

Microwave and Radio Frequency Radiation Safety Policy

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.

Factors Affecting Exposure to Microwave/RF Radiation

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

This combination of factors is used in both evaluating and mitigating the hazard.

Potential Bio effects of Exposure to Microwave/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 (formation of cancer causing cells), teratogenesis (abnormalities in physiological development), 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.

Standards for Microwave/RF Radiation Exposure Protection

A large number of standards have been developed for use in protecting individuals against overexposure to microwave/RF radiation. These standards often address only specific frequency bands or exposure conditions. In an effort to address the broad research potential for microwave/RF radiation exposure at NAU, the following table of exposure standards was developed. The table is a synthesis of several regulatory standards and guidelines (as indicated).

NAU Radio Frequency Policy Exposure Targets
(Derived from ACGIH TLV, AAC Article 14 Sec R12-1-1405, IRPA NIR, FCC OET 65,
and IEEE C95.1)

OCCUPATIONAL EXPOSURE LIMITS

All exposures averaged over 0.1 hour (6 minutes)

<u>Frequency Band</u>	<u>E field (V/m)</u>	<u>H Field (A/m)</u>	<u>S (mW/cm²)</u>
<3 kHz	5000	80 (1000 mG)	N/A
3 kHz - 100 kHz	614	1.63	100
100 kHz-1.34 MHz	614	1.63	100
1.34 MHz - 3 MHz	614	1.63	100
3 MHz - 30 MHz	1842/f	4.89/f	900/f ²
30 MHz - 100 MHz	61.4	0.163	1
100 MHz - 300 MHz	61.4	0.163	1
300 MHz - 3 GHz	N/A	N/A	f/300
3 GHz - 15 GHz	N/A	N/A	f/300
15 GHz - 30 GHz	137	0.36	5
30 GHz - 300 GHz	137	0.36	5

NON-OCCUPATIONAL EXPOSURE LIMITS

All exposures averaged over 0.5 hour (30 minutes)

<u>Frequency Band</u>	<u>E field (V/m)</u>	<u>H Field (A/m)</u>	<u>S (mW/cm²)</u>
<3 kHz	5000	80 (1000 mG)	N/A
3 kHz - 100 kHz	614	1.63	100
100 kHz-1.34 MHz	614	16.3/f	100
1.34 MHz - 3 MHz	823.8/f	16.3/f	180/f ²
3 MHz - 30 MHz	823.8/f	16.3/f	180/f ²
30 MHz - 100 MHz	27.5	158.3/f ^{1.688}	0.2
100 MHz - 300 MHz	27.5	0.0729	0.2
300 MHz - 3 GHz	N/A	N/A	f/1500
3 GHz - 15 GHz	N/A	N/A	f/1500
15 GHz - 30 GHz	N/A	N/A	f/1500
30 GHz - 300 GHz	N/A	N/A	5

Where: f = frequency in MHz

Key to Reference Standards

- International Non-ionizing Radiation Committee (INIRC) of the International Radiation Protection Association (IRPA) - Interim Guidelines on Limits of Exposure to 50/60 Hz Electric and Magnetic Fields (1989).
- Institute of Electrical and Electronics Engineers (IEEE) Publication C95.1 - Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz (1991).
- Arizona Administrative Code (AAC) Article 14 Sec R12-1-1404 to 1410 – Registration of Nonionizing Radiation Sources and Standards for Protection Against Nonionizing Radiation
- American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values for Chemical Substances and Physical Agents Physical Agents Section Sub-Frequency (30 kHz and below) Magnetic Fields & Sub-Frequency (30 kHz and below) and Static Electric Fields
- Federal Communications Commission Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields OET Bulletin 65, Edition 97-01, 1997

Identifying and Controlling Microwave/RF Radiation Hazards

The Office of Environmental Health and Safety (EH&S) will work with you to identify and assess the microwave/RF radiation hazards in your work area. Because of the difficulties of performing actual microwave/RF radiation surveys (near field measurements, cost of equipment, etc.), it is often necessary to use calculations and/or computer models to replace actual measurements in evaluating the hazard.

Antennas and Antenna Arrays

Operation of radio, television, microwave, and other related communication systems using electromagnetic radiation, and carrier-current systems require prior review and approval by EH&S. Once contacted, EH&S will conduct a hazard assessment and advise and assist you in reaching and maintaining compliance on any licensing requirements, operational and training issues, and any applicable FCC regulations. EH&S maintains an inventory of all transmission antennas on campus for the purpose of ensuring the maintenance of any mandatory registrations and safety program elements. Please contact EH&S before you place a new transmission antenna in or on any campus building or location.

Wireless Local Area Networks (WLAN)/WiFi

Radio frequency based wireless local area networks (LAN's)/WiFi are becoming available on the campus. WiFi systems (indoor and outdoor) are very safe when properly installed and used. WiFi systems operate on extremely low power (less than that of a cell phone). It is important that only approved equipment be used to build a campus operated WiFi.

Campus operated WiFi equipment installations shall be designed to prevent potential hazardous conditions from existing. The placement of base station antennas should be high on a wall or on the ceiling. This not only increases the useful range of the system, but also allows for a separation distance of 50 cm, which is sufficient of safe operation. In general, persons should avoid direct contact with antennas attached to computer cards. A separation distance of 10 cm is sufficient for safe operation. For more information on the safety of WiFi

networks at NAU, please refer to EH&S position paper PP:NAU:RF:1; [Position Statement on WiFi Radiation Concerns](#).

Other Potential Microwave/RF Radiation Sources (Leakage Sources)

For waveguides, co-axial cables, generators, sealers, and ovens, the most important aspect of controlling microwave/RF radiation hazards is a careful physical inspection of the source. Leaking sources will normally show misalignment of doors or plates, missing bolts, or physical damage to plane surfaces. Sources, which are suspected of leaking should be repaired and then surveyed with appropriate instrumentation to verify they are no longer leaking. Contact EH&S if you need assistance with evaluating microwave/RF radiation leakage hazards.

Power Supplies

Many high voltage power supplies operate in the microwave or radiofrequency regions. If damaged, or not properly shielded, these sources can leak, producing unintended microwave/RF radiation exposure. Most of the time, the leakage from these sources is minimal and does not present a hazard. However, if you have an indication of microwave/RF radiation leakage (RF interference with other equipment or documentation warning of interference), please contact EH&S for a survey.