Non-Ionizing Radiation: Infrared, Radiofrequency, and Magnetic Fields

University of Tennessee Safety Program RAD-100

Document Contact: Radiation Safety
Date effective: July 1, 2022
Revision Date: July 1, 2022

Purpose

The University of Tennessee, Knoxville Non-Ionizing Radiation Safety Program exists to support the safe use of non-ionizing radiation sources on our campus and the University of Tennessee System Policy SA0100–Safety and Health Program.

Scope and Applicability

The scope of this program applies to faculty, staff and students on the University of Tennessee, Knoxville campus who are using devices that generate non-ionizing infrared, radiofrequency microwave and magnetic field generating equipment. Laser generated hazards are covered under the Laser Safety Program RAD-120. Ultra-Violet safety program guide is described in RAD-110.

Abbreviations and Definitions

EHS: Environmental Health and Safety

NIR: Non-Ionizing Radiation

OSHA: Occupational Safety and Health Administration

PPE: Personal Protective Equipment

UTK: University of Tennessee, Knoxville

Non-Ionizing Radiation: is a form of electromagnetic radiation with varying effects on the body, depending largely on the particular wavelength of the radiation. The types of non-ionizing radiation are: radio frequencies (RF, including radar and microwave); infrared (IR), ultraviolet (UV) light, and visible light.

Roles and Responsibilities

Employees/Students shall:

- Report all unintended or improper exposure incidents, near misses or unsafe equipment to your supervisor in the operation of NIR sources or related equipment.
- Follow all recommended work practices and specific operating procedures.
- Use PPE and equipment provided to decrease exposure to NIR hazards in the work area.
- Comply with all university policies, OSHA requirements and regulations to assure a safe and healthful working environment.
- Attend all required safety training and seek additional training or information if a NIR hazard is likely.
- Immediately terminate any work that is deemed unsafe or could lead to personal injury.

Supervisors/Principal Investigators shall:

- Provide employees with appropriate PPE and other controls. Ensure that employees properly use PPE and other control measures.
- Ensure that employees are familiar with the hazards associated with NIR and have been instructed on these hazards.
- Develop operating procedures specific to the NIR equipment.
- Ensure that proper warning signs are posted (if needed).

EHS shall:

- Provide on-site hazard analysis upon request, and assist in determining appropriate methods to minimize NIR exposure to within acceptable limits.
- Develop and implement UTK's NIR program and update, as needed.
- Provide, or arrange for, exposure testing and monitoring, as appropriate.
- Investigate accidents or incidents involving NIR and initiate appropriate action.

Training and Information

EHS can provide guidance and general instruction on exposure prevention to various types of hazardous NIR upon request.

At a minimum, supervisors should provide individuals in the workplace with instruction of their specific NIR hazards.

Specific IR Hazards (IR, RF, Mag)

Infrared Radiation

IR Hazards

Infrared (or heat) radiation is defined as having a wavelength between 780 nm and 1 mm. Specific biological effectiveness "bands" have been defined) as follows:

- IR-A (near IR) (780 nm to 1400 nm)
- IR-B (mid IR) (1400 nm to 3000 nm)
- IR-C (far IR) (3000 nm to 1 mm)

Infrared radiation in the IR-A range can cause damage to the retina. 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

Implement an appropriate set of controls to ensure hazard awareness and control of visible light hazards.

- Engineering Controls: Use barriers, appropriate shades, curtains or enclosures when practical. When possible, orient light sources so that they cannot be viewed. Visible light and Infrared can be reflected off shiny surfaces. The walls of enclosures should have a matte finish.
- Administrative Controls: Personnel should be informed of the location of IR hazards. This can be done through on-the-job instruction of the hazards in the workplace, written procedures for safe use of IR sources, and through the posting of hazard signage to identify the presence this type of hazard.
- Personal Protective Equipment: Viewing of bright light sources (plasma arcs, flash lamps, etc.) should occur with the use of personal protective face shields and eyewear with appropriate filters for the wavelength of light being encountered. The eyewear should be compliant with ANSI Z87.1. requires markings on eye protection that relate directly to the device's ability to defend against specific hazards. Eye protection that is Z87.1-compliant is marked with "Z87." Welders gloves or tightly woven fabric gloves and protective coat or clothing may be necessary to protect skin.

Radiofrequency (including Microwave)

RF and Microwave Hazards

The campus contains many potential sources of microwave or radiofrequency (RF) radiation exposure. Some of these sources-primarily antennas or transmission equipment - are designed to emit radiofrequency 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
- Evaluating if the exposure occurs in the near or far field
- Orientation of the human body to the radiation field

Potential Effects from Exposure to Microwave or RF Radiation

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 Hazards

Engineering controls are the best and preferred method for microwave safety. Shielding materials can greatly reduce or eliminate exposures.

Commercially available microwave ovens are manufactured to meet their stated intent with safety interlocks and barriers in place. They are not included in this program due to the federal safety requirements these products must meet. Do not defeat interlocks, degrade barriers, or alter controls within this type of equipment.

Safety evaluations for microwave radiation are not performed unless engineering controls such as shielding, and enclosures need to be evaluated. Review and follow manufacturer instructions for equipment set-up and safety.

Procedure Radiofrequency Hazards

If the radiofrequency source is a transmission source, determine if posting and a physical barrier is required by consulting the manufacturer or the FCC license. If posting is required, personnel must be informed of the location of microwave/RF hazards. This can be accomplished through the posting of hazard signage on the physical barrier. Hazard instruction and PPE may be necessary for individuals accessing RF controlled areas.

EHS will rely on the services of outside consultants if safety and hazard assessments for radiofrequency electromagnetic fields related to transmission, communication services, cellular phones, or extremely low frequency fields from sources such as power lines is necessary.

Radiofrequency sources not associated with transmission can include RF sealers, heaters, diathermy, or other applications. The hazard from these items is based on the exposure conditions and sources. Signage, controlled areas or barriers, and safety instruction may be necessary. Review and follow manufacturer instruction. Contact EHS for assessments or guidance.

Magnetic Field Hazards

Under certain conditions, sources of static magnetic fields can present health hazards and require appropriate controls to mitigate potential hazards. There are no regulatory exposure limits for magnetic fields. The American Conference of Governmental Industrial Hygienists 2012 exposure limits for static magnetic fields are as follows:

Whole body (general workplace):	2 Tesla
Whole body (controlled workplace environment):	8 Tesla
Limbs:	20 Tesla
Cardiac Pacemaker or medical device wearers:	0.5 milliTesla

Magnetic devices with a static field strength of less than 5 Gauss (G) or 0.5 milliTesla and 1 Gauss or less for 50/60 Hz fields are excluded from this program.

Areas where the magnetic field is 5 Gauss or higher must have public access restrictions. At magnetic fields stronger than 30 Gauss, ferromagnetic objects are strongly attracted to the magnet and can become projectiles.

Procedure for Magnetic Field Hazards

1. 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.
2. All access points to rooms containing magnets fields in excess of 5 Gauss shall be marked with magnetic field hazard signs.
3. The 5 Gauss threshold line shall be clearly identified with floor tape, chain, or equivalent threshold markings.
4. Persons with cardiac pacemakers or other implanted medical devices shall be restricted to areas outside the 5 Gauss threshold line.
5. Security (locked doors) and proper door markings shall be maintained to prevent unauthorized access to the magnet area.

References

University of Tennessee System Policy SA0100–Safety and Health Program
https://policy.tennessee.edu/

Federal Communications Commission
https://www.fcc.gov/general/fcc-policy-human-exposure

International Commission of Non-Ionizing Radiation Protection (ICNIRP)
https://www.icnirp.org/

OSHA Non-Ionizing Radiation
https://www.osha.gov/non-ionizing-radiation

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