THE UNIVERSITY OF TENNESSEE HEALTH SCIENCE CENTER

Non-Ionizing Radiation Program
NRP01 – Non-Ionizing Radiation Program

Memphis

Knoxville

Chattanooga

Nashville

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Related Policies: SA0500-Laser Safety, & RSPL01-Laser Registration and Inspection Policy		

PURPOSE

Non-ionizing radiation (NIR) refers to electromagnetic radiation that does not have sufficient energy to ionize (remove electrons from) atoms or molecules. In general, NIR tends to be less hazardous to humans than ionizing radiation (ionizing radiation has a wavelength less than 100 nm or a photon energy > 12.4 eV). However, depending on the wavelength/frequency and the irradiance (or power density) value, NIR sources may present a human health hazard. Therefore, those working with non-ionizing radiation must take precautions to ensure they are not exposed to excessive levels of NIR.

The Non-Ionizing Radiation (NIR) Safety Program is designed to help protect employees, students, and the general public from the harmful effects of non-ionizing radiation on campus. The NIR program is intended to provide a workplace where known hazards of NIR are mitigated.

SCOPE

The scope of this program applies to the Memphis campus of UTHSC and applies to non-ionizing radiation use and users on campus.

TYPES OF NR

There are three broad categories of NIR. They are optical radiation, microwave radiation, and radiofrequency radiation. Optical radiation includes ultraviolet, visible light, and infrared light. Please note that optical radiation resulting from laser use is addressed in the laser safety program.

UV LIGHT HAZARDS

Ultraviolet (UV) radiation is a known carcinogen. UV radiation has substantial energy that approaches the photon energy of ionizing radiation. UV radiation causes biological effects primarily through photochemical interactions. In addition to cancer, erythema (sunburn), and skin aging are also known products of ultraviolet skin exposure. The biological effects are dependent

on the time of exposure, the specific UV wavelength, and the susceptibility of the individual

exposed. Various components of the human eye are susceptible to damage from extended exposure to direct/reflected UV exposure from photochemical effects. The cornea like the skin can be “sunburned” by exposure to too much UV radiation. This is called keratoconjunctivitis (snow blindness or welders flash), a condition where the corneal (epithelial) cells are damaged or destroyed. This condition usually does not present until 6 to 12 hours following the UV exposure. Although very painful (often described as having sand in the eyes), this condition is usually temporary (a few days) because the corneal cells will grow back. In very severe cases, the cornea may become clouded and corneal transplants may be needed to restore vision. Exposure to the UV-C and UV-B present the greatest risk to the cornea. The lens of the eye is unique in that it is formed early in human development and is not regenerated if it becomes damaged. For normal vision, it is essential that the lens remains clear and transparent. Unfortunately, UV-A exposure is suspected as a cause of cataracts (clouding of the lens).
Procedure for UV Light Hazards

1. Notify the RSO of UV light devices, excluding those used for surface disinfection (e.g. inside of biosafety cabinets.
2. If the light source is a laser, then refer to UTHSC Laser Safety procedure for requirements for the safe use of laser systems.
3. Implement an appropriate set of controls to ensure hazard awareness and control of light hazards.

- *Engineering Controls:* Whenever possible UV light systems should utilize a protective interlock system to disengage the UV light source when there is potential for human exposure. Additional engineering controls may include the use of shielding to ensure that UV light is exposes only desired surfaces.
- *Administrative Controls:* Personnel must be informed of the location of UV light hazards. This can be done by training and through the posting of warning signage to identify the presence of UV light.
- *Personal Protective Equipment:* Personnel must wear polycarbonate safety glasses, or a polycarbonate face shield rated to provide protection from UV light whenever there is the potential for exposure. Contact the Radiation Safety Officer (RSO) for information and advice on appropriate UV protective eyewear.

VISIBLE LIGHT HAZARDS

All visible light (400 to 700 nm) entering the human eye is focused upon the sensitive cells of the retina where human vision occurs. The retina is the part of the eye normally considered at risk from visible light hazards.

Any very bright visible light source will cause a human aversion response (we either blink or turn our head away). Although we may see a retinal afterimage (which can last for several minutes),

the aversion response time (about 0.25 seconds) will normally protect our vision. This aversion response should be trusted and obeyed. NEVER STARE AT ANY BRIGHT LIGHT SOURCE FOR AN EXTENDED PERIOD. Overriding the aversion response by forcing yourself to look at a bright light source may result in permanent injury to the retina. This type of injury can occur during a single prolonged exposure. Welders and other persons working with plasma sources are especially at risk for this type of injury.

Visible light sources that are not bright enough to cause retinal burns are not necessarily safe to view for an extended period. In fact, any sufficiently bright visible light source viewed for an extended period will eventually cause degradation of both night and color vision. Appropriate protective filters are needed for any light source that causes viewing discomfort when viewed for an extended period of time.

For these reasons, prolonged viewing of bright light sources (plasma arcs, flash lamps, etc.) should be limited by the use of appropriate filters. Traditionally, welding goggles or shields of the appropriate "shade number" will provide adequate protection for limited viewing of such sources. Please contact the RSO for advice on appropriate eye protection.

Procedure for Visible Light Hazards

1. If the light source is a laser, then refer to UTHSC Laser Safety procedure for requirements for the safe use of laser systems.
2. Implement an appropriate set of controls to ensure hazard awareness and control of visible light hazards.

    - *Engineering Controls:* Use barriers or appropriate shades when practical.
    - *Administrative Controls:* Personnel must be informed of the location of visible light hazards. This can be done by training and through the posting of warning signage to identify the presence this type of hazard.
    - *Personal Protective Equipment:* Prolonged viewing of bright light sources (plasma arcs, flash lamps, etc.) should be limited by the use of appropriate filters. Traditionally, welding goggles or shields of the appropriate "shade number" will provide adequate protection for limited viewing of such sources. Please contact the RSO for guidance on appropriate eye protection.

The blue light wavelengths (400 to 500 nm) present a unique hazard to the retina by causing photochemical effects similar to those found in UV radiation exposure. Visible light sources strongly weighted towards the blue should be evaluated by the RSO to determine if special protective eyewear is needed.

INFRARED RADIATION

Infrared radiation in the IR-A that enters the human eye will reach (and can be focused upon) the sensitive cells of the retina. For high irradiance sources in the IR-A, the retina is the part of the eye that is at risk. For sources in the IR-B and IR-C, both the skin and the cornea may be at risk from "flash burns." In addition, the heat deposited in the cornea may be conducted to the lens of the eye. This heating of the lens is believed to be the cause of so called "glass blowers" cataracts because the heat transfer may cause clouding of the lens.

- Retinal IR Hazards (780 to 1400 nm) - possible retinal lesions from acute high irradiance exposures to small dimension sources.
- Lens IR Hazards (1400 to 1900 nm) - possible cataract induction from chronic lower irradiance
  exposures.
- Corneal IR Hazards (1900 nm to 1 mm) - possible flash burns from acute high irradiance exposures.
- Skin IR Hazards (1400 nm to 1 mm) - possible flash burns from acute high irradiance exposures.

The potential hazard is a function of the following:

- The exposure time (chronic or acute)
- The irradiance value (a function of both the image size and the source power)
- The environment (conditions of exposure)

Evaluation of IR hazards can be difficult, but reduction of eye exposure is relatively easy through the use of appropriate eye protection.

Procedure for IR Hazards

1. If the light source is a laser, then refer to UTHSC Laser Safety procedure for requirements for the safe use of laser systems.
2. Implement an appropriate set of controls to ensure hazard awareness and control of visible light hazards.

   - *Engineering Controls:* Use barriers or appropriate shades when practical.
   - *Administrative Controls:* Personnel must be informed of the location of IR hazards. This can be done by training and through the posting of warning signage to identify the presence this type of hazard.
   - *Personal Protective Equipment:* Prolonged viewing of bright light sources (plasma arcs, flash lamps, etc.) should be limited by the use of appropriate filters. Traditionally, welding goggles or shields of the appropriate "shade number" will provide adequate protection for limited viewing of such sources. Specialized glassblowers goggles may be needed to protect against chronic exposures. Please contact the RSO for advice on appropriate eye protection.

MICROWAVE/RF RADIATION SOURCES

The campus contains many potential sources of microwave/RF radiation exposure. Some of these sources (primarily antennas) are designed to emit microwave/RF radiation into the environment.

Other types of sources (co-axial cables, waveguides, transmission generators, heaters, and ovens) are designed to produce or safely contain the microwave/RF radiation but may present a hazard should they leak for some reason. A third type of source (primarily power supplies) may create microwave/RF radiation as a byproduct of their operation.

The hazards from exposure to microwave/RF radiation are related to the following parameters:

- Frequency of the source
- Power density at the point of exposure
- Accessibility to the radiation field
- Does the exposure occur in the near or far field
- Orientation of the human body to the radiation field

In general, most biological effects of exposure to microwave/RF radiation are related to the direct heating of tissues (thermal effects) or the flow of current through tissue (induced current effects). Non-thermal effects resulting in carcinogenesis, teratogenesis, etc. have been demonstrated in animals but have not been proven by epidemiological studies on humans. The following biological effects have been demonstrated in humans:

- Cataract formation (from eye exposure).
- RF (induction) burns.
- Burns from contact with metal implants, spectacles, etc.

Procedure for Microwave/RF Hazards

1. If the microwave/RF source is a primary antenna, determine if posting and a physical barrier is required by consulting the manufacturer or contacting the RSO. If posting is required, personnel must be informed of the location of microwave/RF hazards. This can be done by training and through the posting of warning signage.
2. If the Microwave/RF source is contained in a device, it typically uses engineering controls such as interlocks or physical barriers. Do not defeat interlocks or degrade barriers. If the interlocks or barriers, fail to function contact the RSO.

MAGNETIC FIELD HAZARDS

Under certain conditions, sources of static magnetic fields can present health hazards.
Sources of large static magnetic fields may require appropriate controls to mitigate potential hazards. For sources intended to produce human exposure to the magnetic field (such as MRI devices), it is critical that safety precautions cover not only the user of the device, but also the research subject.

There are no known adverse bioeffects for flux densities within the ACGIH (American Conference of Governmental Industrial Hygienists) exposure limits. Implanted medical devices present a potential hazard to individuals exposed to fields above the ACGIH limits (see following section on kinetic energy hazards).

Due to the large fields associated with Nuclear Magnetic Resonance (NMR) magnets, ferrous objects can be accelerated toward the magnet with sufficient energy to seriously injure persons and/or damage the magnet. As a precaution, even small metal objects (screws, tools, razor blades, paper clips, etc.) should be kept at least 1.5 meters from the magnet (or anywhere the field exceed 30 G). Large ferrous objects (equipment racks, tool dollies, compressed gas cylinders, etc.) should be moved with care whenever the field approaches 300 G. There are many recorded instances in which large objects have been drawn towards and even into the bore of the magnet.

Procedure for Magnetic Field Hazards

1. Notify the RSO of NMR/MRI devices, excluding those that generate field strength less than 5 Gauss (G).
2. A field strength map of the area surrounding the magnet should be developed and posted in the vicinity of the system generating the magnetic field. The system manufacturer may be able to provide this information. If the magnetic field strength in your laboratory has not yet been evaluated, please call the RSO.
3. All access points to rooms containing magnets fields in excess of 5 G shall be marked with magnetic field hazard signs (contact RSO).
4. The 5 G threshold line shall be clearly identified with floor tape or equivalent markings. <u>NOTE: The location of the 5 G line will vary with the operating frequency and resulting magnetic fields.</u>
5. Persons with cardiac pacemakers or other implanted medical devices shall be restricted to areas outside the 5 G threshold line.
6. Security (locked doors) and proper door markings shall be maintained to prevent unauthorized access to the magnet area.