CHAPTER 33 – NONIONIZING RADIATION

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A. INTRODUCTION

1. This Chapter applies to Smithsonian Institution (SI) employees working with or in areas that contain nonionizing radiation sources. The information contained in this chapter is based primarily on standards and guidelines promulgated by the Occupational Safety and Health Administration (OSHA), American Conference of Governmental Industrial Hygienists (ACGIH), the American National Standards Institute (ANSI) and the National Institute for Occupational Safety and Health (NIOSH).
2. Nonionizing radiation is a form of electromagnetic radiation with varying effects on the body, depending on the frequency, wavelength, and power of the radiation involved. This chapter will focus on hazards associated with the following types of nonionizing radiation:
   a. ultraviolet (UV) light,
   b. radio waves,
   c. microwaves, and
   d. electromagnetic fields.
3. Lasers, which also emit nonionizing radiation, are addressed in Chapter 34, "Laser Safety", of this *Manual*.

B. CHAPTER-SPECIFIC ROLES AND RESPONSIBILITIES

1. Safety Coordinators shall:
   a. Provide oversight for the possession and use of sources of nonionizing radiation within their facilities.
   b. Identify all sources of nonionizing radiation hazards as part of the Job Hazard Analysis (JHA, refer to Chapter 4, "Safety Risk Management Program", of this *Manual*) and maintain an inventory of sources, which are capable of emitting energy that could exceed current exposure limits.
   c. Ensure all sources of nonionizing radiation meet regulatory and SI requirements, with assistance from the Office of Safety, Health and Environmental Management (OSHEM), as needed. Coordinate the review and approval of new protocols and practices that use sources of nonionizing radiation.
   d. Ensure staff receives training commensurate with the type of work being performed and the degree of hazard present.

e. Forward requests for occupational health evaluations through OSHEM/Occupational Health Services Division (OHSD).

2. Supervisors shall:

   a. Manage and use sources of nonionizing radiation within their areas of responsibility and the activities conducted by individuals working under their supervision.

   b. Develop and implement safety procedures for specific projects and research applications for sources of nonionizing radiation. New or modified protocols shall be submitted to the Safety Coordinator for review.

   c. Ensure workers and associated personnel receive appropriate training prior to work or entry into areas that contain sources of hazardous nonionizing radiation.

   d. Notify the Safety Coordinator when a radiation survey or monitoring may be necessary.

   e. Maintain inventories of sources of hazardous nonionizing radiation and provide this information to the Safety Coordinator.

   f. Report employee health complaints related to nonionizing radiation exposure to the Safety Coordinator for investigation and documentation.

3. Employees shall:

   a. Complete training commensurate to exposure risks prior to beginning tasks associated with sources of nonionizing radiation.

   b. Wear required personal protective equipment (PPE) and follow safe work practices when working with sources of nonionizing radiation.

   c. Notify coworkers, supervisors and/or the Safety Coordinator when they believe a task or a situation, in which nonionizing radiation is present, may contribute to a potential safety hazard.

4. Office of Safety, Health and Environmental Management (OSHEM) shall appoint the SI Radiation Safety Officer (RSO) who shall be responsible for coordination of the requirements outlined in this Chapter, including:

   a. Providing nonionizing radiation hazard training for workers, supervisors, and Safety Coordinators, as required.

   b. Assisting Safety Coordinators in developing facility and program specific safe work practices for sources of nonionizing radiation.

   c. Reviewing protocols to ensure the safe use of sources of nonionizing radiation.

   d. Assisting in conducting nonionizing radiation surveys.

5. Ancillary Personnel. Personnel visiting or frequenting a restricted area shall receive instructions concerning the sources of nonionizing radiation hazards in the area, commensurate with their activities.

C. HAZARD IDENTIFICATION

1. A Job Hazard Analysis (JHA), as outlined in Chapter 4, "Safety Risk Management Program", of this *Manual*, shall be conducted to identify potential sources of nonionizing radiation and evaluate the potential of overexposure to nonionizing radiation.
2. Measurements of nonionizing fields in terms of electric (volts per meter) and magnetic (amperes per meter) field strength or power density (milliWatts per square centimeter) shall be used to evaluate exposure as a function of frequency.
3. Ultraviolet radiation (UV):
   a. UV occupies that portion of the electromagnetic spectrum from 100-400 nanometers (nm). Because of differences in biological effects, UV radiation is commonly sub-grouped as UV-A (315-400 nm), UV-B (280-315 nm), and UV-C (100-280 nm).
   b. The primary source of UV radiation in the environment is the sun. The earth's atmosphere absorbs much of this UV, but not all.
   c. UV hazards may be recognized by understanding the processes and conditions that produce UV energy. Sources include:
      (1) Hot work, such as welding.
      (2) Fluorescent Lamps, which produce UV radiation primarily by ionizing metals (mercury vapor), metal halides, and gases (xenon). They are commonly placed in HVAC systems, hospitals, and laboratories (biological safety cabinets) where control of bacteria and fungi is desirable, and to fluoresce certain chemicals. UV lamps are also commonly used in some biological procedures (gel electrophoresis), and by art conservators.
      (3) Black-light Lamps, which emit long wave UV radiation and very little visible light. They are commonly used to view the UV watermark on sensitive documents.
      (4) Certain photosensitive chemicals, which are found in foods, medicines, plants, and commercial compounds. Where simultaneous exposure to UV radiation and photosensitive chemicals may occur, additional control measures may be needed. Photosensitive chemicals may be found in coal tar, anthracene, naphthalene, hydrogen peroxide, sulfonamides, tetracycline, thiazide diuretics, figs, parsley, limes, and St.

John's Wort. For operations with UV hazards, the material safety data sheets (MSDS) of all chemicals should be reviewed for photosensitivity. In addition, consideration of medicines and dietary supplements in conjunction with UV exposure is recommended.

4. Radiofrequency waves, Microwaves, and Electromagnetic fields:

   a. Radiofrequency (RF) and microwave (MW) radiation refers to electromagnetic radiation in the frequency ranges 3 kilohertz (kHz) - 300 Megahertz (MHz), and 300 MHz - 300 gigahertz (GHz), respectively. Electromagnetic fields are created by moving electrical current and have no defined frequency range.

   b. Hazard assessments conducted for radiofrequency (RF) and microwave radiation hazards shall consider if the exposure is occurring over the whole body or only part of the body, to include the affected tissue.

   c. Some sources of every-day RF and MW radiation include hand-held radios, cellular phones, the processing and cooking of foods, and microwave drying equipment. RF radiation is also commonly emitted by industrial equipment such as heat sealers, vinyl welders, high frequency welders, induction heaters, flow solder machines, communications transmitters, radar transmitters, ion implant equipment, and sputtering equipment. RF radiation may be emitted in high quantities around radar traffic devices, radio transmission, and electromagnetic resonance imaging (MRI) equipment.

   d. RF fields can induce currents in nearby conducting objects, such as a metal barrier or fence used to restrict access to RF hazard areas. In some instances, touching these objects can produce a spark.

   e. RF radiation can be absorbed by the human body and cause heating effects on tissue. This heating effect varies with the frequency of the electromagnetic energy, the quantity of the energy deposited and affected tissue. The specific absorption rate (SAR) is one measure of absorbed energy in units of Watts per kilogram of body mass.

   f. Electromagnetic fields are also produced by high voltage power sources.

D. HAZARD CONTROL

1. Employee exposure to nonionizing radiation from any source shall not exceed applicable standards established by OSHA. Where regulatory standards do not exist, recommended guidelines by professional organizations such as ANSI or ACGIH shall apply.

2. The principles of time, distance and shielding shall be considered in evaluating a potential hazard. Where applicable, consideration of a potential hazard should address the most likely area of the body to be exposed. Employee rotation shall only be used when engineering controls are inadequate to control and maintain exposures below recommended standards or guidelines.
3. Ultraviolet radiation (UV):
    a. Where exposures exceed, or may exceed, exposure limits, engineering controls, process changes, administrative practices, and or personal protective equipment (PPE) shall be implemented to protect employees from overexposure to UV radiation.
    b. Engineering controls will vary depending on the source type, strength and operational process. Examples of controls include:
        (1) Welding barriers and enclosures: Welding curtains can be made of flame retardant materials that are opaque or transparent to visible light. Some opaque materials include canvas duck and polymer laminates.
        (2) Laboratory biological safety cabinets: Sash glass greater than 2.4 mm thick transmits almost no UV below 300 nm.
        (3) HVAC systems: Access panels to components where UV sources are contained may be interlocked with the source power supply to reduce the likelihood of exposure during maintenance.
    c. Personal protective equipment (PPE) is one form of shielding which shall be considered when evaluating potential hazards. Examples of PPE include the following:
        (1) Sunscreens, such as zinc oxide and titanium dioxide, are very effective sun-blocks, reflecting up to 99% of UV radiation.
        (2) Clothing may be an effective UV shield. Factors which contribute to the effectiveness of clothing in protecting against UV include material, weave, stretch, color, and weight.
        (3) The level of UV protection afforded by sunglasses and eyewear varies. The higher the optical density, the more effective the eyewear will be at attenuating UV. Generally, most eyewear contains a UV coating which provides some UV protection.
4. Radiofrequency, Microwaves, and Electromagnetic fields:
    a. Control measures which include the use of time, distance and shielding shall be based on measurements of nonionizing fields in terms of electric, magnetic and field strength or power density.
    b. Exposure to radiofrequency (RF), microwave (MW) and electromagnetic frequency hazards may be controlled through the

use of warning signs that alert staff to the presence of the nonionizing radiation sources. Signage shall meet the requirements of the OSHA Nonionizing Radiation Standard (29CFR 1910.97) or the American National Standards Institutes (ANSI) standard, ANSI C95.2-1982.

c. Wearers of cardiac pacemakers are restricted from exposure to electromagnetic flux density at power frequencies above 0.1 milliTesla (mT), unless specific information on electromagnetic interference is available from the manufacturer which would allow higher exposure levels.

E. TRAINING. Employees whose duties involve sources of hazardous nonionizing radiation shall receive training which is commensurate with the level of risk associated with their work.

F. RECORDS AND REPORTS

1. Nonionizing radiation surveys shall be maintained for a period of 5 years.
2. Inventories of nonionizing radiation sources shall be maintained for a period of 5 years.
3. Surveys to evaluate and document potential occupational exposures shall be maintained in accordance to OSHA requirements.

G. REFERENCES

1. OSHA General Industry Standards. 29CFR 1910.97 Nonionizing Radiation.
2. ACGIH Threshold Limit Values (TLV's) and Biological Exposure Indices (BEI's). (Most Current Edition). Cincinnati, OH.
3. National Fire Protection Association (NFPA) Standard 70, "National Electrical Code (NEC)," 2005 Edition.
4. Plog, Barbara A., Editor. Fundamentals of Industrial Hygiene, Third Edition. Published by the National Safety Council, Chicago, Illinois, 1988.