NON-IONIZING RADIATION USER GUIDE

University of California, Riverside

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Introduction

In addition to hazards associated with using radioactive materials, radiation producing machines, and lasers, there are hazards associated with sources of non-ionizing radiation. Generally, non-ionizing radiation tends to be less hazardous to humans than ionizing radiation. However, depending on the wavelengths/frequencies, non-ionizing radiation may present a human health hazard. This document will cover three of the most common types of non-ionizing radiation encountered on the UCR campus: ultraviolet (UV) radiation, RF (Radiofrequency)/Microwave radiation, and magnetic fields.

Ultraviolet (UV) Radiation

Background

Ultraviolet radiation is a part of electromagnetic spectrum with wavelength of 100 to 400 nm. UV Radiation is a known carcinogen for human skin.

Potential Hazards:

There are no immediate warning symptoms to indicate overexposure. Symptoms of overexposure include varying degrees of erythema (sunburn) or photokeratitis (welder's flash), and typically appear hours after exposure has occurred.

- **Skin injury**: Wavelengths below 320 nm are primarily responsible for reddening and burning. These symptoms may vary from a simple reddening at the site of exposure to sever blistering and desquamation.
- **Eye Injury**: UV exposure can injure the cornea, the outer protective coating of the eye. Symptoms include a sensation of sand in the eye that may last up to two days. Chronic exposure to acute high energy radiation can lead to the formation of cataracts.

Never allow the skin or eyes to be over-exposed to UV radiation sources. UV radiation generated by some of the laboratory equipment can exceed recommended exposure limits and cause injury with exposures as brief as three seconds in duration.

Common Sources of UV Radiation

Transilluminators

Nucleic acid transilluminators are used for visualization of DNA in a gel. The DNA is stained with ethidium bromide. Never use a transilluminator without the protective shield in place. Damage to the eyes is the most common injury with this equipment, so face shields must be worn. Maintenance should be performed according to the manufacturer's instructions. Generally, there is no reason to perform periodic monitoring of transilluminator devices.

Crosslinkers

Crosslinkers use UV energy for curing applications or for bonding nucleic acids to a medium. They are equipped with a UV blocking window. They pose little UV hazard due

to door safety interlocks, and cause the crosslinker to shut off when the door opens or prevents the crosslinker from starting if the door is open. Do not use a crosslinker if the interlocks are not functioning properly and send it out for repair

Hand-held UV Units
These units are used to visualize nucleic acids following gel electrorophoresis. Maintenance should be performed according to the manufacturer's instructions. Generally, there is no reason to perform periodic monitoring of hand-held UV units.

Labeling
Many overexposures to UV radiation have occurred as a result of individuals not knowing the hazards associated with UV-emitting equipment. To help prevent eye and skin injuries, any equipment that emits UV radiation or areas such as fume hoods where experiments involving UV are taking place must be conspicuously labeled with a caution or warning label. Below are some examples of UV labels:

To request UV labels, contact UCR EH&S at 951-827-5528.

Personal Protective Equipment

Protective Clothing

Per UCOP PPE Policy, wear standard laboratory apparel including a fully buttoned lab coat, long pants, and closed toe shoes. While working with UV radiation sources, lab workers must be particularly careful to prevent gaps in protective clothing that commonly occur around the neck and wrist areas.

Eye/Face Protection
If there is any potential for the eyes and face to be exposed to UV radiation, a polycarbonate face shield stamped with the ANSI Z87.1-2015 UV certification or polycarbonate safety glasses must be worn to protect the eyes and face. Ordinary prescription eyeglasses may not block UV radiation. UV certified goggles and safety glasses will protect the eyes, but it is not uncommon for lab workers to suffer facial burns in the areas not covered by the goggles or glasses.

Gloves
Wear disposable nitrile gloves to protect exposed skin on the hands. Make certain wrists and forearms are covered between the tops of gloves and the bottom of the lab coat sleeves

Response to UV Exposure

If an exposure to UV radiation is suspected, report the incident to EH&S at https://ehs.ucr.edu/

Radiofrequency (RF) /Microwave Radiation

Introduction

When RF current is supplied to an antenna, an electromagnetic field (EMF) is created to carry the signal through space. This is the basis for wireless broadcasting (radio, TV) and communications (cell phones, Wi-Fi).

Potential Hazards of RF/Microwave Radiation

RF heats biological tissue. Possible effects are similar to those of physical activity. Extreme levels are not ordinarily encountered by the general public. The Federal Communications Commission (FCC) regulates RF transmissions to protect people from harm.

Common sources of RF

Antennas

Cellular communication antennas are mounted several ways such as a rooftop, side of a building, or pole/tower. Before installation, plans are reviewed to ensure that RF emissions are within FCC limits. Warning signs should be posted by the manufacturer that include information on the hazard and the point of contact for the antenna.

Wireless LAN systems

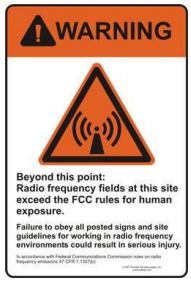
Wireless LAN systems (indoor and outdoor) operate on extremely low power(less than that of a cell phone) Only approved equipment can be used to build a campus operated WLAN.

Microwave ovens

Microwave ovens are widely used in campus offices and research labs. It is very unusual for a commercial microwave oven to leak, but misuse, damage, and interlock failures have caused ovens to leak. Any microwave oven suspected of leaking should be taken out of service.

Labeling

There are blue, yellow, and orange signs giving notice, caution, or warning to RF hazards. Read carefully and do not enter unauthorized areas.



Personal Protective Equipment

There are no special PPE requirements.

Monitoring and Maintenance

If there are concerns regarding a potential exposure, EH&S will contact UCR Real Estate Services, who will contact the owner of the cell tower. The owner of the cell tower will be responsible for performing RF surveys of antennas and antenna arrays and be responsible for any repairs.

Protection against RF Radiation for Antennas for Facilities Personnel

- Before working on a building, inquire if cellular or other RF generating antennas are present. Do a visual assessment to make sure.
- Signage should be posted by the manufacturer that include information on the hazard and point of contract for information on the antenna
- Ensure that the antenna owner powers down the device
- Avoid standing right in front or close to antennas.
- Make sure that the antennas are not pointed directly toward your work area
- Stay 6 feet away from a single antenna or 10 feet away from a group of antennas.

Microwave Oven Safety Guidelines

- Do not operate the oven if it is damaged or does not operate properly. It is important that the oven door seals properly and there is no damage to the door seal, hinges, latches, or oven surfaces.
- Do not use aluminum foil or any metal containers.
- Never heat flammable materials, combustible materials, or sealed objects
- All ovens produced for sale in the US must meet strict FDA/CDRH performance requirements that limits leakage during service to 5mW/cm^2 at 5 cm from the oven surface.

Magnetic Fields

UCR MRI Unit

Introduction

Instruments such as Nuclear Magnetic Resonance (NMR) spectrometers or MRIs generate magnetic fields. These magnets have fields of 1.4-23.5 tesla (T). The Tesla is the International Unit of magnetic flux density. One Gauss = .0001T (Tesla). These units are used interchangeably. The magnitude of the magnetic field decreases with distance and operates in three dimensions. A magnetic field is invisible and unlike x-ray machines, the magnetic field is ALWAYS “on”.

Potential Hazards

- **Kinetic energy hazards:** The high field around the magnet can accelerate ferrous objects toward the magnet with sufficient energy to seriously injure people or damage the magnet. **Follow these precautions:**
  - Keep small metal objects (screws, tools, razor blades, paper clips, etc.) at least 1.5 meters from the magnet, or in places where the field exceeds 30 Gauss (G).
  - Move large ferrous objects (equipment racks, tool dollies, compressed gas cylinders, etc.) with great care whenever the field approaches 300 Gauss. In many recorded instances, large objects have been drawn toward, and even into, magnets. Additionally, iron, nickel, and cobalt, 400 series stainless steel is magnetic. Most 300 stainless steels are not magnetic.

- **Biological hazards:** Consider the continuous exposure limit **guidelines** established by the American Conference of Governmental Industrial Hygienists (ACGIH) when evaluating safety standards for the magnets operating in your lab. More research must be done to ascertain if exposure to magnetic fields causes cancer.

- **Cryogen hazards:**
    - **Quench - asphyxiation hazard:** Quench is a sudden (usually unexpected) boil-off of large volumes of cryogenic liquids used to create superconductivity in the magnet. This can violently damage the magnet and potentially (should venting systems fail) cause rapid venting of large volumes of helium and nitrogen gas into the room, quickly resulting in an oxygen-deficient atmosphere. Contact EH&S at 951-827-5528 for a hazard assessment to determine if an oxygen sensor is required.
    - **Note:** Quench conditions can result from ferrous objects being drawn into the magnet. See Kinetic Energy Hazards
  - **Frostbite hazard:** Contact with liquid or gaseous cryogens may cause frostbite to human skin or eye tissue.
- **Electrical hazards:**
  - Keep electrical panels clearly visible and unobstructed.
  - Know how your circuits are labeled so equipment can quickly be de-energized in an emergency.
  - Permit only properly qualified personnel to work on electrical equipment.
  - Make sure cables, wires, and conduits do not create trip hazards.
- **Earthquake hazards:** Securely restrain magnet assemblies and power supplies to prevent movement or tipping during an earthquake.

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Labeling

Post a basic magnet hazard warning sign. Signs can be obtained by contacting EH&S at 951-827-5528.

Mark the 5 Gauss threshold line with floor tape or equivalent markings where appropriate. Five Gauss is the safe level of magnetic field exposure for the general public.

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Personal Protective Equipment

- Wear appropriate personal protective equipment. This may include eye protection, hearing protection, and gloves. Contact EH&S if you have any questions regarding personal protective equipment.

Monitoring and Maintenance

To request a survey of your area, please contact EH&S at 951-827-5528.

Protection against Magnetic Fields

- Keep doors locked and posted with magnetic hazard warning signs to prevent unauthorized access to the magnet room.
- Make sure people with cardiac pacemakers or other implanted medical devices stay outside the 5 Gauss (G) threshold
- Don't work alone
- Have a well-planned method to evacuate all personnel from the magnet room in case of a quench event.
- In the event of a liquid or gas cryogen exposure, call UCR Police at 951-827-5222.
- Make sure personnel understand the hazards before allowing them to enter the magnet room.

Regulatory References:

UV Radiation:

- Title 8 CCR https://www.dir.ca.gov/Title8/5085.html
- ACGIH(American Council of Governmental Industrial Hygienists) https://www.aiha.org/get-involved/VolunteerGroups/Documents/NONIONRAD-UVRadiationQuickReferenceGuide.pdf

RF/Microwave Radiation:

- FCCOET65https://transition.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65.pdf
- IEEE C95.1, Institute of electrical and electronics engineers
- Title 8-CCR https://www.dir.ca.gov/Title8/5085.html
- ACGIH

Magnetic Fields: ACGIH

Additional References:

UCSD Webpage- (Magnetic Fields, RF)
Case Western Reserve University UV Training Presentation
Radiofrequency Awareness Guide -UC Berkeley
UC Berkeley Non-ionizing Radiation Safety Manual