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1.0 PURPOSE OF STANDARD

This document serves as the written procedure for the Center's Radiation Protection Program per NPR 1800.2, Chapter 4:13.2.4 requirement.

2.0 SCOPE, APPLICABILITY, & WAIVER

Scope: This standard applies to the Ionizing Radiation Safety Program at Dryden Flight Research Center (DFRC). It describes the DFRC Ionizing Radiation Safety Program including policies, organizations, procedures, and standards for the procurement, use, and the handling of radioactive materials and/or ionizing radiation producing machines and devices. The DFRC Ionizing Radiation Safety Program addressed in this document includes radioactive sources and materials covered by the United States Nuclear Regulatory Commission (NRC) for both specific and general licenses as they pertain to radiation producing sources and equipment to protect human exposure to levels that are as low as reasonably achievable (ALARA).

Applicability: This procedure applies to any NASA, on-site contract employee, and visitor who works in or visits areas with machinery, equipment, and/or material that has or produces any ionizing radiation source of energy, when there is potential for exposure to this radiation. It also applies to grant recipients and other partners to the extent specified in their contracts or agreements. In those contracts or agreements in which this procedure is not specifically required, it is strongly recommended.

Waiver/Deviation: Requests for waivers and variances to DFRC specific safety documents shall be made to the Chief of the Safety, Health, and Environmental Branch. Requests for waivers and variances to NASA safety instructions shall be made to NASA HQ in accordance with instructions provided by NASA-STD-8709.20, Management of Safety and Mission Assurance Technical Authority Requirements. All requests for waivers and variances to safety instructions, including those to other regulatory agencies, shall be submitted to the Chief of the Health and Environmental Office for review and feedback and forwarded to the Director of Safety and Mission Assurance for final approval.

3.0 RESPONSIBILITIES

NASA Procedural Requirement NPR 1800.1 4.13.1.1 states that "*NASA Centers shall maintain and preserve the health of the NASA workforce by minimizing occupational exposures, eliminating unnecessary exposures, and reducing the potential for accidental exposures to ionizing and non-ionizing (laser, radio frequency, and non-laser optical) radiation.*" Compliance is mandatory. NASA Centers shall achieve these objectives by following all requirements within NPR 1800.1, Chapter 4.13 – Radiation Program, 4.14 - Radioactive Materials, 4.15 – Radiation- Generating Equipment; and all

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regulations and laws stipulated with Code of Federal Regulations (CFR) 10 of the US Nuclear Regulatory Commission. All entities herein responsible in any way or form shall comply with all requirements stipulated within the above-mentioned documents. Authorization for possession and use of ionizing radiation devices and/or materials may be rescinded at time as a result of noncompliance with any of the provisions within these documents or any other regulatory requirement.

3.1 Chief, Office of Safety & Mission Assurance

The Chief, Office of Safety and Mission Assurance, is the official charged with the responsibility for safety programs at DFRC and will:

- A. Ensure a continuing surveillance of operations utilizing sources of ionizing radiation.
- B. Ensure adequate procedures are in place to provide adequate protection to DFRC personnel, contractors, visiting scientists, the public, and the environment from sources of ionizing radiation controlled by DFRC to ensure that all applicable employees/visitors are not injured by the misuse or malfunction for any radiation equipment/material at DFRC.

3.2 Directorates & Single Letter Offices

Directorates and single letter offices are responsible for reviewing and approving the need for and use of ionizing emitting equipment or machinery within their jurisdiction. The directorates and single letter offices will ensure the following prior to initiation of activity with radiation source:

- A. A Radiation Project Safety Plan is developed and submitted to the S&MA/SHE office for review and approval. See [D-WK 210-8](#), Radiation Project Request.
- B. Form [D-WK 211-8](#), Radiation Project Authorization, has been reviewed and signed by the Center's Radiation Safety Officer (RSO), the user of the radiation source and the Branch Chief for Safety, Health, and Environmental Branch.
- C. Form [D-WK 212-8](#), Application for Radioisotope Procurement, has been reviewed and signed by RSO.

3.3 Safety, Health, & Environmental Office

The Chief of the Safety, Health, and Environmental Branch, within the Office of Safety and Mission Assurance, is responsible for oversight of the Radiation Safety Program and will:

- A. Establish and maintain policies for the safe control of ionizing radiation hazards in conformance with applicable regulations and technical guidelines.
- B. Advise management on matters concerning ionizing radiation safety.
- C. Investigate ionizing radiation accidents and report findings to management and appropriate regulatory agencies.
- D. Appoint the RSO.

3.4 Radiation Safety Officer (RSO)

The RSO is appointed by the Chief, Safety, Health, and Environmental Branch, and functions as a link between the user and the Chief, Safety, Health, and Environmental Branch, and the Nuclear Regulatory Commission (NRC) in matters of radiation safety. The RSO has the authority to stop ionizing radiation operations if he/she determines the operation is unsafe. In the absence of the RSO, the Chief, Safety, Health, and Environmental Branch, will delegate an alternate. The RSO is responsible for the planning, design, and implementation of the Ionizing Radiation Program in compliance with the NRC policy and procedures based on the license the Center has been granted. The RSO shall:

3.4.1 NRC License

- A. Ensure that licensed material possessed by DFRC is limited to the types and quantities of by-product material specified on the license.
- B. Ensure that all radioactive materials brought onto a DFRC site are authorized by the NRC or licensed under an NRC's agreement statute for by-product materials. The user must be authorized to work at the DFRC site either by direct employment with NASA, under a contract, or any other valid reciprocity agreement.
- C. Ensure that sealed sources are tested for leakage every six (6) months.
- D. Ensure security of radioactive material.
- E. Act as liaison with NRC and other regulatory authorities.
- F. Maintain licenses issued by the U.S. Nuclear Regulatory Commission (USNRC) or the State of California that are required for possession/use of licensable quantities / concentrations of radioactive materials on DFRC premises. In some cases, reciprocal recognition of other Agreement State licenses or specific registrations may be approved for possession/use of radiation sources authorized by such licenses

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or by the State. Copies of all such licenses, pertinent supportive documentation, and reciprocity authorizations (if applicable) must be provided to the DFRC RSO.

3.4.2 Incoming/Outgoing/Transfer of Radioactive Material

- A. Ensure that licensed material is transported in accordance with applicable regulations (i.e., 10 CFR Part 71.5 and the Department of Transportation, DOT 49 CFR 172 Subpart H), Packaging and Transportation of Radioactive Material.
- B. Oversee proper delivery, receipt, and conduct of radiation surveys for all shipments of radioactive material arriving at or leaving DFRC, as well as packaging and labeling all radioactive material leaving DFRC.
- C. All radioactive containing materials will be secured by Logistics, and not released to the end user until the RSO has inspected the package.
- D. Any radioactive materials or radiation-producing devices improperly or illegally transported onto DFRC will be subject to impoundment until either the irregularities are corrected and appropriate DFRC authorizations are obtained or removal from DFRC is arranged.

3.4.3 Inventory

- A. Conduct a physical inventory every six (6) months to account for all sources.
- B. Ensure all users submit a copy of their inventory to the RSO every 6 months.
- C. Overall inventory control and administrative accountability of all sources of radiation on DFRC will be maintained by the DFRC RSO. Individual users and/or using organizations will ensure inventory control and accountability for their sources and will coordinate this effort with the DFRC RSO

3.4.4 Leak Testing

- A. Perform or arrange for leak tests on all sealed sources
- B. Leak test sealed sources, when required, prior to shipment.

3.4.5 Monitoring/Exposures

- A. Ensure that radiation exposures are as low as reasonably achievable (ALARA), which is NASA DFRC's requirement for all radiation safety programs.

- B. Provide the services and equipment for monitoring personnel exposures or dosages, such as dosimeters, film badge service, and for measuring ionizing radiation. Notify individuals and their supervisors of radiation exposures approaching the limits and recommend appropriate remedial action. Provide an Annual Occupational Dose Record using NRC form 5.
- C. Conduct inspections and surveys necessary to measure the performance of the Radiation Safety Program and report findings to the Chief, Safety, Health, and Environmental Branch.
- D. Oversee all activities involving radioactive material, including monitoring and surveying all areas in which radioactive material is used.
- E. Provide for the calibration of radiation survey instruments.

3.4.6 Training

- A. Conduct training programs and otherwise instruct personnel in the proper procedures for handling radioactive material prior to use, at periodic intervals (refresher training) and as required by changes in procedures, equipment, regulations, etc.
- B. Provide necessary information on all aspects of radiation protection to personnel at all levels of responsibility, pursuant to 10 CFR Parts 19 and 20, and any other applicable regulations.

3.4.7 Disposal

- A. Supervise and coordinate the disposal of radioactive waste.
- B. Supervise and coordinate a radioactive waste disposal program, to include monitoring and recordkeeping on waste storage and disposal records.

3.4.8 Accidents/Incidents

- A. Notify the Chief, Safety, Health, and Environmental Branch, in the event of an accident involving radioactive sources.
- B. Ensure that all incidents, accidents, and personnel exposure to radiation in excess of 10 CFR Part 20 limits are investigated and reported to NASA headquarters, NRC and other appropriate authorities within the required time limits.

3.4.9 Audits/Reviews

- A. Provide the Chief, Safety, Health, and Environmental Branch, with quarterly updates on the health of the Radiation Safety Program, including the annual review of this document for necessary revisions.

- B. Review ionizing radiation projects annually.
- C. Perform annual audits of the Radiation Safety Program to ensure that DFRC is complying with all applicable NRC regulations and the terms and conditions of the license.
- D. Ensure that the results of audits, identification of deficiencies, and recommendations for change are documented and provided to users and management for review.

3.4.10 Operations

Brief the Director of Flight Operations on the hazards of any radioactive sources aboard DFRC aircraft, including information to be relayed to the Edwards Fire Department or other emergency agency, in the event of a crash or landing emergency. (See National Fire Protection Association (NFPA) 801, Standard for Facilities Handling Radioactive Materials, B-2.5.)

3.4.11 United States Air Force (USAF)

- A. Serve as the point of contact with Air Force Test Center (AFTC) for ionizing radiation concerns.
- B. Ensure approval from the Bio Environmental Engineering (BEE) group at AFTC for all radioactive sources brought onto Edwards Air Force Base (EAFB) prior to these items being shipped, hand carried, or flown to the base (661/277-3272).
- C. Ensure specific approval by the BEE group at AFTC for all projects prior to operation.
- D. Notify the AFTC fire chief annually of all radioactive materials present on the site.

3.4.12 Documentation

- A. Maintain a record of exposure levels on each person working with ionization radiation.
- B. Maintain up-to-date copies of NRC regulations, the license, and procedures, and ensure that the license is amended whenever there are changes in licensed activities, responsible individuals, or information or commitments provided to NRC during the licensing process.

3.4.13 Review & Approval

- A. Review and approve [D-WK 210-8](#), Radiation Project Request, before the radiation project is put into operation.

- B. Issue a Radiation Project Authorization, form [D-WK 211-8](#), to authorized users (AU) for his/her acceptance and the acceptance of the branch chief, upon approval.
- C. Review and approve form [D-WK 212-8](#), Application for Radioisotope Procurement, upon receipt.
- D. Review and make approval decision on qualifications of AU, form [D-WK 213-8](#), Radiation Experience Record.
- E. Review [D-WK 214-8](#), Receipt of Radiation Regulations, when received from the AU.
- F. Ensure form [D-WK 215-8](#), Radioisotope Inventory Record, is submitted by AU semi-annually and review.
- G. Issue form [D-WK 216-8](#), Radiation Work Permit, as necessary for ionizing radiation projects involving other than sealed sources.
- H. Approve x-ray generating equipment operators.
- I. Review and approve requests for field radiography.
- J. Review and approve of training curriculum.

3.5 Authorized User (AU)

The Authorized User (AU) is personally responsible for compliance with DFRC and government regulations as they pertain to authorized use of radioisotopes or radiation. All AUs shall be identified on form [D-WK 211-8](#). Specific responsibilities include:

- A. Prepare a standard operating procedure (SOP) specifying the manner of handling, use, storage, emergency procedures, and eventual disposition of the ionizing source. In general, the SOP will describe the actions the AU plans to take to meet the requirements of this DST. The SOP must be reviewed and approved by the RSO prior to beginning the project. Information provided by the SOP will be used to determine if the project falls under NRC licensing requirements.
- B. Implement the measures in the SOP and other requirements prescribed by the RSO as indicated in [D-WK 211-8](#).
- C. Submit [D-WK 213-8](#), Radiation Experience Record, to the RSO upon submittal of a project request.
- D. Comply with the provisions of [D-WK 214-8](#), Receipt of Radiation Regulations, and submit this form to the RSO.
- E. Complete a semi-annual radioisotope inventory using [D-WK 215-8](#), Radioisotope Inventory Record. A copy of the inventory will be sent to the RSO upon completion.

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- F. Comply with the provisions of D-WK 216-8, Radiation Work Permit, if issued.
- G. Responsibility for the custody of any radioactive material acquired and for the proper accountability, storage, labeling, use, inventory, posting of work and storage areas, and disposal. Records of these transactions must be maintained by the AU with copies provided to the RSO.
- H. Ensure the appropriate signage is posted for each area or room in which there is used or stored an amount of licensed material; "CAUTION, RADIOACTIVE MATERIAL(S)" or "DANGER, RADIOACTIVE MATERIAL(S)". Additional or more restrictive posting requirements may be mandated as deemed necessary or prudent by the Radiation Safety Officer
- I. Ensure employees working for the AU have met the training requirements for working with/near radioactive materials or radiation producing equipments.

3.6 Off-site Contractors & Experimenters

- A. Off-site contractors and experimenters are required to provide documented verification that any radioactive material they intend to bring onto a DFRC site is authorized on a current NRC or a valid state license. (A valid license will require having a valid reciprocity agreement with the NRC for the possession and use of that radioactive material at DFRC or within any of the DFRC platforms).
- B. Off-Site Contractors – The contracting officer (CO) or the contracting officer's representative (COR) will ensure off-site contractors conform to this document and supporting documentation.
- C. Experimenters – Experimenters who use radioactive sources at DFRC will conform to the provisions of this document. Experimenters will provide a written SOP for each experiment to the RSO for approval prior to the ionizing source being brought onsite and prior to the use of the source at DFRC or within any of the DFRC platforms.

4.0 AUTHORIZED USER APPLICATION

- A. The prospective AU is required to submit the following DFRC forms or equivalent:
 - 1) Form [D-WK 210-8](#), Radiation Project Request – This form alerts the RSO that a radiation program is coming on line. The RSO reviews and approves D-WK 210-8. This form is to be accompanied by the following:
 - a) A SOP for the project, which must include all the radiation safety procedures to be used, including self-monitoring.

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- b) A risk assessment for the project.
 - c) Form [D-WK 213-8](#), Radiation Experience Record, for the AU and each worker.
 - d) Form [D-WK 214-8](#), Receipt of Radiation Regulations.
- B. Form [D-WK 211-8](#), Radiation Project Authorization, is generated by the RSO giving authorization for the project to the AU or project manager. The RSO specifies any additional approval requirements that need to be addressed. This may include requesting an amendment to the NRC license as a result of requesting radioactive isotopes that are not currently on the license or requesting quantities in excess of the existing NRC license limits. The NRC amendment can take 6 to 12 months.
- C. The radiation project authorization form must be accepted and signed by both the AU and the branch chief. A completed and signed copy will be maintained by the RSO and the AU.

5.0 ACQUISITION, RECEIPT, STORAGE, INVENTORY, DISPOSAL, TRANSFER, & SHIPMENT OF RADIOISOTOPES / RADIOACTIVE MATERIAL OR RADIATION PRODUCING EQUIPMENT

The acquisition, receipt, use, inventory, storage, transportation, and disposal of any radioactive material or radioactive emitting equipment for use by DFRC shall conform to all NPR 1800.1 requirements, CFR 10 NRC regulations, State of CA regulation on radioactive materials, the equipment/material manufacturer and Materials License conditions.

5.1 Acquisition

Purchase requests for radioisotopes will be originated by the AU and must be accompanied by a [D-WK 212-8](#), Application for Radioisotope Procurement. A copy of form [D-WK 211-8](#) signed by the RSO must also accompany the purchase request. The RSO or designee will approve the request upon review. Once the form is signed by the RSO, the AU can procure the material. The procurement order will need to be accompanied by a copy of the NRC license.

6.0 RECEIVING

Incoming radioactive shipments will be handled expeditiously by Logistics. Notify the RSO immediately upon receipt of any package labeled, in accordance with DOT requirements, as containing radioactive material. The package is to be placed in a secure location until the RSO picks it up. The RSO will take action to ensure that the package's external surfaces are monitored to verify that removable contamination levels

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are less than 2200 dpm/100cm² beta/gamma and 220 dpm/100cm² alpha, if applicable, (see 10 CFR 71.87) and that external radiation levels are as indicated on the shipping papers and label (see 10 CFR 71.47). The monitoring will be performed as soon as practicable after receipt, but not later than three (3) hours after the package is received at DFRC during normal working hours and not later than three (3) hours from the beginning of the next work day if it is received after working hours.

- A. If a package containing radioactive material, even if unlabeled, shows evidence of being crushed, wet, or damaged; precautions must be taken to ensure any potential removable contamination is contained, and it will be surveyed promptly in accordance with the preceding instructions. The shipping company and shipper will be notified of the package condition and potential for contamination.
- B. Packages of limited quantities of radioactive materials and excepted articles (49 CFR § 173.421-428) do not require receipt survey as described in the preceding instructions (A & B above) if they are undamaged and do not require labeling in accordance with DOT requirements.
- C. The RSO will immediately notify the final delivery carrier and the NRC Regional Office if removable contamination levels on the package exceed the above limits or if external radiation levels exceed those specified in 10 CFR § 71.47 or significantly exceed the levels indicated on the shipping papers

Packages producing external dose rates between 5 and 100 mrem/h at 12 inches will be stored only in a "caution" posted radiation area. Packages producing external dose rates of 100 mrem/h or greater immediately will be placed in a "danger" posted and locked high radiation area.
- D. After the receipt survey is complete, the package may be transferred to the AU and moved to an appropriately posted and controlled storage or work area.

7.0 STORAGE & INVENTORY OF RADIOACTIVE MATERIAL

- A. Radioactive material is to be stored in appropriately posted and controlled rooms, lockers, or cabinets in accordance with the requirements of 10 CFR 20, subpart I and J.
- B. In conjunction with the semi-annual radioisotope inventory, the AU will survey the sealed sources or request a survey from the RSO.

8.0 DISPOSAL OF RADIOISOTOPES

- A. If licensed radioactive material no longer has any potential future programmatic use or if it is considered radioactive waste, it may only be disposed of by transfer to an authorized user, return to the manufacturer, or transfer to a waste disposal facility.

- B. If waste disposal becomes necessary, specific waste handling, preparation, packaging, and shipment procedures must be developed and implemented in accordance with the requirements of 10 CFR 20, Subpart K, and the guidance of NUREG-1556, vol. 7, Appendix K.

9.0 TRANSFER & SHIPMENT

- A. Shipments to the Center – Prior to arranging for radioactive material transfer to DFRC, the AU will contact the RSO to ensure requirements have been met. Use [D-WK 212-8](#), Application for Radioisotope Procurement, to meet this requirement. See Section 5.2, Receiving, above.
- B. Transfer within the Center – Radioactive materials may not be transferred from one person or project to another without the approval of the RSO. Radionuclides must be packed so they do not present a hazard to employees or the environment and be moved under the direction of the RSO.
- C. Shipment from the Center – Shipments of radioactive materials from the Center must be approved by the RSO. This requirement applies to all methods of removal including mailing, hand carrying, or flown out. Packaging, monitoring and labeling of radioactive materials must be performed under the direct supervision of the RSO or designee and must comply with Department of Transportation regulations contained in 49 CFR. Shipments must be made through the DFRC shipping Logistics contractor unless otherwise coordinated with the RSO.

10.0 SAFETY PRECAUTIONS

All safety precautions shall be followed according to NPR 1800.1 requirements, CFR 10 NRC regulations, and the State of CA regulation on radioactive materials.

10.1 General

Only authorized and trained personnel will be permitted to use radioisotopes or radiation generating devices. Such persons must have read and understand required radiation regulations and signed [D-WK 214-8](#), Receipt of Radiation Regulations.

10.2 Dosimetry

- A. All persons working with sources of radiation who are likely to receive in 1 year a dose in excess of 10 percent of the limits of 10 CFR § 20.1201 will participate in a dosimetry program as determined by the RSO. The badges are to be processed quarterly and the results made available to the user. The RSO will investigate all cases of exposures in excess of one-third of the permissible annual limits.

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- B. Personnel who are occupationally exposed to radiation producing equipment or radioactive materials will have their exposures monitored in accordance with the requirements of 20 CFR, subpart F, to verify compliance with the occupational dose limits of subpart C. At present, the use of sealed sources is not sufficient to require individual monitoring. No detectable external radiation exposure is expected to result from their use. If occupational radiation exposure from byproduct radioactive materials becomes possible in the future, a dosimetry program in support of that activity will be instituted.
- C. The RSO must be notified immediately if any radiation exposure occurs or is suspected to be above one-third of permissible annual limits. The film badge of the individual concerned must be processed and evaluated at once.

10.3 Posting & Labeling

- A. Areas containing radioactive materials or radiation hazards will be posted in accordance with the requirements of 10 CFR 20, subpart J.
- B. Establish restricted area(s) outside of which no person can receive a dose equivalent of 2 mrem in any one hour or 100 mrem in any one year.
- C. Containers of radioactive material will be labeled in accordance with the requirements of 10 CFR 20 § 1904 and 1905.
- D. Current NRC Form 3, Notice to Employees, shall be posted for all employees who may or are expected to be exposed to radioactive materials or radiation producing equipment. A notice shall be posted with the RSO information.

10.4 Emergencies

All real or suspected incidents, accidents or emergencies involving sources of ionizing radiation shall be immediately reported to the DFRC RSO, the Chief of Safety, Health and Environmental Branch.

- A. Accidents Inside Buildings – In emergencies involving radioactive materials caused by plant operations, (explosives, accidental release of materials, etc.) or by external forces (earthquake, storm, etc.), the following general procedures apply:
 - 1) The RSO and the Chief, Safety, Health, and Environmental Branch, must be notified of the emergency immediately. If the situation dictates, use the emergency 911 telephone emergency notification system.

- 2) The affected area must be surveyed by the RSO or an individual specified as a qualified person as soon as possible to assess any radiological hazard.
- B. Transportation Accidents – In the event of an accident or emergency that results in damage to a radioactive source while such materials are being transported on-site, the person discovering or reporting the accident must :
- 1) Immediately notify the RSO and the Chief, Safety, Health, and Environmental Branch. If the situation dictates, use the emergency 911 telephone emergency notification system.
 - 2) Remain at the scene in a safe area as the responsible person until relieved.

The authorized person(s) will assist in making an initial assessment of potential hazards.

11.0 SURVEILLANCE & REVIEW

RSO shall comply with 10 CFR 20 for ensuring proper surveys, leak tests, and record reviews.

11.1 Surveys

The RSO will make, or cause to be made, such surveys as may be necessary to comply with 10 CFR 20, and to evaluate the extent of radiation levels; concentrations or quantities of radioactive material; and the potential radiological hazards that may be present.

11.2 Sealed Source Leak Testing

Sealed sources must be tested for leakage or external contamination under the supervision of the RSO at intervals specified in the NRC license under which they are possessed. If any leak test reveals the presence of more than 0.005 microCuries of contamination, the sources must be repaired, removed from use and decontaminated or disposed of. A report must be filed with the NRC.

11.3 Record Reviews

- A. Annual Records Review – In addition to the records listed below the RSO will maintain and review records of orders, receipts, inventories, transfers, and disposal of radioactive material annually. These records are in addition to those required to be kept by each AU:
- 1) Record of leak tests of all sealed sources

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- 2) Reports of periodic radiation surveys
- B. Annual Program Review – The RSO will conduct an annual audit of the radiation safety program and the activities of each AU to ensure that DFRC
- Complies with all NRC regulations and the terms and conditions of the license,
 - Maintains required records.
 - Effectively implements the DFRC radiation safety program ensuring that all occupational doses incurred within DFRC are ALARA.

12.0 X-RAY GENERATING EQUIPMENT & OTHER RADIATION MACHINES

12.1 Approval Requirements

The use of x-ray generating equipment is not subject to NRC control, but may require permits and licensing from the California Department of Public Health. Ionizing radiation produced by x-ray or other radiation equipments can be a hazard to Dryden personnel and therefore the Center Director has an obligation to ensure the safe uses of these equipments. The RSO approves and oversees all uses of ionizing radiation at DFRC and reserves the right to approve the operators of these units. The Authorized User (AU) and each prospective operator must complete with all radiation safety training for x-ray machine use as described by the manufacturer and follow all guidelines for radiation project approval.

12.2 Types of X-Ray Machines

- A. Analytical X-Ray Machines – This type of x-ray machine is used to examine the chemical or physical structure of a material by diffraction of an x-ray beam or fluorescence from the material and use energies generally less than 100 keV. Specific requirements for analytical x-rays may be found in ANSI N43.2, Radiation Safety for X-Ray Diffraction and Fluorescence Analysis Equipment.
- B. Radiography X-Ray Machines – Used for inspection by producing images on photographic film. This type of x-ray may also be used to deliver radiation dose to a biological or material specimen. When the power level is over 1 MeV the machine is considered an accelerator and must be treated as such.
- C. Cabinet X-Ray System – Used primarily for inspection of packages to determine the contents without opening. This type of x-ray machine

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has a highly focused x-ray beam and is contained inside a cabinet that has leaded curtains.

13.0 FIELD RADIOGRAPHY

The RSO will ensure that field radiography is accomplished in compliance with the following:

- A. The RSO must be notified one month prior to any field radiography. This time is required to evaluate and approve the operation as well as to ensure proper notification of DFRC personnel of any restrictions resulting from the operation as well as to obtain approval from the USAF.
- B. The radiographer will have a current safety manual and radioactive material license on file with the RSO and if not on file, he/she must submit it with the request to perform radiography. If the radiographer does not possess NRC radioactive material license, reciprocity to work on a federal site will be required.
- C. The RSO will conduct safety audits of the radiography installation and monitoring procedures. The radiographers will assume primary responsibility in controlling personnel access and exposures to restricted radiographic areas.
- D. The RSO or designee has the authority to shut down a field operation if he or she believes the safety of the radiographer or ancillary people is in jeopardy.
- E. Based on the radioactive material being used, a barricade will be set up around the radiography operations and the area will be posted Radiation or High Radiation as required by the RSO.
- F. Radiography operations in close proximity to buildings require extreme caution.
- G. Radiography operations will only be performed after hours and buildings in close proximity will be evacuated.

14.0 RADIATION DOSE LIMITS

Compliance with all occupational radiation dose limits of 10 CFR 20, subpart C, shall be expected. A review of these radiation dose limits are:

- A. Persons working with ionizing radiation must not be exposed to radiation from any source, either internally or externally, that causes a dose level greater than 5.0 rem per calendar year. If a person is transferred from one radiation program to another, their cumulative exposures must be determined and recorded on their exposure history.
- B. The dose equivalent received by any organ or tissue during any calendar year from internal and external sources must not exceed 50 rem.
- C. The dose equivalent received by the lens of the eye must not exceed 15 rem.

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- D. Persons may receive larger doses than listed above if the requirements listed in 10 CFR 20 § 1206 are met.
- E. If exposure occurs due to an accident or deep dose exposure, the amount received must be subtracted from the annual limit.

Employees who believe they are pregnant or trying to get pregnant will have to declare their pregnancy to the Medical office and SHE office to monitor and enforce ALARA dose to embryo/fetus (see the Pregnant Workers section).

14.1 Occupational Dose Limits

Occupational Dose Limits for Adults are set forth in Title 10 Code of Federal Regulations 20.1201 unless otherwise stated.

- A. An annual limit of 5 rem (50 mSv) total effective dose equivalent (TEDE).
- B. A limit of 2 rem (20 mSv) TEDE per year averaged over 5 years (ICRP 103).
- C. An annual limit of 50 rem (0.50 Sv) to an individual organ or tissue other than the lens of the eye, as determined by the deep-dose equivalent and the committed dose equivalent.
- D. An annual limit of 15 rem (0.15 Sv) to the lens of the eye.
- E. An annual limit of 50 rem (0.50 Sv) to the skin.
- F. An annual limit of 50 rem (0.50 Sv) to each of the extremities.
- G. The dose equivalent to an embryo/fetus during the entire pregnancy, from occupational exposure of a declared pregnant woman, shall not exceed 500 mrem (5mSv). Effort shall be initiated to preclude substantial variation above a uniform monthly exposure rate to a declared pregnant woman that would satisfy the 500 mrem (5mSv) limit. These limits may be found in the NRC Regulatory Guide 8.36.

14.1.1 ALARA Goals

ALARA goals are set at 10% of the dose limits listed above.

- A. An ALARA goal of 500 mrem (5 mSv) TEDE.
- B. An ALARA goal of 200 mrem (2 mSv) TEDE per year averaged over 5 years (ICRP 103).
- C. An ALARA goal of 5 rem (50 mSv) to an individual organ or tissue other than the lens of the eye, as determined by the deep-dose equivalent and the committed dose equivalent.
- D. An ALARA goal of 1.5 rem (15 mSv) to the lens of the eye.

- E. An ALARA goal of 5 rem (50 mSv) to the skin.
- F. An ALARA goal of 5 rem (50 mSv) to each of the extremities.
- G. An ALARA goal of a dose equivalent to an embryo/fetus during the entire pregnancy, from occupational exposure of a declared pregnant woman not exceeding 50 mrem (0.5 mSv).

Effort shall be initiated to preclude substantial variation above a uniform monthly exposure rate to a declared pregnant woman that would satisfy the 50 mrem (0.5 mSv) goal.

14.2 Persons Under 18 Years of Age

At DFRC no personnel under the age of 18 shall be authorized to handle radioactive material or equipment or allowed access to the area where radiation-producing devices are located.

14.3 Pregnant Workers

10 CFR 20 §1208 limits the dose to an embryo/fetus during the entire pregnancy, due to occupational exposure of a declared pregnant woman, to 0.5 rem. The biological effects of ionizing radiation upon the embryo/fetus are summarized in NRC Regulatory Guide 8.13. A pregnant worker or a worker who could become pregnant should consider the information provided in the regulatory guide and the specific requirements of the regulations. If that worker elects to declare her pregnancy, DFRC will take action to control that worker's occupational exposure to ionizing radiation in accordance with the requirements of the regulation.

15.0 TRAINING & CERTIFICATION

15.1 General Radiation Training

General radiation training is offered to all personnel working in areas where radioactive materials are being used at DFRC. This training informs personnel that DFRC has a radioactive material license with the NRC and that radiation producing devices and other radioactive materials are being used on site. This general training details the hazards of the radiation sources, identifies the Notice to Employees, regulations and conditions of the license, this document, and the procedures in use. The training also identifies the locations where documents and postings can be found, instructs employees in the postings in use, labeling, and actions required of personnel with regard to postings and labeling.

15.2 Specific Radiation Training

15.2.1 Initial Radiation Training

- A. Authorized User (AU) Training – Personnel who work under the authority of a radiation project authorization or radiation work permit will receive training commensurate to the hazard involved. Training will include:
- 1) Review of regulations, standards, and guidelines that direct radiation programs.
 - 2) Structure of the radiation safety program.
 - 3) Review of safety requirements.
 - 4) Other items specific to current or proposed radiation operations at DFRC.
 - 5) Personnel required to have AU training are non-destructive inspection (NDI) technicians, x-ray machine operators, Niton (lead analyzer) operators, shipping and receiving personnel, and any personnel involved with specific projects requiring a [D-WK 210-8](#).
- B. Incidental Personnel Training – Personnel who work around radiation, but are not authorized users will receive training commensurate to the hazard involved. These individuals include personnel who perform leak testing. Personnel who collect dosimeter badges and prepare them for shipment have no potential for exposure in performing this task.
- C. Shipping and Receiving Personnel – Personnel involved in the shipping and receiving of hazardous materials including radioactive materials are required by the Department of Transportation to be trained in accordance with 49 CFR 172 § 704.

15.2.2 Refresher Training

- A. Authorized Users – Refresher training is required annually. This training covers update of regulations, standards, guidelines, and DFRC policies. NOTE: Persons who operate specialized radiation equipment should take advantage of the manufacturer's training programs whenever possible.
- B. Incidental Personnel – Refresher training is required annually. This training will be commensurate with the potential hazard of

the task being performed and will include any updates to the DFRC policy or the regulations.

- C. Shipping and Receiving Personnel – Refresher training is required every three (3) years. This training is clearly designated in the DOT regulations.
- D. Certificates of training – Certificates of training, or copies thereof, will be kept on file by the RSO for three (3) years following termination of the project.

16.0 MANDATORY REPORTS

Reports shall be made to the Nuclear Regulatory Commission in accordance with 10 CFR 20, Subpart M-Reports.

16.1 Immediate Notification

Notwithstanding any other requirements for notification, each licensee must immediately report any event involving byproduct, source, or special nuclear material possessed by the licensee that may have caused or threatens to cause any of the following conditions:

- A. An individual receiving
 - 1) A total effective dose equivalent of 25 rem (0.25 Sv) or more, or
 - 2) A lens dose equivalent of 75 rem (0.75 Sv) or more, or
 - 3) A shallow-dose equivalent to the skin or extremities of 250 rad (2.5 Gy) or more.
- B. The release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake five times the annual limit on intake. (The provisions of this paragraph do not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures.)
- C. A loss of 1 working week or more of the operation of any facilities affected.
- D. Damage to property in excess of \$200,000.

16.2 Twenty-Four Hour Notification

Within 24 hours of discovery of the event, each licensee will report any event involving loss of control of licensed material possessed by the licensee that may have caused, or threatens to cause, any of the following conditions:

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- A. An individual to receive, in a period of 24 hours:
 - 1) A total effective dose equivalent exceeding 5 rem (0.05 Sv); or
 - 2) A lens dose equivalent exceeding 15 rem (0.15 Sv); or
 - 3) A shallow-dose equivalent to the skin or extremities exceeding 50 rem (0.5 Sv).
- B. The release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake in excess of one occupational annual limit on intake. (The provisions of this paragraph do not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures.)
- C. A loss of 1 day or more of the operation of any facilities affected.
- D. Damage to property in excess of \$2,000.

16.3 Other Reportable Events

In addition to the immediate and 24-hour reports listed above, 30 day written reports are also required for each incident. There may be other reportable conditions. See 10 CFR 20 § 2203 for details.

17.0 MANAGEMENT RECORDS & RECORDS RETENTION

Destruction of any records, regardless of format, without an approved schedule is a violation of Federal law.

Records will be maintained in the office of the RSO according to the following schedule unless otherwise noted:

1. Radiation training records will be maintained In SATERN, as recorded in the Medical Office Records retention schedule.
2. Dosimeter records for employees and contractor personnel who may be exposed to radiation will be kept for 75 years.
3. Disposal of Radioactive Materials records will be kept for 75 years.
4. Radiation procurement, use, storage, and transfer records will be kept for 10 years after the permit is renewed or expired.
5. Copies of records and receipts such as approval requests and authorizations, procurement, inventories, surveys, calibrations, bioassay results, individual dose records, waste disposal, and any other records that pertain to the NRC license under

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which the Center is operating will be kept by the Radiation Safety Officer for 10 years.

6. Records that include, but may not be limited to, records of radiation exposure (NRC Form 4, Cumulative Occupational Dose History, and NRC Form 5, Occupational Dose Record for a Monitoring Period), records of surveys, records of individual monitoring results, inventories, and records of receipt, transfer, and disposal of radioactive materials will be kept by the authorized user.

After completion of the project, a disposition for the records will be made. Title 10 CFR Part 20 Subpart L and NPR 1441.1, Records Retention Schedules, shall be used for disposition of these records. Records of all radioactive materials used in projects under DFRC control must be included. The AU will maintain all such records in an ordered and accessible manner as they are subject to periodic RSO and NRC review.

18.0 RELEVANT DOCUMENTS

18.1 Authority Documents

10 CFR 19, 20, 21, 30, 34, 71, & 170	Nuclear Regulatory Commission
29 CFR 1910.96	Department of Labor
49 CFR 171-180	Department of Transportation
NPD 8700.1	NASA Policy for Safety and Mission Success
NPD 8710.2	NASA Safety and Health Program Policy
NPR 1800.1, Ch. 4	NASA Occupational Health Program Procedures
NPR 8715.3	NASA Safety Manual
American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values for Chemical Substances and Physical Agents "TLVs [®] " and Biological Exposure Indices "BEIs [®] "; latest edition.	

18.2 Reference Documents

NFPA 801	Standard for Fire Protection for Facilities Handling Radioactive Materials
NASA-STD- 8709.20	Management of Safety and Mission Assurance Technical Authority (SMA TA) Requirements
ANSI N43.2	Radiation Safety for X-Ray Diffraction and Fluorescence Analysis Equipment

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18.3 Informational Documents

California Administrative Code, Title 17 (Public Health), Subchapter 4, California Radiation Control Regulations, and Title 8, Industrial Relations

18.4 Forms

NRC Form 3	Notice to Employees
NRC Form 4	Cumulative Occupational Dose History
NRC Form 5	Occupational Dose Record for a Monitoring Period
D-WK 210-8	Radiation Project Request
D-WK 211-8	Radiation Project Authorization
D-WK 212-8	Application for Radioisotope Procurement
D-WK 213-8	Radiation Experience Record
D-WK 214-8	Receipt of Radiation Regulations
D-WK 215-8	Radioisotope Inventory Record
D-WK 216-8	Radiation Work Permit

19.0 ACRONYMS, & DEFINITIONS

19.1 Acronyms & Abbreviations

AFTC	Air Force Test Center
ALARA	as low as reasonably achievable
ANSI	American National Standards Institute
AU	authorized users
BEE	bio-environmental engineering
Bq	Becquerel
CDE	committed dose equivalent
CFR	Code of Federal Regulations
CEDE	committed effective dose equivalent
Ci	Curie
CO	contracting officer
COR	contracting officer's representative
DCP	Dryden Centerwide Procedure
DFRC	Dryden Flight Research Center

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D-WK	Dryden work (form)
DOT	Department of Transportation
EAFB	Edwards Air Force Base
H _E	effective dose equivalent
HQ	headquarters
NASA	National Aeronautics and Space Administration
NDI	non-destructive inspection
NFPA	National Fire Protection Association
NPD	NASA Policy Directive
NPR	NASA Procedural Requirement
NRC	Nuclear Regulatory Commission
NUREG	(This is not an acronym.)
Rad	radiation absorbed dose
Rem	radiation equivalent man
RSO	Radiation Safety Officer
S&MA	Safety and Mission Assurance
SHE/SH&E	Safety, Health, and Environmental
SOP	standard operating procedure
Sv	Sievert
TEDE	total effective dose equivalent
USAF	United States Air Force
Wt	weighting factor

19.2 Definitions

Absorbed dose	The energy imparted by ionizing radiation per unit mass of irradiated material.
Activity	The rate of disintegration or decay of radioactive material. The units of activity are the Curie (Ci) and the Becquerel (Bq).
Adult	An individual 18 or more years of age
As low as reasonably achievable (ALARA)	To make every reasonable effort to maintain exposures to radiation as far below the 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

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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. (See 10 CFR 20.1003.)

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.
Committed dose equivalent (CDE)	The dose equivalent to organs or tissues of reference 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)	The sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues.
Controlled area	An area, outside of a restricted area but inside the site boundary, to which access may be limited by the licensee for any reason.
Declared pregnant woman	A woman who has voluntarily informed the licensee, 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.
Deep dose equivalent	The dose equivalent at a tissue depth of 1 cm.
Dose equivalent (Ht)	The product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest.
Dose or radiation dose	The generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalence or total effective dose equivalent, as defined in 29 CFR 20.1003, Definitions.
Effective dose equivalent (H _E)	The sum of the products of the dose equivalent to the organ or tissue and the weighting factors applicable to each of the body organs or tissues that are irradiated.

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Exposure	Being exposed to ionizing radiation or to radioactive materials.
External dose	The portion of a dose equivalent received from radiation sources outside the body.
Eye dose equivalent	The external exposure of the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 centimeter.
Gray	The SI unit of absorbed dose; equivalent to 1 joule per kilogram (100 rad).
Internal dose	The portion of a dose equivalent received from radioactive material taken into the body.
Licensed material	Source material, special nuclear material, or by-product material received, possessed, used, transferred, or disposed of under a general or specific license issued by the NRC.
Limits or dose limits	The permissible upper bounds of radiation doses.
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.
Nonstochastic effect	The health effects, the severity of which varies with the dose and for which a threshold is believed to exist.
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 radioactive material from licensed and unlicensed 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 individuals administered radioactive material and released in accordance with §35.75, from voluntary participation in medical research programs, or as a member of the public.

Planned special exposure	An infrequent exposure separate from and in addition to the annual dose limits.
RAD	The unit of radiation absorbed dose. One rad is equal to 100 ergs/grams or 0.01 joule/kilogram.
Radiation	Alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ion.
Rem	The special 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 the quality factor (1 rem=0.01 Sievert).
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 or radioactive materials.
Sealed source	Any byproduct material that is encased in a capsule designed to prevent leakage or escape of the byproduct material.
Shallow-dose equivalent	The external exposure of the skin or an extremity is taken as the dose equivalent at a tissue depth of 0.007 centimeter averaged over 1 sq. centimeter.
Sievert (Sv)	Sievert is equal to the absorbed dose in grays multiplied by the quality factor. (1Sv = 100 rem).
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.
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.

The Commission	The Nuclear Regulatory Commission
Total effective dose equivalent (TEDE)	The sum of deep-dose equivalent and committed effective dose equivalent.
Weighting factor (Wt)	For an organ or tissue is 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.

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