

Chapter 7.3

Radiation protection

This could be you . . .

A researcher ingested radioactive dust. He made notes on his work and then held his pencil, which had dust on it from his hands, in his mouth.

1. Applicability of this chapter

You are required to follow this chapter if you handle radioactive materials or radiation-producing equipment.

2. What this chapter covers

This chapter covers the minimum requirements for handling and using radioactive materials or radiation-producing equipment. The chapter includes ionizing radiation such as X-ray diffraction units and nonionizing radiation such as that produced by radar and microwaves.

Requirements for ionizing radiation

3. Ionizing radiation and why is it harmful

Ionizing radiation is any of the following: alpha particles, beta particles, gamma rays, X rays, neutrons, high-speed electrons, protons, and other atomic particles. Ionizing radiation doesn't include sound waves, microwaves, radio waves, or visible, infrared, or ultraviolet light. These are covered in the next subchapter. Ionizing radiation is harmful because it alters the cells of the human body and could produce cancer and other chromosome damage.

4. Precautions to take when working with ionizing radiation

If you work with ionizing radiation, you shall:

- a. Get approval to bring radioactive materials or radiation-producing devices onto JSC, Sonny Carter Training Facility, Ellington Field, and White Sands Test Facility. *No one*, whether NASA employees, contractors, visiting scientists, post-doctorate researchers, visiting product vendors, etc., is allowed to bring any radioactive materials or radiation-producing devices onto JSC-, Sonny Carter Training Facility-, Ellington Field-, or White Sands Test Facility-controlled property until he or she gets approval from the NASA/JSC Radiation Safety Officer.

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- b. Make sure you have been authorized by the Radiation Safety Committee (RSC) to work with radioactive materials or radiation-producing equipment. See specific authorization procedures described in Part 3 of JPR 1860.2, "Radiological Health Manual."
- c. Wear appropriate protective clothing whenever you or your clothing could be contaminated.
- d. Wear personnel-monitoring equipment (usually dosimeters) if you work in a "Radiation Area." The JSC Radiation Safety Officer (JSC RSO) may require you to have a bioassay to check your level of internal radioactive material uptake.
- e. Make sure that you don't expose yourself or anyone else to radiation unnecessarily or beyond the permissible exposure levels contained in Part 3.9 of JPR 1860.2.
- f. Keep contamination levels as low as possible. Make sure that you don't carry contamination beyond restricted areas. See Part 3.6 of JPR 1860.2 for specific procedures on personnel and area contamination and maximum permissible contamination levels.
- g. Have written emergency response plans for both major and minor spills and releases as required by the RSC. Report to the JSC RSO and the Facility Manager as soon as possible after any incident where:
 - 1. Someone could have been overexposed to radiation.
 - 2. Government equipment could have been damaged due to a spill or loss of control of a radiation source.
- h. Use appropriate signs to mark restricted, radiation, high-radiation, or very-high-radiation areas. Mark any area that requires personnel-monitoring equipment. Standard signs with the radiation CAUTION symbol are available from the JSC RSO. Part 3.6 of JPR 1860.2 describes specific sign requirements.

5. Controlling radioactive materials and radiation-producing equipment

You control radioactive materials and radiation-producing equipment by tracking when and where it comes on site, where it is stored and used, how it is transferred, and how it is disposed of. Follow these precautions:

- a. The JSC RSO or designee shall approve all purchase requests for or any evaluations of radioactive material or radiation-producing equipment. They will survey new packages containing radioactive material promptly (usually at logistics receiving) for contamination and radiation levels. See Part 3.5 of JPR 1860.2 for specific procedures.
- b. The JSC RSO needs to approve all storage and use areas for radioactive material. You shall:
 - 1. Mark each room or area in which radioactive material is used or stored as containing radioactive material.

2. Label each container of radioactive material as such. Part 3.5c of JPR 1860.2 describes specific marking and labeling procedures.
- c. Document all transfers of licensed material, making sure that the material is properly identified and the radiation levels are controlled. The JSC RSO or designee shall:
 1. Approve and keep a record of all radioactive material shipments.
 2. Certify that materials are properly classified, described, packaged, marked, and labeled under applicable regulations (both NRC and DOT). Part 3.5d of JPR 1860.2 describes specific procedures for transferring licensed material.
- d. Request disposal through the JSC RSO. Only a licensed radioactive waste disposal contractor may dispose of radioactive wastes. There are limited exceptions. Don't release radioactive gases or particulate radioactive material into the air. Part 3.13 of JPR 1860.2 describes specific procedures for disposing of waste.

6. Special requirements for off-site contractors doing radiographic work on site

If you are doing any kind of work involving radiation on site at JSC, you shall follow all requirements in this handbook as well as in JPR 1860.2. In addition, you shall notify the JSC RSO 24 hours before beginning work or before bringing radioactive materials or equipment on site.

Requirements for non-ionizing radiation

7. Nonionizing radiation and why is it harmful

Nonionizing radiation includes any of the following from the electromagnetic radiation spectrum: ultraviolet rays, visible light, lasers (for laser controls, see Chapter 6.2 of this handbook), infrared radiation, radar, radio waves, microwaves, and Hertzian waves. Equipment that produces nonionizing radiation includes radio frequency (RF) and microwave devices such as radar, telemetry, communications systems, and test equipment; laser systems and optical devices; and microwave ovens. Nonionizing radiation is classified as a physical agent and can be harmful because it produces thermal and other effects that damage cells in the body. RF and microwave devices may cause these effects through electric and magnetic fields and induced currents. For more information on hazards from nonionizing radiation at JSC, contact the JSC Radiation Safety Office.

8. Exposure limits for nonionizing radiation

The exposure limits for nonionizing radiation depend on frequency. JSC uses limits found in the ACGIH publication "Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices" (latest version). You can find additional information on exposure limits for RF radiation in the ANSI/IEEE C95.1 Standard, "IEEE

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Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.” Remember, as with all hazardous physical agents, keep the exposure as low as reasonably achievable. Contact the JSC Radiation Safety Office for assistance in determining the specific exposure limit for the nonionizing radiation from your equipment, process, procedure, or application.

9. Approvals for using equipment that produces nonionizing radiation

You shall receive approval from the JSC RSO/Laser Safety Officer before using any nonionizing radiation source that can cause health or biological damage. UL-listed COTS equipment that isn't modified is exempt from this requirement.

10. Information to provide and precautions to observe to get approval for using equipment that produces nonionizing radiation

You shall:

- a. Describe the potential nonionizing radiation hazards and their controls to all personnel within the area.
- b. Make sure that everyone in the area knows your emergency procedures.
- c. Make sure that everyone who uses the equipment has demonstrated a thorough knowledge of the system operations and safety precautions.
- d. Immediately notify the JSC RSO and the area supervisor of any known or suspected mishap from your nonionizing radiation source.
- e. Notify the JSC RSO and the area supervisor of modifications to previously authorized nonionizing radiation systems. Don't operate the modified system without prior JSC RSO approval. Your modification may require approval by the JSC RSO or the RSC.

11. Precautions when working with nonionizing radiation

You shall follow these precautions when working with nonionizing radiation:

- a. Don't look into waveguide horns, antennas, or open waveguides when any microwave equipment is on.
- b. Don't stay around high-frequency radiation over 25 mW/cm².
- c. Ask the Radiological Safety Office to measure and evaluate the X-ray hazard posed by all equipment with voltages over 15,000 V.
- d. Don't wear metal jewelry or eyeglasses near electronic equipment radiating RF energy, even if the level is below the established safe value. Jewelry or eyeglasses may act as a conductor and cause a shock or burn.

- e. Follow Chapter 6.2 of this handbook, “Laser safety and health,” for using and controlling lasers.

12. Requirements for RF interference

For RF interference, you shall:

- a. Make sure that the operation of industrial, scientific, medical, and other equipment generating RF energy doesn’t interfere with authorized radio, radio-navigation, and telecommunication systems.
- b. Treat equipment generating RF energy between 30 Hz and 30,000 MHz as a cause of interference unless you provide the equipment with power line filters, shielding, bonding, and grounding.
- c. Keep RF energy within the limits in Chapter 7 of the *Manual of Regulations and Procedures for Federal Radio Frequency Management*.

13. For more information on radiation protection

You can find more information on radiation protection in these documents:

- a. 10 CFR, “U.S. Nuclear Regulatory Commission Rules and Regulations”
- b. 21 CFR 1000 – 21 CFR 1040, “Food and Drug Administration Rules and Regulations”
- c. 29 CFR 1910.1096, “Ionizing Radiation”
- d. 29 CFR 1910.97, “Nonionizing Radiation”
- e. 49 CFR 177, “Carriage by Public Highway”
- f. ANSI/IEEE C95.1, “IEEE Standard for Safety Levels With Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz,” American National Standards Institute, 1982
- g. JPR 1860.2, “Radiological Health Manual”
- h. JPD 1860.4, “Radiological Protection Policy”
- i. JPR 1107.1, “The JSC Organizations,” paragraph 4.5, “JSC Radiation Safety Committee”
- j. JPC 1152.15, “Medical Isotopes Subcommittee of the JSC Radiation Safety Committee”
- k. *Manual of Regulations and Procedures for Federal Radio Frequency Management*, U.S. Department of Commerce, Chapter 7: “Authorized Frequency Usage,” National Telecommunications and Information Administration, Washington, D. C., 1989
- l. *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices (TLVs[®] and BEIs[®])*, American Conference of Governmental Industrial Hygienist, latest edition

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- m. ANSI/IEEE C95.1 Standard, “IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz”
- n. Presidential Guidelines for Diagnostic X-Rays at Federal Installations, approved January 16, 1978

14. Responsibilities for radiation safety

- a. As a *supervisor*, you are responsible for:
 - 1. Making sure that your employees participate in the JSC Radiation Protection Program.
 - 2. Providing training to your employees in their radiation tasks and procedures.
 - 3. Assuring that all JSC issued personal radiation dosimetry devices are returned to the Radiation Safety Office in conjunction with all employment termination.
- b. As the *JSC RSO*, you are responsible for:
 - 1. Implementing JSC’s radiation protection program.
 - 2. Supervising the Radiation Safety Office.
 - 3. Answering to the JSC Radiation Safety Committee.
 - 4. Being appointed by the Director, Space and Life Sciences.
 - 5. Following your specific JSC RSO responsibilities described in Part 2.4 of JPR 1860.2.
- c. The *Director of the Space and Life Sciences* is responsible for:
 - 1. Making sure that the radiation protection program is developed and carried out.
 - 2. Securing licenses or permits where required.
 - 3. Establishing an RSC.
- d. The *Radiation Safety Committee* is responsible for:
 - 1. Coordinating the requirements for controlling radiation among the various agencies that regulate radiation.
 - 2. Approving all uses of radiation on site.
- e. The *Radiation Safety Office* is responsible for:
 - 1. Reviewing procedures.
 - 2. Monitoring operations.
 - 3. Educating personnel in radiation protection and in the safe handling of radioactive materials and radiation-producing equipment.

4. Providing radiation dosimetry equipment such as thermo-luminescent dosimeters, pocket dosimeters, warning signs, and labels for radiation or radioactive materials.
5. Making sure that all operations meet NRC requirements.