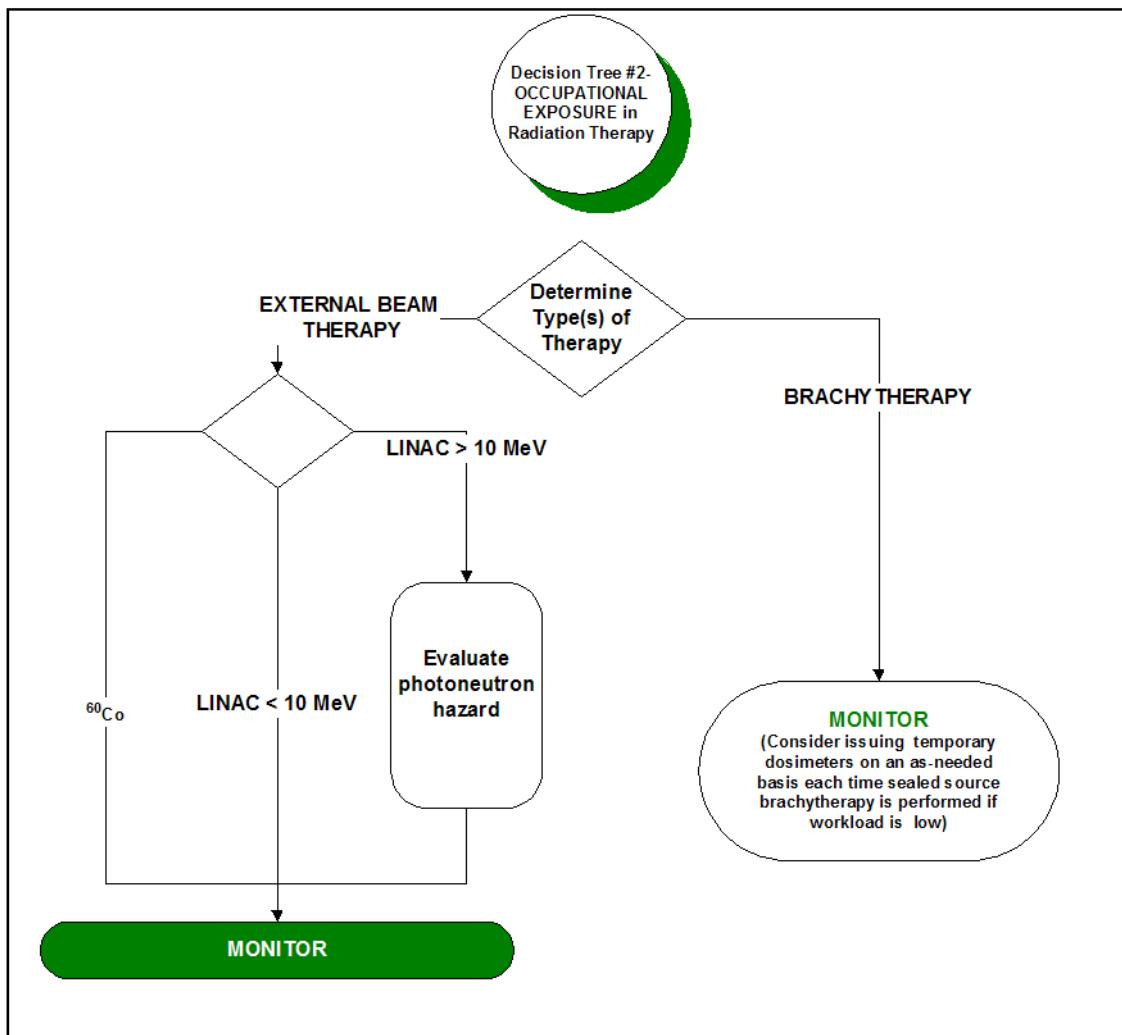
**A3.1.** These "decision trees" are designed to aid in evaluating the need for enrolling an individual in the AF Personnel Ionizing Radiation Dosimetry Program.

**A3.2.** When asked for guidance on whether an individual needs to be provided with dosimetry services, first determine if dosimetry is mandatory from AFI 48-148, the radioactive material use permit, and other sources. Some occupations where dosimetry is generally mandated are nuclear medicine technicians, radiologists and radiology technicians, non-destructive inspection technicians, pregnant radiation workers and personnel entering high radiation areas. Many circumstances will be less clearly defined. In such cases, the "decision trees" on the following pages may be used to assist in deciding whether or not to enroll an individual in the AF Personnel Ionizing Radiation Dosimetry Program.

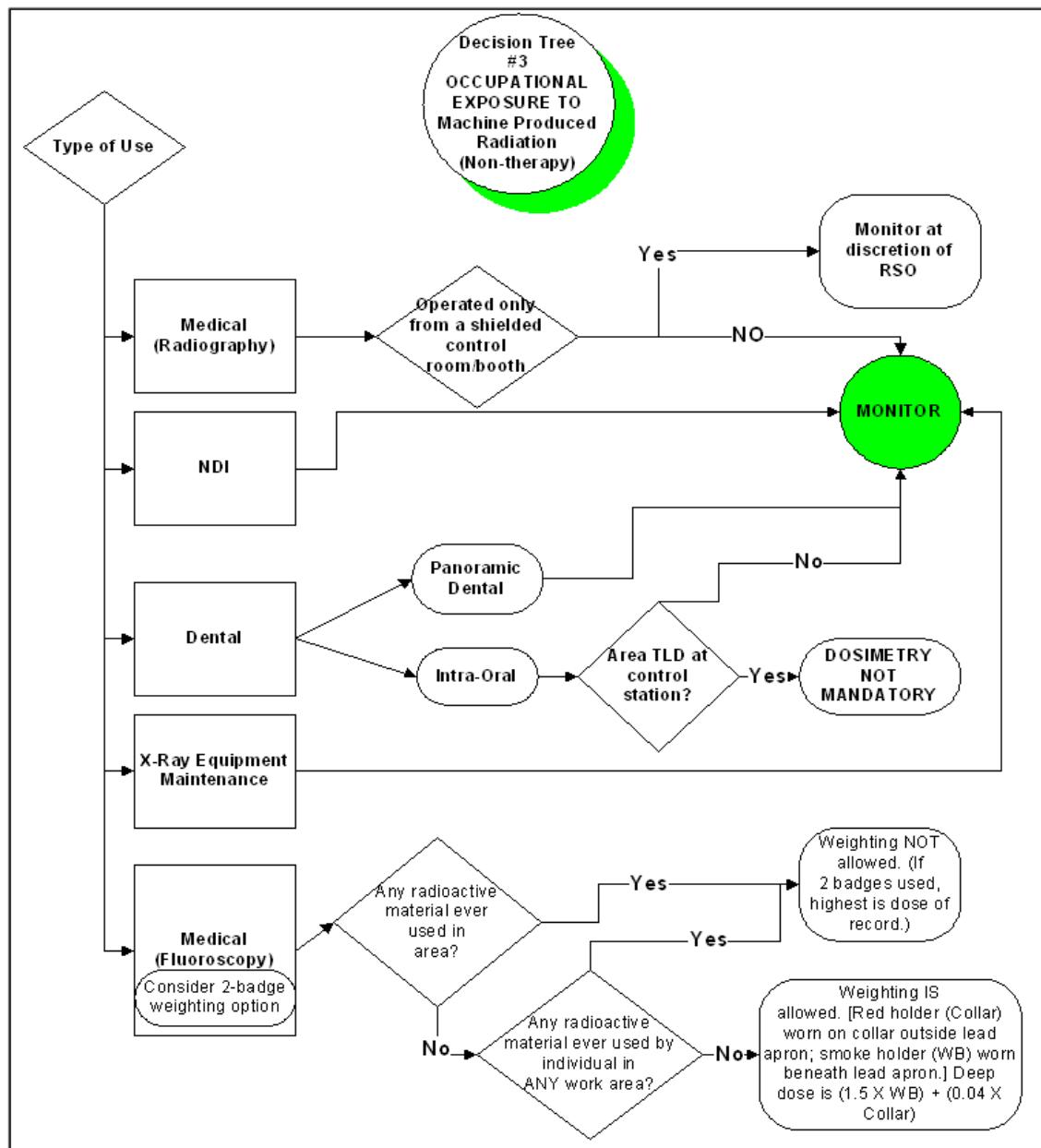
**A3.3.** The following "decision trees" are only advisory in nature. They must NOT be represented as official policy of AFIOH/SDRD or of AFMOA/SGPR.

**A3.4.** Except in cases where personnel dosimetry is mandated by AFI 48-148 or other regulation or law, the decision on who receives this service is made at the local base level. AFIOH/SDRD will NOT decline to provide dosimetry services to a customer solely because these "decision trees" may appear to indicate that dosimetry is not required.

**Decision Tree #1 - General Considerations.**

**Decision Tree #2 – Occupational Exposure in Radiation Therapy.**

**Decision Tree #3 – Occupational Exposure to X-Rays and other Machine Produced Radiation (non-therapy).**



## Attachment 4

### DESCRIPTION OF AIR FORCE DOSIMETERS

#### **A4.1. Air Force Whole Body Dosimeters**

**Table A4.1. Composition of AF Whole Body Dosimeter**

UD-802	Element 1	Element 2	Element 3	Element 4
Phosphor	$\text{Li}_2\text{B}_4\text{O}_7$ : Cu		$\text{CaSO}_4$ : Tm	
Shielding	Plastic	Plastic		Plastic + Lead
Thickness (mg/cm <sup>2</sup> )	18	360		1040

**A4.1.1. Evaluating Radiation Dose using Whole Body Dosimeters :** The Air Force Dosimetry System utilizes a dose algorithm capable of calculating external whole body doses from photon, beta, and neutron radiation fields. The algorithm calculates absorbed radiation doses from exposures to pure and mixed x-ray, gamma ray and neutron sources as well as beta particles that may occur in work environments. The range of radiation fields over which the algorithm is applicable is defined by the range of energies of each radiation type used in the algorithm development.

**A4.1.1.1. Applicable Radiations :** Photon dose calculations accommodate a range of photon energies from 20 to 1.3 MeV. The photon sources used for algorithm development were chosen for applicability to the NVLAP proficiency-testing category IIA (photons general). The beta ( $\beta$ ) shallow and eye dose calculations apply to average beta energies between 0.556 MeV ( $^{90}\text{Sr}/^{90}\text{Y}$ ) and 0.267 MeV ( $^{204}\text{Tl}$ ).

**A4.1.1.2. Evaluating Neutron Exposures with the Whole Body TLD :** The neutron dose calculation is specific for deuterium oxide ( $\text{D}_2\text{O}$ ) (heavy water) moderated  $^{252}\text{Cf}$ . This source/geometry is used to generally simulate a nuclear power plant neutron energy spectrum. The neutron spectrum greatly affects dosimeter response and, consequently, can have a significant impact on the dose equivalent assessed for individuals wearing the badge. Monitoring programs for neutron exposures should be coordinated with AFIOH/SDRD and AFIOH/SDRH (Health Physics Consulting Branch) to determine whether neutron spectroscopy measurements are required to provide an accurate determination of neutron dose. The dose processing software has been customized to allow the use of customer-specific; source determined neutron factors to accommodate neutron sources other than  $\text{D}_2\text{O}$  moderated  $^{252}\text{Cf}$ . When available, use of customer-specific neutron factors is preferred. *Note:* When neutron exposure is expected a neutron specific TLD should be worn.

**A4.1.1.3. Algorithm Limitations:** The major limitation of the UD-802 dosimeter and algorithm is that beta and neutron radiations are not monitored simultaneously. AFIOH/SDRD uses two separate and different badge hangers to monitor beta and neutron. However, the whole body dosimeter (smoke hanger) is not capable of determining a difference between simultaneous exposures to both types of radiation.

**A4.1.1.4. Lower Limit of Detection:** At low dose levels, normal statistical variation in the element readings makes calculation of energy specific correction factors inherently unreliable. A Lower Limit of Detection (LLD) study was performed using the protocol specified by the Department of Energy Laboratory Accreditation Program (DOELAP) standard in publication DOE-EH-0027. The LLDs for most radiations evaluated in the algorithm were calculated to be between 0.001 – 0.0025 mSv (0.1 - 2.5 mrem). Because of increased uncertainties inherent with field deployment of personnel dosimeters, an administratively determined minimum dose level of 0.1 mSv (10 mrem) is applied when reporting doses to the MRER. This is consistent with generally accepted LLD reporting practices throughout the external radiation dosimetry industry.

**A4.1.1.5. High Responses :** High range doses require special attention. Any element reading above 417 mR\* (element readout) is reported on the raw data printout obtained after the readout is complete<sup>1</sup>. If the estimated deep dose on a dosimeter issued to a person (as opposed to a dosimeter used for calibration, blind testing, or similar purposes) is greater than 417 mrem and the element glow curves are satisfactory, the base RSO and the Air Force Radioisotope Committee (RIC) are contacted<sup>2</sup>. The TLD is isolated and a follow-up investigation is initiated as detailed in the Operating Instructions (OIs) and the AFMAN. The high reading is noted on the dose processing form.

**A4.1.2. Evaluating Radiation Doses using Neutron Dosimeters:** The Air Force neutron dosimeter uses the same TLD as is included with the whole body dosimeter. A specialized neutron hanger with a 314 mg/cm<sup>2</sup> cadmium filter over the front of Element 1 is provided. The cadmium filter improves the dosimeter's response to the wide range of neutron energies that may be operationally encountered. As noted above, the amber neutron dosimeter is never worn alone, but in combination with the standard "smoke" colored dosimeter/hanger combination.

**Table A4.2. Composition of AF Neutron Dosimeter**

UD-802	Element 1	Element 2	Element 3	Element 4
Phosphor	$\text{Li}_2\text{B}_4\text{O}_7$ : Cu		$\text{CaSO}_4$ : Tm	
Shielding	Front, Plastic + Cadmium Back, Plastic	Plastic		Plastic + Lead
Thickness (mg/cm <sup>2</sup> )	Front, 314 Back, 220	360		1040

**A4.1.2.1. Applicable Radiations:** Photon response of the amber hanger UD-802 dosimeter is characterized at gamma photon energy of 662 keV (<sup>137</sup>Cs). The photon sources used for algorithm development were chosen for applicability to the NVLAP proficiency testing categories II and VI. The neutron dose calculation is specific for D<sub>2</sub>O moderated <sup>252</sup>Cf. This type of source is used to generally simulate a nuclear power plant neutron energy spectrum. The neutron spectrum greatly affects the dose equivalent of the neutron exposure. If field neutron energies can be identified and

1. mR\* (mR star) is a term unique to Panasonic dosimetry technology that refers to the results obtained when reading an individual element of a dosimeter after application of all machine correction factors to the raw data, but without applying a dose calculation algorithm.

2. 417 mrem is the administrative dose limit for dosimeters deployed on a monthly exchange frequency. The corresponding administrative dose limit for dosimeters deployed on a quarterly exchange frequency is 1,250 mrem.

measured, site-specific correction factors can be applied to increase the accuracy of the dose estimate.

#### A4.2. Air Force Extremity Dosimeters.

A4.2.1. As stated in section [3.2.2.](#), the dose calculation algorithms for the single element extremity dosimeters (DXT-RAD and EXT-RAD) do not automatically compensate for exposures to beta radiation at energies other than those used to characterize the dosimeter (i.e., 0.556 MeV  $^{90}\text{Sr}/^{90}\text{Y}$  and 0.267 MeV  $^{204}\text{Tl}$ ). Because of this inherent limitation in dosimeter design, it is important that the customer advise the laboratory of the type and energy of beta radiation for which the dosimeter is to be evaluated so that appropriate correction factors can be applied to compensate for extremity dosimeter under response with low energy beta ( $\beta$ ) radiations. Experimental data illustrates that when exposed to radiation from  $^{204}\text{Tl}$ , the DXT-RAD and EXT-RAD dosimeters exhibit significant under response when compared to that obtained from the same delivered dose of  $^{90}\text{Sr}/^{90}\text{Y}$ . Neither model of extremity dosimeter will be sensitive to very low energy  $\beta$  emitters like  $^{14}\text{C}$  or tritium ( $^3\text{H}$ ), most alpha emitters (although they may respond to the characteristic x-rays they emit), or to low energy x-ray (low voltage tubes).

A4.2.2. The approximations listed in [Table 3.](#) may be applied to compensate for anticipated DXT-RAD and EXT-RAD under response when the identity of the beta emitter is known. It is essential that the customer inform AFIOH/SDRD of the energy of beta radiation desired for evaluating dosimeter results so that appropriate energy correction factors can be applied. Unless otherwise specified by the customer, the calculation software presumes that the beta radiation is of an energy closely approximating that of  $^{90}\text{Sr}/^{90}\text{Y}$  (0.556 MeV).

**Table A4.3. Response vs. Energy - Bicron/Harshaw Extremity Dosimeters**

<b>Isotope</b>	<b>Energy (b max ave)</b>	<b>DXT- RAD Response</b>	<b>EXT- RAD Response</b>
<sup>204</sup> Tl	0.267	0.1331	0.4967
	0.300	0.2261	0.5459
	0.320	0.2825	0.5756
	0.350	0.3671	0.6203
	0.360	0.3953	0.6352
	0.380	0.4517	0.6650
	0.400	0.5081	0.6948
	0.420	0.5645	0.7245
	0.440	0.6209	0.7543
	0.460	0.6773	0.7841
	0.480	0.7337	0.8139
	0.500	0.7901	0.8437
	0.520	0.8464	0.8734
	0.530	0.8746	0.8883
<sup>90</sup> Sr <sup>90</sup> Y	0.556	0.9480	0.9270
<sup>137</sup> Cs	0.662	0.8889	0.9490
DXT-RAD Response = $2.8197 X_{(\text{MeV})} - 0.6198$			
EXT-RAD Response = $1.4889 X_{(\text{MeV})} + 0.0992$			

**A4.2.3. Bicron/Harshaw DXT-RAD Extremity (Ring) Dosimeter:** The Bicron/Harshaw DXT-RAD extremity dosimeter is a single element "ring" type dosimeter. The active phosphor is a disk with a permanent, individual circular barcode surrounding a LiF: Mg, Tl chip. The dosimeter incorporates a clear plastic cover to seal the phosphor from the environment, thereby permitting hot or cold sterilization. The phosphor has inherent attenuation of approximately 42 mg/cm<sup>2</sup>. The clear plastic lens adds an additional 100 mg/cm<sup>2</sup> attenuation, for a total attenuation of approximately 142 mg/cm<sup>2</sup>. The active element is 3 mm in diameter. Absorbed doses are calculated based on the background-corrected element response exhibited when the dosimeter is read in a properly calibrated Bicron/Harshaw 6600 Automatic TLD reader. The reader is calibrated by mounting dosimeters on a finger phantom constructed according to the specifications of ANSI/HPS N13.32-1995, *Performance Testing of Extremity Dosimeters*, August 1995 and exposing them to known <sup>137</sup>Cs radiation levels. Ring response is calibrated using a number of radiation sources including <sup>137</sup>Cs, <sup>90</sup>Sr/<sup>90</sup>Y, and <sup>204</sup>Tl. Exposures were made over the range of 30 to 10,000 mrem (shallow).

**A4.2.3.1. Evaluation of DXT-RAD Data:** The DXT-RAD dosimeter is evaluated by applying previously determined element correction coefficients (ECC), subtracting the mean ECC adjusted results from reading associated unirradiated control dosimeters and applying a reader calibration factor. This general approach applies to dosimeters exposed to gamma and high-energy beta radiation such as <sup>137</sup>Cs or <sup>90</sup>Sr/<sup>90</sup>Y. The protective lens incorporated into this dosimeter results in a significant under response to low energy beta radiation such as <sup>204</sup>Tl. If it is known that the dosimeter was exposed exclusively to low energy beta radiation, an additional dosimeter sensitivity correction factor must be manually applied to more accurately evaluate the dose. A review of experimental data from test irradiations showed that, when exposed to low energy  $\beta$  radiation from <sup>204</sup>Tl, the DXT-RAD dosimeter under responds by about 87%. This means that the ECC corrected raw data results for a DXT-RAD dosimeter exposed to <sup>204</sup>Tl is about 13% of the actual absorbed dose equivalent. The calculated DXT-RAD energy compensation coefficient ( $E_n$ ) for <sup>204</sup>Tl is 0.13.

**Figure A4.1. DXT-RAD Extremity Dosimeter****Figure A4.2. Components of DXT-RAD Extremity Dosimeter**

**A4.2.4. Bicron/Harshaw EXT-RAD Extremity Chipstrate Dosimeter:** The Bicron/Harshaw EXT-RAD extremity dosimeter is a single element "ring" type dosimeter. The active phosphor EXT-RAD dosimeter is a LiF:Mg,Tl chip with a permanent, individual barcode. The manufacturer refers to the chip/barcode assembly as a "chipstrate." The chipstrate is heat sealed into a plastic throwaway pouch with adjustable attachment straps to form the complete dosimeter. The chipstrate has inherent attenuation of approximately  $100 \text{ mg/cm}^2$ . The pouch adds an additional  $7 \text{ mg/cm}^2$  attenuation, for a total attenuation of approximately  $107 \text{ mg/cm}^2$ . Absorbed doses are calculated based on the background-corrected element response exhibited when the dosimeter is read in a properly calibrated Bicron/Harshaw 6600 Automatic TLD reader.

Ring response is calibrated using a number of radiation sources including  $^{137}\text{Cs}$ ,  $^{90}\text{Sr}/^{90}\text{Y}$ , and  $^{204}\text{Tl}$ . Dosimeter response characteristics and calibrations were determined in the same manner as described for the DXT-RAD dosimeter in paragraph 3.3.3., above.

A review of experimental data from test irradiations made by the Pacific Northwest National Laboratory (PNNL) showed that, when exposed to low energy  $\beta$  radiation from  $^{204}\text{Tl}$ , the Air Force EXT-RAD dosimeter under responds by about 50%. This means that the ECC corrected raw data results for an EXT-RAD dosimeter exposed to  $^{204}\text{Tl}$  is about half the actual absorbed dose equivalent. The calculated energy compensation coefficient ( $E_n$ ) for  $^{204}\text{Tl}$  with the USAF EXT-RAD dosimeter is 0.50.

**Figure A4.3. EXT-RAD "band-aid" Chipstrate Extremity Dosimeter**



**Figure A4.4. EXT-RAD Extremity Dosimeter in use**



**Attachment 5**

<b>OCCUPATION CODES</b>
<b><u>Medical X-Ray</u></b>
1 – 5. Not used*
6. Medical Maintenance
7. Physician: Interventional Radiologist
8. Physician: Cardiologist
9. Physician: Gastroenterologist
10. X-Ray Technician
11. Physician: Radiologist (X-Ray)
12. Physician: Urologist
13. Physician: Orthopedist
14. Physician: Anesthesiologist
15. Physician: Other (X-Ray)
16. Nurse and Nurse Anesthetist
17. Technician: Other (X-Ray)
18. Student (Medical X Ray)
19. Temporary: Medical X-Ray
<b><u>Dental and Veterinary X-Ray</u></b>
20. Dental Technician
21. Dentist: General
22. Dentist: Oral Surgeon
23. Student: Dental and Veterinary
24. Not used since 1985**
25. Not used since 1985**
26. Veterinarian
27. Veterinary Technician
28. Not used since 1985**
29. Military Working Dog Handlers
<b><u>Medical Use of Radioisotopes</u></b>
<b>(Other than X-Ray)</b>
30. Physician: Pathologist
31. Physician: Radiologist (Isotopes)
32. Physician: Other
33. Technician: X Ray and Isotopes
34. Technician: Laboratory
35. Technician: Other (Isotopes)
36. Nurse (all categories not already listed)
37. Technician: Radioisotope Laboratory
38. Pharmacist: Nuclear Medicine
39. Ophthalmology Oncologist
<b><u>Industrial Use of Radioisotopes</u></b>
<b>(Other than X-Ray)</b>
40. $^{60}\text{Co}$ Instrument Calibration (PME Lab)
41. Radium Dial Painting
42. Industrial Radiography (Isotopes)
43. $^{137}\text{Cs}$ Instrument Calibration (PME Lab)
44. Not used since 1985**
45. Electron Tubes
46. Magnesium Thorium Operations
47. Isotopes Other than Above (Specify)
48. Training Sources
49. Not used since 1985**
<b><u>Industrial X-Ray</u></b>
50. Portable Field Units
51. Not used since 1985**
52. Super Voltage Units
53. Not used since 1985**
54. Not used since 1985
55. Postal Inspection Units
56. OSI Inspection Units
57. Baggage Inspection
58. X Ray Diffraction
59. Not used since 1985**
<b><u>Radar</u></b>
60. Radar Operators
61. Radar Maintenance Personnel
62. Radar Administration/Supply Personnel
63. Not used since 1985**
64. Not used since 1985**
65. Not used since 1985**
66. All Airborne Radar Personnel

\* These Occupation Codes have never been used.

\*\* These Occupation Codes were previously active, but have not been used since 1985. They are not available for reassignment.

67. BMEWS\*\*\* Personnel  
 68. Space-Track Facilities Personnel  
 69. Not used since 1985\*\*

**Special Weapons**

70. Weapons Maintenance  
 71. Weapons Inspection  
 72. Weapons Personnel  
 73. High Altitude Sampling  
 74. Kr-85 (Batteries)  
 75. Fission Product Contamination  
 76. Electron Microscope  
 77. Not used since 1985\*\*  
 78. Not used since 1985\*\*  
 79. Not used since 1985\*\*

**Reactors**

80. Reactor Operators  
 81. Nuclear Engineers  
 82. SNAP\*\*\*\* Projects  
 83. Nuclear Powered Missiles  
 84. Not used since 1985\*\*  
 85. Waste Processing  
 86. Not used since 1985\*\*

- Miscellaneous**
87. Scientists  
 88. Engineers  
 89. Physicists  
 90. AF Contractors  
 91. Radioactive Waste Disposal Personnel  
 92. Maintenance Personnel  
 93. Administrative and Supply Personnel  
 94. Disaster Control  
 95. EOD Personnel  
 96. Health Physics and Environmental Health

**Technicians**

97. Health Physicist and Bioenvironmental Engineer  
 98. Visitors  
 99. None of the Above  
 100. Non AF Employment  
 111. Nevada Test Site  
 901. Test Occ Code (Reserved)  
 902. Test Occ Code (Reserved)  
 903. Test Occ Code (Reserved)

All other categories will be used only when specifically cleared through AFIOH/SDR

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\*\*\* BMEWS = Ballistic Missile Early Warning System

\*\*\*\* SNAP = Special Nuclear Applications Program