

**BY ORDER OF THE  
7TH BOMB WING COMMANDER**



**AIR FORCE INSTRUCTION 48-148**

**DYESS AIR FORCE BASE  
Supplement**

**5 NOVEMBER 2018**

**Aerospace Medicine**

**IONIZING RADIATION PROTECTION**

**COMPLIANCE WITH THIS PUBLICATION IS MANDATORY**

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This instruction implements Air Force Policy Directive (AFPD) 48-1, *Aerospace Medicine Enterprise*, and Department of Defense Instruction (DoDI) 6055.08, *Occupational Ionizing Radiation Protection Program*. It also implements the requirements of North Atlantic Treaty Organization (NATO) Standardization Agreement 2473, Commander's Guide to Radiation Exposures in Non-Article 5 Crisis Response Operations-ED 2, for the protection of personnel from low-level radiation exposures. This instruction applies to Department of Defense (DoD) personnel, Air Force Reserve Command (AFRC) units, Air National Guard (ANG) units, and all tenants (including Department of Energy (DOE) personnel and prime contractors) of AF installations IAW host-tenant support agreements, and other civilian contractors as specified herein. This instruction is a companion to AFI 40-201, *Managing Radioactive Materials in the US Air Force*, and establishes the requirements outlined in Air Force Manual (AFMAN) 48-125, *Personnel Ionizing Radiation Dosimetry*. It serves as a reference for AFI 91-108, *Air Force Nuclear Weapons Intrinsic Radiation (INRAD)* and 91(b) Radioactive Material Safety Program. Ionizing radiation protection roles and responsibilities in this AFI apply to all ionizing radiation threats including those encountered by nuclear capable units and weapons storage areas unless stated otherwise in DoD publications or AF 91-series publications. This instruction specifies the requirements for the protection of AF personnel and their dependents as well as the public from exposure to ionizing radiation resulting from AF activities. It defines responsibilities for the protection, monitoring and medical follow-up of military personnel for the full spectrum of military operations. This instruction applies to uniformed AF personnel, AF civilians and individuals living on AF installations who might be exposed to radiation. This instruction does not apply to employees working under government contract or private contractors performing

work under government contracts, except when complying with Base Contracting requirements. Contractors are solely responsible for compliance with Occupational Safety and Health Administration (OSHA) standards and the protection of their employees unless otherwise provided by law or regulation to be specified in the contract. This AFI does not prohibit providing workplace sampling and survey information to contractors, based on local arrangements. This publication may be supplemented at any level. Requirements are tiered signifying the appropriate waiver authority to the requirement and is indicated in parentheses [T-0, T-1, T-2, or T-3] following the sentence/paragraph that drives the requirement, IAW AFI 33-360, *Publications and Forms Management*. Requests for waivers must be submitted through the chain of command to the appropriate Tier waiver approval authority IAW AFI 33-360. Ensure that all records created as a result of processes prescribed in this publication are maintained IAW Air Force Manual (AFMAN) 33-363, Management of Records, and disposed of IAW Air Force Records Information Management System (AFRIMS) Records Disposition Schedule (RDS). Refer recommended changes and questions about this publication to the Office of Primary Responsibility (OPR) using the AF Form 847, *Recommendation for Change of Publication*. Route the AF Form 847 from the field through the appropriate chain of command. 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 AF. See Attachment 1 for a Glossary of References and Supporting Information. This publication requires the collection and or maintenance of information protected by the Privacy Act (PA) of 1974. The Systems of Records Notice (SORN) for the Master Radiation Exposure Registry is F044 AF SG O. The authority to collect and or maintain the records prescribed in this publication is DoDI 6055.08.

**(Added)** This supplement details the operations and procedures at Dyess AFB to ensure radiation safety of all Airmen and the public at large in accordance with AFI 48-148, *Ionizing Radiation Protection*. It incorporates related publications: AFI 40-201, *Radioactive Materials Management*, and AFMAN 48-125, *Personnel Ionizing Radiation Dosimetry*. Ensure that all records created as a result of processes prescribed in this publication are maintained IAW Air Force Manual (AFMAN) 33-363, Management of Records, and disposed of IAW Air Force Records Information Management System (AFRIMS) Records Disposition Schedule (RDS). Refer recommended changes and questions about this publication to the Office of Primary Responsibility (OPR) using the AF Form 847, *Recommendation for Change of Publication*. Route the AF Form 847 from the field through the appropriate chain of command. 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 AF. See Attachment 1 for a Glossary of References and Supporting Information. This publication requires the collection and or maintenance of information protected by the Privacy Act (PA) of 1974. The Systems of Records Notice (SORN) for the Master Radiation Exposure Registry is F044 AF SG O. The authority to collect and or maintain the records prescribed in this publication is DoDI 6055.08.

### ***SUMMARY OF CHANGES***

**(Added)** This supplement is new to Dyess AFB and must be reviewed in its entirety. It sets forth the investigation action levels required for potential radiation overexposures, procedures for the approval of contractor use of radioactive materials, and incident planning and preparation.

1.1.1. **(Added)** This supplement covers Dyess AFB operations in regards to AFI 40-201, *Radioactive Materials Management*, and AFMAN 48-125, *Personnel Ionizing Radiation Dosimetry*, to alleviate multiple installation publications that are closely related.

1.2.4.1. **(Added)** This supplement applies to any potential general public and occupational doses controlled by Dyess AFB units, tenants, and contractors -- such are considered Avertable.

1.5.2.4. **(Added)** Interventions as defined in para 1.5.2 must be pre-coordinated with the IRSO when time allows during non-emergency events. During incident management operations, the Incident Commander--directly or through the BE Disaster Response Team, will seek IRSO guidance at an appropriate stage in emergency responses to mitigate exposures to personnel and prevent contamination spread.

2.15.2. **(Added)** The appointment shall be transparent to all Units such that they are aware of the services that the IRSO provides for Dyess AFB, and the authorities granted the IRSO by the Installation Commander. Attachment 10, *Appointment of the IRSO* has example verbiage to provide this level of communication. Appointment may be made at an ESOH Council where all Unit commanders are present for a briefing of the IRSO responsibilities and authorities, and documented in ESOH Council minutes.

2.15.4. **(Added)** Ensures radiation safety compliance for organizations or units conducting classified operations.

2.16.1.1. **(Added)** The appointment of the URSO shall be transparent to all Unit personnel such that they are aware of the existence of the URSO, and knowledgeable of the services and authority that the URSO provides for the unit. Attachment 10, *Appointment of the IRSO* has example verbiage to provide this level of communication.

2.16.11.1. **(Added)** Documents initial and annual training. Provides records to the IRSO as requested for installation program management reviews. Maintains training records for three years.

2.18.8. **(Added)** Recommends to unit commanders when personnel need to be relieved from duties that could involve further radiation exposure. This will occur when the MTF commander determines the individuals have been, or are likely to be, exposed to ionizing radiation in excess of limits specified in 10 CFR 20 and AFI 48-148. Outside of routine occupational, the guidance in AFI 48-148 will be used for major nuclear accidents, terrorist attacks, and combat operations in a radioactive environment.

2.20.1.3. **(Added)** Will inform emergency responders of known radiation activities on base. Routine uses of ionizing radiation by Dyess Units and contractors/non-Dyess units will be communicated to applicable offices for awareness to properly support planning and preparation for emergency management. The IRSO will provide a succinct assessment of the risks and hazards with such activities. Offices to be notified: Emergency Management, Fire Emergency Services, and Security Forces).

2.20.2.1. **(Added)** Deviations or deficiencies in regards to ionizing radiation safety will be presented at the quarterly ESOH Council meetings. Deviations creating an urgent safety concern will be handled immediately by the Unit in concert with Installation Radiation Safety Officer (IRSO) guidance, and then a report will made to the Installation Commander.

2.21.7. **(Added)** Is appointed in writing by the Unit/CC. A copy of the appointment letter is submitted to the IRSO. The URSO and/or PRSO will coordinate an annual radiation safety review with the IRSO.

2.23.3.1. **(Added)** Will obtain a radiation assessment from the IRSO or Bioenvironmental Engineering for workplace practices that emit radiation regardless of availability of technical orders or any other publications advising on radiation safety risks. Utilizes criteria in the radiation assessment report to ensure non-radiation workers and the public at large are protected from radiation exposure generated by workplace practices.

2.23.9. **(Added)** When the workplace or personnel within the workplace are placed on the base ionizing radiation dosimetry monitoring program, all of Section 2.12, *Supervisor Responsibility*, Section 2.13, *Individual Responsibility*, Section 4.8, *Wearing and Handling of Dosimeters*, and Section 4.9, *Storing Dosimeters*, in AFMAN 48-125, *Personnel Ionizing Radiation Dosimetry*, become mandatory. Supervisors will incorporate these sections into documented initial and annual radiation safety training.

2.25.3. **(Added)** Base Contracting will ensure that contractors contact the IRSO no later than 30 days prior to commencing work involving radiation. Contractor approval to conduct radiation activities on Dyess AFB requires review of applicable government-issued RAM permits, training records/certifications, SOWs, emergency procedures, and logistical details (e.g., demarcations, transport methods, storage, etc) necessary to ensure the safety of Dyess personnel. Further guidance is in Attachment 10.

2.25.4. **(Added)** Ensure that verbiage is included in contracts to follow the criteria provided by the IRSO for contract work utilizing RAM or radiation producing devices (RPDs).

3.1.2.3. **(Added)** Commanders, organization and URSOs, and workplace supervisors shall coordinate radiation safety policy and procedures with the IRSO to ensure that goals, procedures, and controls are adequate for specific radiation hazards.

3.3.2.1. **(Added)** The training plan shall be coordinated through the IRSO to ensure the proper scope and depth for the radiation hazards. Workplace supervisors and URSOs will review the training plans annually. The training plan will need to be coordinated with the IRSO whenever there are changes to the processes, locations, and types of radiation.

3.4.3.1. **(Added)** The Investigation Action Levels (IALs) for Dyess AFB are listed in Appendix 11, Table A11.1.

3.9. **(Added)** Radioactive Material Management. Proper management of these hazardous materials is critical for protection of personnel and the public. Refer to AFI 40-201, *Radioactive Material Management* for general compliance. Refer to Section 5.4 of this supplement for Dyess specific actions and requirements.

4.2.4.1.8.1.1. **(Added)** Ensure that the IRSO coordinates on the report if the injury is an occupational injury; Public Health must also initiate the injury investigation through the Air Force Safety Automated System (AFSAS).

4.7.2.5.2. **(Added)** Contracted medical services involving RAM or RPDs must be coordinated through the IRSO if the radiation activities of the medical services are conducted on Dyess AFB.

4.7.3.5.1. **(Added)** Contracted mobile services that are used or support Air Force radiation therapy clinics must comply with **paragraph 4.7.2.5.2** [T-2]

5.4. **(Added)** Radioactive Material Management. This section supplements AFI 40-201, *Radioactive Material Management*, for Dyess specific items not already included in other parts of Dyess Supplement 48-148.

5.4.1. **(Added)** Approval for use of non-Dyess owned RAM and RPDs are detailed in Attachment 9. Base contracting personnel reference [para. 2.25.3](#) of this supplement for contractor approval of the use of RAM/RPDs. Non-Dyess Federal entities must contact the IRSO for coordination of radiation activities as well as review Attachment 9.

5.4.2. **(Added)** The IRSO advises commanders on radiation safety compliance IAW several regulations. Those regulations are included in the Commander's Brief attached to the Appointment Letter. Attachment 10 is an example appointment letter with the required verbiage.

5.4.3. **(Added)** Texas Department of State Health Services (DSHS), *Radiation Control Program* shall be reviewed by the IRSO every three years. The IRSO shall sign up to receive regulatory updates from the state of Texas. The IRSO shall consider state regulations when work may exceed areas of federal jurisdiction. The 7 BW/JA office will be consulted for any conflicts between state and federal requirements. 7 BW/JA will, in turn, consult with AFMSA/SG3PB (Radioisotope Committee Secretary – RICS) through the installation IRSO and, in turn, AFLOA/JACE FSC (RIC counsel) either directly or through the appropriate JACE Environmental Liaison Officer (ELO) for assistance in resolving the conflict of law issue.

5.4.4. **(Added)** The IRSO will communicate requirements in this supplement, AFIs 48-148 and 40-201 to Dyess AFB offices involved in disposition, transportation and shipment (CES, LRS), and validate compliance with radiation regulations.

6.1.1. **(Added)** If interventions are anticipated or deemed necessary, involvement of the IRSO is mandatory. The exception is during an incident response in which the Incident Commander will ensure involvement of the IRSO and/or BE Subject Matter Expert as soon as appropriate after life saving measures, and incident control is achieved.

BRANDON D. PARKER, Col, USAF  
Commander, 7th Bomb Wing

## Attachment 1

## GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

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### ***Adopted Forms***

AF Form 847, *Recommendation for Change of Publication*

*Abbreviations and Acronyms*

**AAPM**—American Association of Physicists in Medicine  
**ABC**—Automatic Brightness Control  
**ABH**—American Board of Health Physics  
**ABMP**—American Board of Medical Physics  
**ABR**—American Board of Radiology  
**ACR**—American College of Radiology  
**ADCL**—Accredited Dosimetry Calibration Laboratory  
**AFDIRB**—Air Force Diagnostic Imaging and Radiotherapy Board  
**AFI**—Air Force Instruction  
**AFIA**—Air Force Inspection Agency  
**AFMAN**—Air Force Manual  
**AFMPWG**—Air Force Medical Physics Working Group  
**AFMSA**—Air Force Medical Support Agency  
**AFOSH**—Air Force Occupational Safety and Health  
**AFPD**—Air Force Policy Directive  
**AFRAT**—Air Force Radiation Assessment Team  
**AFRRAD**—Air Force Radioactive Recycling & Disposal  
**AF-RSC**—Air Force Radiation Safety Committee  
**AF-RSCES**—Air Force Radiation Safety Committee Executive Secretariat  
**AFSC**—Air Force Specialty Code  
**AFSEC**—Air Force Safety Center  
**ALARA**—As Low As Reasonably Achievable  
**ALI**—Annual Limits of Intake  
**AOR**—Area of Responsibility  
**ARRT**—American Registry of Radiologic Technologists  
**ASRT**—American Society of Radiologic Technologists  
**BCB**—Bioenvironmental Engineering (BE) Corporate Board  
**BCE**—Base Civil Engineer  
**BE**—Bioenvironmental Engineering  
**BEE**—Bioenvironmental Engineer  
**BMET**—Biomedical Equipment Technician

**CBRNE**—Chemical, Biological, Radiological, Nuclear and high-yield Explosive

**CE**—Civil Engineer

**CEDE**—Committed Effective Dose Equivalent

**CFR**—Code of Federal Regulations

**CME**—Continuing Medical Education

**COCOM**—Combatant Command

**CONUS**—Continental United States

**CRCPD**—Conference of Radiation Control Program Directors

**CT**—Computed Tomography

**CTDI**—Computed Tomography Dose Index

**DHS**—Department of Homeland Security

**DMC**—Deployed Medical Commander

**EDF**—Equipment Data File

**EM**—Emergency Management

**EPA**—Environmental Protection Agency

**ESE**—Entrance Skin Exposure

**ESEG**—Entrance Skin Exposure Guide

**ESOH**—Environmental, Safety, and Occupational Health

**eV**—Electron Volt

**FDA**—Food and Drug Administration

**GSU**—Geographically Separated Unit

**IAW**—In Accordance With

**ICRP**—International Commission on Radiological Protection

**HLC**—High Level Control

**JTF**—Joint Task Force

**IAEA**—International Atomic Energy Agency

**INRAD**—Intrinsic Radiation

**IRSO**—Installation Radiation Safety Officer

**MAJCOM**—Major Command

**MERC**—Medical Equipment Repair Center

**MOA**—Memorandum of Agreement

**MQSA**—Mammography Quality Services Act

**MRER**—Master Radiation Exposure Registry  
**MRI**—Magnetic Resonance Imaging  
**MSAD**—Multiple Scan Average Dose  
**MTF**—Military Treatment Facility  
**NARM**—Naturally Occurring or Accelerator Produced Material  
**NATO**—North Atlantic Treaty Organization  
**NCOIC**—Non-Commissioned Officer In Charge  
**NCRP**—National Council on Radiation Protection  
**NEXT**—Nationwide Evaluation of X-ray Trends  
**NIST**—National Institutes of Standards and Technology  
**NRC**—Nuclear Regulatory Commission  
**OCONUS**—Outside the Continental United States  
**ODG**—Operational Dose Guidance  
**OEG**—Operational Exposure Guidance  
**OPR**—Office of Primary Responsibility  
**OSHA**—Occupational Safety and Health Administration  
**pCi/L**—picoCurie/Liter  
**PCM**—Primary Care Manager  
**PET**—Positron Emission Tomography  
**PPE**—Personal Protective Equipment  
**PRSO**—Permit Radiation Safety Officer  
**QA**—Quality Assurance  
**QAP**—Quality Assurance Program  
**QC**—Quality Control  
**RADIAC**—Radiation Detection Instrumentation and Calculation  
**RAM**—Radioactive Material  
**rem**—Roentgen Equivalent Man  
**RES**—Radiation Exposure Status  
**RIC**—Radioisotope Committee, see USAF RIC  
**RICS**—Radioisotope Committee Secretariat  
**RM**—Risk Management  
**RSC**—Radiation Safety Committee

**RSO**—Radiation Safety Officer

**SEI**—Special Emphasis Investigation

**SMDA**—Safe Medical Devices Act of 1990

**SMO**—Senior Medical Officer

**SOFA**—Status of Forces Agreement

**SPECT**—Single Photon Emission Computed Tomography

**SSD**—Source-to-Skin Distance

**SSN**—Social Security Number

**Sv**—Sievert

**TDY**—Temporary Duty

**TEDE**—Total Effective Dose Equivalent

**TO**—Technical Orders

**URSO**—Unit Radiation Safety Officer

**USAF RIC**—United States Air Force Radioisotope Committee

**USAFSAM**—United States Air Force School of Aerospace Medicine

**WLM**—Working Level Month

### *Terms*

**General**—Ionization is the process by which atoms lose, or sometimes gain electrons and thus become electrically charged. Ionizing radiation are those forms of sub-atomic particles and electromagnetic waves that are capable of causing ionization in matter. Historically, the quantities used to measure the amount of radiation have been defined by the gross number of ionizing events in a given mass of material. The most commonly used quantity reported in early radiation protection was the Roentgen (R) equal to the quantity of x-ray or gamma radiation producing ions in air carrying one electrostatic unit of charge per cubic centimeter of air. At standard temperature and pressure, this is equivalent to 2.58E-4 Coulomb per kilogram of air. Although this quantity is still in use, the more appropriate units for radiation protection are based on the ionizations that occur in given mass of human tissue, and the subsequent risk of biological affect that that dose may cause.

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

**Absorbed Dose (D)**—The fundamental dose quantity in radiation protection is the absorbed dose, D. This is the energy absorbed per unit mass and is in units of joule per kilogram, which is given the special name gray (Gy). One Gy is equal to 100 rad, the conventional quantity of absorbed dose equal to 100 ergs/gm.

**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**—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. Administratively assigned doses must be investigated by the installation RSO as "Abnormal Exposures" IAW AFMAN 48-125.

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

**Annual Average Effective Dose Equivalent in the US Population**—The following table provides a list of common exposure sources and the annual average dose an individual in the U.S. receives from each source. The rounded annual dose for non-smokers per year is 6.2 mSv, or 620 mrem. It provides a basis for comparison to the limits and dose guidance specified in this instruction. Below is a comparison showing the increase in the annual average exposure based on results from National Council on Radiation Protection and Measurements (NCRP), Report No. 160, Ionizing Radiation Exposure of the Population of the United States (2009), and Report No. 093, Ionizing Radiation Exposure of the Population of the United States, showing recent data indicating an increase of effective dose. This is namely due to medical exposures.

**Annual Limit of Intake (ALI)**—The derived limit of RAM taken into the body of an adult worker by inhalation or ingestion in a year. The ALI is the smallest value of intake of a given radionuclide in a year that would result in a committed effective dose equivalent of 0.05 Sv (5 rem) or a committed dose equivalent of 0.5 Sv (50 rem) to any individual organ or tissue.

**Background Radiation**—Radiation from cosmic sources; naturally occurring RAM, including 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 or from past nuclear accidents such as Chernobyl that contribute to background radiation. Background radiation does not include radiation from source, byproduct, or special nuclear materials regulated by the NRC or from NARM that the AF regulates through AFI 40-201.

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

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

**Biomedical equipment repair technician**—considered a qualified expert to support QC, equipment repair, collection of data and calibration IAW AFI 41-201, Managing Clinical Engineering Programs.

**Byproduct Material**—(1) Any RAM (except source material and special nuclear material) yielded in, or made radioactive by, exposure to the radiation incident to the process of producing

or utilizing special nuclear material; (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.

**Committed Dose Equivalent (HT,50)**—The dose to a specific organ or tissue that is received from an intake of radioactive material by an individual over a specified time after the intake. For radiation protection purposes, the specified time is to the age of 70, which is normally taken to be 50 years for a radiation worker and 70 years for a member of the public.

**Committed Equivalent Dose and Committed Effective Dose Equivalent (HE,50)**—Following an intake of radionuclides in the body, there is a period during which the material irradiates various organs and tissues. The committed equivalent dose, HT,50 is the integral of the equivalent dose rate in a specific tissue (T) following intake of a radionuclide in the body. For the purpose of radiation protection, the time of integration is taken as 50 years for occupational exposures and 70 years for members of the public. The committed effective dose, E(), for each internally deposited radionuclide is calculated by summing the products of the committed equivalent doses and the appropriate wT values for all tissues irradiated. The expression for the occupational committed effective dose equivalent is given as:  $E(50) = \text{SUM}(WT*HT(50))$

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

**Curie (Ci)**—A unit of radioactivity equal to 37 billion Becquerels. See definition of Becquerel.

**Declared Pregnant Woman**—A woman who is also a radiation worker and has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception. The declaration remains in effect until the declared pregnant woman withdraws the declaration in writing or is no longer pregnant.

**Derived Air Concentration (DAC)**—The concentration of a given radionuclide in air which, if breathed for a working year of 2,000 hours under conditions of light work (inhalation rate of 1.2 cubic meters of air per hour), results in an inhalation of one ALI.

**Deterministic Effect**—Biological effects for which the severity of the effect in an exposed individual varies with the dose, and for which a threshold usually exists (e.g., skin erythema and cataracts).

**Diagnostic Source**—In the healing arts, a source of ionizing radiation used in the diagnosis of injury or disease. Includes: x-ray units (fixed, portable, fluoroscopy, computed tomography, etc.), RAM (capsules, liquids or gases) used in nuclear medicine, and RAM used in a laboratory setting to perform in-vitro studies (on blood, urine, cells, etc.).

**Deep Dose Equivalent (Hd)**—The dose assigned to personnel from external whole-body exposure, it is the dose equivalent at a tissue depth of one cm (1000 mg/cm<sup>2</sup>) which is expressed in units of rem or Sievert (Sv).

**Dose Equivalent (HT)**—A quantity used for radiation protection to indicate the biological effectiveness of different radiations to cause stochastic health effects (e.g., cancer). The product of the absorbed dose in tissue (DT) and the quality factor (Q), and all other necessary modifying factors at the location of interest where  $HT = DT * Q$ . The units of dose equivalent are the rem

and Sievert (Sv). ( $0.01 \text{ Sv} = 1 \text{ rem}$ ). The dose equivalent in Sv is equal to the absorbed dose in gray multiplied by the Q;  $1 \text{ Sv} = 100 \text{ rem}$ . Its purpose is to have a single unit, regardless of the type of radiation, describing the biological effect due to exposure to radiation on man.

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

**Electron Volt (eV)**—A unit of energy equal to approximately  $1.6\text{E}-19$  joule.

**Equivalent Dose**—A quantity used for radiation protection to indicate the biological effectiveness of different radiations to cause stochastic health effects (e.g., cancer). The equivalent dose equals the absorbed dose multiplied by a radiation weighting factor,  $w_R$ . Expressed in units of Sievert (Sv) or rem.

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

**Gray (Gy)**—The SI unit of any absorbed dose. One gray is equal to the absorption of one joule per kilogram of material ( $1 \text{ Gy} = 100 \text{ rad}$ ).

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

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

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

**Intervention**—An activity that is not part of a controlled practice and is intended to reduce or mitigate sources of existing exposure (e.g., radon in structures); actions that save life or limb or mitigate threats greater than that posed by radiation; or those that are done to achieve higher objectives, including those of national security.

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

**Investigation Level**—1) A dose equivalent value or radionuclide intake activity set by the installation RSO that requires further investigation when exceeded. A 10% default value is recommended for all dose types (e.g.,  $125 \text{ mrem}$  for whole body quarterly badges,  $375 \text{ mrem}$  for lens of eye quarterly badges,  $1250 \text{ mrem}$  for extremity quarterly badges,  $41 \text{ mrem}$  for pregnant women monthly badges), however, at the IRSO discretion, levels can be tailored to each using section's historical dosimetry data in order to promptly identify and correct adverse trends; (2) The CEDE from radioactive material ingested, inhaled, or otherwise taken into the human body or dose equivalent from an external radiation source to which the worker is occupationally exposed which justifies further investigation. 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.

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

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

**Mammography Physics**—A qualified expert must meet the education, training and experience in FDA's Mammography Quality Standards Act (MQSA), 10 CFR Part 900.

**Medical Event**—An event that meets the criteria in paragraph 4.13.1.

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

**Nuclear Medicine/Diagnostic Radiology**—A medical or health physicist may be considered a qualified expert when they have had modality specific training and performed three surveys for a particular type of equipment under the supervision of a board certified medical physicist or a medical physicist who meets all the education, training and experience necessary to complete all aspects of ACR or ABMP board certification.

**Occupational Dose**—The dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to radiation or to RAM from regulated and unregulated sources of radiation, whether in the possession of the licensee or other person. Occupational dose does not include dose received from background radiation; from any medical administration the individual has received; from exposure to patients administered RAM and released IAW applicable regulations; from voluntary participation in medical research programs; or as a member of the public.

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

**Practice**—Routine, controlled operations that produce radiation exposures as an unavoidable and unintentional aspect of the activity.

**Prescribed Dose**—(1) For brachytherapy, stereotactic radiosurgery, or other radiation therapy procedures involving radioactive material, the total dose as documented in the written directive; (2) For external beam radiotherapy, the total dose and dose per fraction as documented in the written directive.

**Public**—All persons who are not already considered occupationally exposed by a source or practice under consideration.

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

**Quality Factors and Dose Equivalent**—The probability of stochastic health effects (like cancer) is dependent not only on the absorbed dose, but also on the type of radiation causing the dose. This has been taken into account by weighting the absorbed dose at a point in tissue with a radiation weighting factor,  $w_T$ , for a given radiation. The radiation weighting factor in turn is based on the density of ionization along a track of the radiation as it traverses a tissue, referred to as its linear energy transfer or LET. The weighted absorbed dose under this system is called the dose equivalent,  $H$ , and expressed in units of rem. The dose equivalent is the dosimetric quantity used in Title 10, Code of Federal Regulations, Part 20, for the purposes of radiation protection from RAM. For the purposes of individual monitoring using personnel dosimetry, three specific quantities of dose equivalent are used:

**Deep Dose Equivalent (HD)**—Dose assigned to personnel from external whole-body exposure, it is the dose equivalent at a tissue depth of one cm (1000 mg/cm<sup>2</sup>) which is expressed in units of rem or Sievert (Sv). It is the primary dose reported in the AF personnel dosimetry program. The deep dose equivalent is derived from the more general Individual Dose Equivalent, Penetrating,  $H_p(d)$ . This is defined as the dose equivalent in soft tissue at a depth,  $d$ , in the body that is appropriate for penetrating radiations.

**Shallow Dose Equivalent (HS)**—Dose equivalent measured 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>. This is otherwise referred to as the shallow or skin dose in the AF personnel dosimetry program. The shallow dose equivalent is derived from the Individual Dose Equivalent, Superficial,  $H_s(d)$ . This is defined as the dose equivalent in soft tissue at a depth,  $d$ , in the body where  $d = 10$  mm for strongly penetrating radiation, and  $d = 7$  mm for weakly penetrating radiation.

**Lens Dose Equivalent (HE)**—Dose equivalent to the lens of the eye from external irradiation. It is measured at an eye lens tissue depth of 0.3 cm (300 mg/cm<sup>2</sup>).

**Radiation Quality Factors and Equivalent Dose**—The most recent paradigm in radiation protection emphasizes the absorbed dose averaged over a tissue or organ (as opposed to a point) and weighted for the radiation quality. The weighting factor for this purpose is currently called the radiation quality factor ( $Q$ ) and is selected for the type and energy of the radiation incident on the body or, in the cases of sources within the body, emitted by the source. The absorbed dose in a tissue, multiplied by the radiation weighting factors is called the equivalent dose,  $HT$ . This can be expressed as:  $HT = \text{SUM}(QR*DT,R)$

where  $DT,R$  is the absorbed dose averaged over the tissue or organ  $T$ , due to radiation  $R$ . The unit of equivalent dose is the joule per kilogram, with the special name Sievert (Sv).

The radiation weighting factor,  $w_R$ , for a given type and energy of radiation is representative of the relative biological effectiveness (RBE) of that radiation to inducing stochastic health effects at low doses.

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

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

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

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

**Radiation Safety Committee**—An advisory committee for the commander to assess the adequacy of an organization's radiation safety program. Radiation control committee and radiation protection committee are synonyms.

**Radiation Safety Officer**—The person that the commander designates, in writing, as the person responsible for the installation, organization or unit radiation safety program. It is the same as a radiation protection officer or health physics officer. (Reference Attachment 2)

**Radiation Safety Program**—A program to implement the objectives of radiation safety regulations directives and instructions.

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

**Radiation Therapy**—A medical physicist must be supervised by a board certified radiation therapy physicist until all education, training and experience necessary to complete board certification is met.

**Radiation Worker**—An individual who may be occupationally exposed in the course of their duties or designated by the IRSO.

**Radio-bioassay**—See bioassay.

**Reference Levels**—A dose established at one-quarter the applicable annual dose limit, for monitoring performed on a quarterly basis, and one-tenth the applicable annual dose limit for monitoring performed on a monthly basis.

**Rem**—The conventional unit of any of the quantities expressed as dose equivalent. The dose equivalent in rem is equal to the absorbed dose in rad multiplied by a radiation quality factor, Q.

**Repeats (or retakes)**—are those images that had to be obtained a second time due to error (dark, light, motion, processor, etc.) thus resulting in a repeated exposure to the patient.

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

**Risk**—Chance of hazard or bad consequences; exposure of chance of injury or loss. Risk level is expressed in terms of hazard probability and severity.

**Risk Assessment**—The identification and assessment of hazards (first two steps of the risk management process).

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

**Senior Health Physicist/BEE**—With readiness experience (i.e., a current or former member of AFRAT or BE NBC unit type codes) can be considered a qualified expert for purposes of accident/incident response and/or consequence management involving radiological and nuclear materials.

**Shallow or Skin Dose Equivalent**—The external exposure of the skin or an extremity, taken as the dose equivalent at a tissue depth of 0.007 cm (7 mg/cm<sup>2</sup> – the average depth of the germinal cell layer) averaged over an area of 1 cm<sup>2</sup> usually expressed in units of rem or Sievert (Sv).

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

**Stochastic Effects**—Health effects that occur randomly and for which the probability of the effect occurring, rather than its severity, is assumed to be a linear function of dose without threshold. Hereditary effects and cancer incidence are examples of stochastic effects.

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

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

**Tissue Weighting Factors and Effective Dose**—The relation between the probability of stochastic effects and equivalent dose also depends on the organ or tissue irradiated. The effective dose is used to express the probability of occurrence of cancer and hereditary effects whether the dose is received by the whole body via uniform irradiation or by partial body or individual organ irradiation. The factor by which the equivalent dose in tissue or organ T is weighted is called the tissue weighting factor,  $w_T$ , and represents the relative contribution of that organ or tissue to the total detriment due to cancer and hereditary effects resulting from uniform irradiation of the whole body. The weighted equivalent dose is given the name effective dose equivalent, or more simply, the effective dose, E, and again has units of joule per kilogram with the special name Sievert (Sv). The effective dose is the sum of the weighted equivalent doses for all irradiated tissues or organs.  $E = \text{SUM}(w_T \cdot HT)$  where HT is the equivalent dose in tissue or organ T and  $w_T$  is the weighting factor for tissue T. Tissue weighting factors are given in the

following table. So that a uniform whole body equivalent dose results in an effective dose that is numerically the same, the sum of the tissue weighting factors is one.

**Total Effective Dose**—This is the sum of the deep dose equivalent,  $H_d$ , and committed effective dose,  $E(50)$ . Limits on occupational and public radiation dose apply to the sum of relevant doses from external exposure deep-dose equivalent in a year and the 50 year committed effective dose from intakes in the same year. The total effective dose can be expressed as:  $E_t = E(50) + H_d$

**Unrestricted Area**—An area, access to which is neither limited nor controlled (for the purposes of radiation safety).

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

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

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

**Weighting Factor (Radiation)**—A factor that accounts for differences in biological effectiveness between different radiations.

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

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

**Attachment 9 (Added): Procedures for the approval of non**—Dyess own RAM/RPDs on Dyess AFB (contractors and federal entities not assigned to Dyess AFB)

A9.1. Use of radioactive materials (RAM) and radiation producing devices (RPDs, e.g, x-ray units) by contractors and federal entities not assigned to Dyess AFB must be pre-approved by the IRSO to ensure safety to Dyess personnel and compliance with federal regulations. Contact the IRSO NLT 30 calendar days prior to the start of operations; sooner is best.

A9.2. For Radioactive Materials:

A9.2.1. Licensed Materials (by Federal or State) submit the following:

A9.2.1. Copies of licenses, which should not expire during the contract project period

- A9.2.2. For state licensed materials, submit NRC Form 241, *Work in Federal Jurisdiction*
- A9.2.3. Statement of Work, describing the radiation activity tasks within the contract
- A9.2.4. List of personnel to conduct radiation activities, proof of training / certification
- A9.2.5. Methods of transportation, storage, security; vehicle make/model and plate number
- A9.2.6. Copy of survey equipment calibrations, if required to use during RAM utilization
- A9.2.7. Depending on the requirements of the license, more documentation may be required
- A9.3. Generally Licensed Devices, submit the following:
  - A9.3.1. Copy of GLD documentation, and results of most recent wipe samples/leak tests
  - A9.3.2. Statement of Work, describing the radiation activity tasks within the contract
  - A9.3.3. List of personnel to conduct radiation activities, proof of training / certification
  - A9.3.4. Copy of survey equipment calibrations, if required to use during RAM utilization
  - A9.3.5. Methods of transportation, storage, security; vehicle make/model and plate number
- A9.4. For Radiation Producing Devices for both non-medical and medical devices:
  - A9.4.1. Specifications of device to include power, current, degrees divergence, pulse times
  - A9.4.2. Copy of device calibrations. Copy of survey equipment calibrations.
  - A9.4.3. Statement of Work, describing the radiation activity tasks within the contract
  - A9.4.4. List of personnel to conduct radiation activities, proof of training / certification
  - A9.4.5. Methods of transportation, storage, security; vehicle make/model and plate number.

**Attachment 10 (Added)****APPOINTMENT OF THE INSTALLATION RADIATION SAFETY OFFICER****Figure A10.1. Installation Radiation Safety Officer Appointment Letter**

To All Unit Commanders

1. In accordance with AFI 48-148, Ionizing Radiation Protection Program, and AFI 40-201, Radioactive Materials Management, I appoint the following personnel to the roles of the Installation Radiation Safety Officer (IRSO) for Dyess AFB. The IRSO is charged with the Radiation Safety Program as detailed in Dyess Supplement 48-148 and parent instructions available on the e-publishing website.

Primary IRSO: Rank First Name Last Name, Contact Number, Office Symbol

Alternate IRSO: Rank First Name Last Name, Contact Number, Office Symbol

2. The IRSO has authority to suspend operations involving radioactive materials or radiation producing devices that pose a significant health risk to personnel, present a clear violation of regulations or requirements, or present a high risk of negative impact to USAF operations, materiel, or real estate. The IRSO shall be granted access to areas where radiation activities occur, and where radioactive materials and devices are stored.

3. Attached you will find the mandatory briefing to Unit Commanders. Direct all questions to the appointed IRSO.

DAVID M. BENSON, Col, USAF  
Commander, 7th Bomb Wing

Attached: Briefing to Unit Commanders

cc:

7 AMDS/SGPB (IRSO)

7 BW/SE

**Figure A10.2. Briefing to Unit Commanders**

## Briefing to Unit Commanders

Radioactive materials (RAM) that are byproducts of the nuclear process are used in many industrial and military applications. Unlike radiation producing devices (RPDs), RAM do not need a power source, and a bullet-sized piece can emit radiation hundreds of feet in any direction. Radiation energy from RAM and RPDs are invisible and typically undetectable by other human senses. Leadership should be aware that RAM and RPDs are present on Dyess AFB. The main threat of mishaps involving overexposure to radiation on Dyess AFB is the reduction of the quality of health/life of personnel, children, and fetuses.

On Dyess AFB, we have several RAM that are inventoried and tracked per regulations. They are located on aircraft -- both in operation and on museum display, detection devices used for maintenance and installation security, and in sealed sources used for equipment calibration. RPDs are used in medical, inspection, response, and security operations on the installation. RAM disposal and transfer must be coordinated through the IRSO. All contracts utilizing RAM/RPDs must be reviewed by the IRSO. The IRSO ensures that emergency responders are aware of these temporary sources of radiation. For your awareness, an inventory of Dyess-owned RAM/RPDs is below.

[The installation inventory will be inserted here for commanders' awareness.]

All units shall remain compliant with applicable Federal policy relating to RAM as found within 10 CFR Chapter I, Title 29 of the Code of Federal Regulations (29 CFR) Chapter XVII *Occupational Safety and Health Administration, Department of Labor*, 40 CFR Chapter I, 49 CFR Chapter I, DTR 4500.9-R-Part II Chapters 204 and 208, AFJI 23-504, AFJMAN 23-209, AFMAN 24-204, AFMAN 24-210, and *IATA Dangerous Goods Regulation* with respect to this Supplement.

Federal authority for compliance with radiation safety is drawn from Title 29 of the United States Code (29 U.S.C.), Chapter 15, *Occupational Safety and Health*; 42 U.S.C. Chapter 23, Chapter 82, *Solid Waste Disposal*, Chapter 85, *Air Pollution Prevention and Control*, Chapter 103, *Comprehensive Environmental Response, Compensation, and Liability*, and Chapter 116, *Emergency Planning and Community Right-to-Know*; and, 49 U.S.C. Chapter 51.

Commanders will be given a Radiation Safety Program Management Review briefing annually at the ESOH Council.

## Attachment 11 (Added)

## INVESTIGATION ACTION LEVELS

**A11.1.** The IRSO has set the investigation action level (IAL) for Dyess AFB at 10% of the federal dose limits for radiation. The IRSO investigates radiation dosage at or above the IAL based on the dosimetry reports received. The IRSO may increase or decrease the IAL for a specific workplace based on trend analysis.

Table A11.1. - Investigation Action Levels

Monitoring Period (separated into population)	Federal Dose Limits (REM)	IAL (10% of Federal) (REM)
Pregnant Workers		
- Gestation Period, from report date	0.500	0.050
- Monthly	0.050	0.005
Workers, below 18 years of age		
- Quarterly	0.125	0.0125
- Annual	0.500	0.050
- Extremities, Quarterly (if applicable)	5.00	0.500
- Extremities, Annual (if applicable)	1.25	0.125
Workers, 18 or older		
- Quarterly	1.25	0.125
- Annual	5.00	0.500
- Extremities, Quarterly (if applicable)	50.00	5.00
- Extremities, Annual (if applicable)	12.50	1.25
Public (including all non-radiation workers)		
- Annual	0.100	N/A

A11.1.1. For public exposures, dosimetry reports are typically not received unless a special investigation is conducted. The IRSO may also perform calculations to estimate a public area's exposure.