

BGSU

Bowling Green State University



Radiofrequency Safety Program

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INTRODUCTION

Foreword

Bowling Green State University is committed to providing a safe and healthful work environment for our entire staff. In pursuit of this goal, the following radiofrequency safety program is provided to minimize occupational exposure to non-ionizing radiation. This Standard will be implemented at both the University's main campus as well as the Firelands College branch campus in Huron, Ohio.

The purpose of this document is to set forth the policies of Bowling Green State University with respect to sources of non-ionizing radiation in the form of radiofrequency (RF) radiation. This plan is to provide an awareness to RF and inform employees how to recognize sources and signage applicable to RF. The policies apply to individuals who will be expected to perform job tasks around sources of RF radiation.

Objective

The objective of the Radio Frequency (RF) Safety Program is to provide safe and healthful working conditions for employees and contractors who are performing work activities for Bowling Green State University through education, awareness, and protective practices and equipment. This program provides basic information on:

- What RF and non-ionizing radiation is;
- the potential hazards posed by exposure to radio frequency;
- how to identify areas where RF sources exist;
- understanding signage associated with RF sources; and,
- control measures to minimize exposure to RF.

Introduction

Radiofrequency (RF) energy is a type of electromagnetic energy. Electromagnetic waves and associated phenomena can be discussed in terms of energy, radiation or fields. Electromagnetic "radiation" can be defined as waves of electric and magnetic energy moving together (i.e., radiating) through space. These waves are generated by the movement of electrical charges. For example, the movement of charge in a radio station antenna (the alternating current) creates electromagnetic waves that radiate away from the antenna and can be intercepted by receiving antennas. Electromagnetic "field" refers to the electric and magnetic environment existing at some location due to a radiating source such as an antenna. An electromagnetic wave is characterized by its wavelength and frequency. The wavelength is the distance covered by one complete wave cycle. The frequency is the number of waves passing a point in a second. For example, a typical radio wave transmitted by a 2-meter VHF station has a wavelength of about 2 meters and a frequency of about 145 million cycles per second (145 million hertz): one cycle/second = one hertz, abbreviated Hz. Electromagnetic waves travel through space at the speed of light. Wavelength and frequency are inversely related by a simple equation: (frequency) times (wavelength) = the speed of light, or $f \times l = c$. Since the speed of light is a constant quantity, high frequency electromagnetic waves have short wavelengths and low-frequency waves have long wavelengths. Frequency bands used for amateur radio transmissions are usually characterized by their approximate corresponding wavelengths, e.g., 12, 15, 17, 20 meters, etc. The electromagnetic "spectrum" includes all the various forms of electromagnetic energy ranging from extremely low frequency (ELF) energy (with very long wavelengths) to all the way up to X-rays and gamma rays which have very high frequencies and correspondingly short wavelengths. In between these extremes lie radio waves, microwaves, infrared radiation, visible light, and ultraviolet radiation, respectively. The RF part of the electromagnetic spectrum can generally

be defined as that part of the spectrum where electromagnetic waves have frequencies that range from about 3 kilohertz (kHz) to 300 gigahertz (GHz). [FCCO – 2001]

The FCC guidelines include two categories of exposure limits that are dependent on the situation in which the exposure takes place and/or the status of the individuals who are subject to exposure. The decision as to which tier applies in a given situation should be based on the application of the following definitions.

Occupational/controlled exposure limits apply to situations in which persons are exposed as a consequence of their employment and in which those persons who are exposed have been made fully aware of the potential for exposure and can exercise control over their exposure. Occupational/controlled exposure limits also apply where exposure is of a transient nature as a result of incidental passage through a location where exposure levels may be above general population/uncontrolled limits (see below), as long as the exposed person has been made fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means. As discussed previously, occupational/controlled exposure limits apply to amateur licensees and members of their immediate household (but not their neighbors - see below). In general, a controlled environment is one for which access is controlled or restricted. In the case of an amateur station, the licensee or grantee is the person responsible for controlling access and providing the necessary information and training as described above.

General population/uncontrolled exposure limits apply to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Therefore, members of the general public always fall under this category when exposure is not employment-related, as in the case of residents in an area near a broadcast tower. Neighbors of amateurs and other non-household members would normally be subject to the general population/uncontrolled exposure limits. [FCCO – 2001]

Controls

Control methods are a way of eliminating or minimizing exposure to a hazard. In this case, the hazard would be RF radiation.

- Antennas that will routinely exceed the occupational standards should be placed in locations least likely to be encountered by common foot traffic (e.g. cell relays mounted on the interior face of the upper floor of a building).
- Exposure of workers to RF radiation should not exceed the recommended exposure limits.
- Areas where worker exposure to RF radiation is suspected to exceed the recommended limits must be surveyed to determine the exposure levels, and precautions shall be made to ensure this area is not accessible to the “public”.
- Needless exposure to RF fields should be avoided.
- Exposure times should be kept as short as reasonably possible.
- Any workers that have pacemakers, metal implants, or other medical devices are not recommended to perform work near RF devices, unless medical authorization from a medical physician permits them to do so.
- Potentially hazardous RF devices should be appropriately labeled, and areas of excessive exposure around them clearly demarcated. Where required notices with warnings and the necessary precautions shall be posted.
 - RF Devices are labeled using four distinct categories:
 - Category 1 – Safe for the general public. (see *Figure 2*)
 - Category 2 – Not safe for general public, but safe for occupational doses. (see *Figure 3*)
 - Category 3 – May exceed occupational doses. (see *Figure 4*)
 - Category 4 – Exceeds occupational doses by at least ten times the regulatory amount. (see *Figure 5*)

- RF devices should not be used in flammable or explosive atmospheres unless deemed “intrinsically safe” by the manufacturer.
- Equipment sensitive to RF radiation, such as telephone switchboards or control panels, should not be installed near sources of RF radiation.
- When exposures cannot be reduced by the above methods, the RF device should be disabled for maintenance/work to be performed (e.g. Offenhauer Tower or other Category 4 devices)
- Maintenance of devices used to produce RF radiation should be done by qualified personnel following standard safety procedures. The equipment should be turned off whenever possible.

Standard Operating Procedures (SOPs)

In addition to the controls listed above, Standard Operating Procedures (SOPs) are required to be followed. SOPs are used to outline safe protocols prior to the work is performed. The most common interaction with RF equipment would be with maintenance or contractors performing work on the rooftops of buildings. The SOP for those personnel is listed below. Although the work performed may cause SOPs to vary on a case-to-case basis, this example signifies a great outline of what safety procedures will need to be followed, regardless of the type of work that will be conducted near RF equipment.

Personal Protective Equipment (PPE)

When controls do not mitigate a hazardous situation, personal protective equipment must be utilized. Category 4 devices are not permitted to perform work until permission is granted from the owner of the device to properly lockout and tagout the device, using BGSU Lockout Tagout procedures. In addition, personnel performing RF surveys on rooftops, should be wearing rubber-soled heeled footwear, to prevent slippage when climbing up or down ladders or incidental electrical shock. The use of heat resistant gloves is also recommended to limit the risk of burns. Other forms of PPE may be required depending on the scope of work that will be performed. Please visit the Standard Operating Procedures (SOPs) for job-specific tasks prior to performing work.

Controlling RF Shocks and Burns

Personnel working around active RF emitters can utilize certain methods to mitigate the potential for shocks or burns.

1. Minimize contact with external surfaces of radiating devices.
2. Metallic structures producing contact shocks should be electrically grounded
3. and/or insulated.
4. Insulating platforms or shoes (e.g., rubber-soled shoes) can be used to reduce energy absorption and currents to ground.
5. When the above measures are ineffective or not reasonably possible, workers should wear insulating gloves.

Training

All individual workers who will have access to roof top environments should take the RF safety training so that accurate assessments of risks and hazard signage evaluations can be made where applicable. Authorized personnel may take RF safety training through classes coordinated by the Department of Environmental Health and Safety, either online or in-person. Both contractors and BGSU personnel that will be performing work will also have access to RF Safety Procedure pamphlets outlining the hazards and procedures to perform work around RF devices safely. At a minimum, anyone performing work near RF devices are to review these procedures prior to performing work.

To access dates for RF safety training classes, or to take the online safety training, please visit the BGSU Environmental Health and Safety website. Training can also be requested by contacting the Department of Environmental Health and Safety.

RF Protection Program

The Occupational Health and Safety Administration (OSHA), in coordination with the regulatory agencies that set guidelines for RF safety guidelines have published an outline of eight standard elements for a comprehensive protection program. These elements reiterate University policies that support the use of engineering controls, such as lockout tagout, in comparison to other methods to ensure a safe working environment near RF devices. Additionally, this program outlines the responsibilities of the owners of the devices and what steps need to be taken to maintain an effective RF safety program. This information is pertinent for owners of RF devices on BGSU property and for administrators of the RF Safety Program.

Element 1: Utilization of RF source equipment which meet applicable RF and other safety standards when new and during the time of use, including after any modifications.

- Manufacturers of RF source equipment are responsible for making equipment that complies with applicable standards, and for providing information on the hazards of operating and servicing the equipment. The information must be sufficient to alert the end-user of potential hazards and necessary controls applicable to using the equipment. Manufacturers are therefore required to make detailed RF emission measurements of their products. Appropriate RF survey results should be provided to the end-user for comparison purposes.
- For many low-power products, such as cellular phones, no additional measurements are required by the end-user.
- For other products, the users should conduct RF "screening" measurements of equipment emissions after installation, major maintenance, and any modifications which could affect RF emissions. Significant deviations from previous measurements should be resolved.

Element 2: RF hazard identification and periodic surveillance by a competent person who can effectively assess RF exposures.

- Screening measurements are normally sufficient to identify potentially hazardous RF areas which will require some control strategy, such as to determine where a fence should be located. More complex measurements are necessary if the employer intends to allow exposures to employees approaching RF standards. For example, detailed measurements are necessary if whole-body and/or time-weighted averaging of exposures is necessary to bring exposures into compliance.
- RF fields can induce currents in nearby conducting objects, such as a metal barrier or fence used to restrict access to RF hazard areas. These must be evaluated to ensure they do not constitute RF shock and burn hazards. Although detail measurements can be made, the "measurement" of startling/annoying RI spark discharge can usually be made by a quick touch.

Element 3: Identification and Control of RF Hazard Areas.

- Controlling exposure time and the distance between the RF source and the operator are important in maintaining workers' exposures below recommended levels. When necessary due to excessive leakage, "RF hazard areas" must be identified to alert workers of areas that are not to be occupied during RF application. The location of the hazard areas must be based on exposure measurements made during maximum field generation and duty factor (i.e., ratio of RF "on" time during any 6-minute period, assuming intermittent exposure).
- Access to RF hazard areas should be controlled with BGSU Lockout/Tagout procedures (ref. 29 CFR 1910.147) to ensure workers are not occupying these areas during the application of RF energy. It may be possible to use continuous monitors and/or personal monitors in lieu of, or to supplement, more traditional Lockout/Tagout procedures which lockout the RF power source.
- The RF hazard areas shall be clearly marked with appropriate signs, barricades, floor markings, etc. such that any worker who has access to the facility will be alerted not to occupy the hazardous locations. Signs shall be of standard design and shape (ref ANSI C95.1), and of sufficient size to be recognizable and readable from a safe distance.
- Screening measurements can be used to determine where to locate signs to alert workers approaching an RF hazard area, including the appropriate warning message on the sign (e.g., Notice, Caution, Danger).
- The evacuation of hazard areas prior to RF application must be strictly enforced.

Element 4: Implementation of controls to reduce RF exposures to levels in compliance with applicable guidelines (e.g., ANSI, ICNIRP), including the establishment of safe work practice procedures.

- Reliance on averaging is normally not "recommended" when establishing basic control strategies because it obligates the employer to conduct "measurement" of employee activity to ensure the averaging is applicable, such as timing an employee's access inside an area which cannot be occupied for 6 minutes without exceeding the allowable time-weighted exposure. Where possible, controls should be

established under the assumption that standards are not time-weighted, i.e., assume the standards are ceiling limits which are not to be exceeded.

- Measurements are necessary during the development of work practices to ensure the practices are effective in preventing excessive exposures. Detailed measurements are required if exposures are approaching guideline limits as discussed above.
- Appropriate work practices must be followed during the repair and maintenance of RF equipment. Occasionally, cabinet panels must be removed by service personnel to allow access for maintenance. Failure to replace a panel properly may result in excessive RF leakage. RF screening measurements can be used to determine which panels can be removed during operation (assuming other hazards, such as electrical shock, are controlled), and to ensure the shielding is reinstalled properly.
- Detailed measurements must be made by the manufacturers of RF personal protective equipment (PPE) to show its effectiveness and limitations. Limited measurements are necessary by the user to ensure the PPE is applicable and effective for the specific worksite conditions.

Element 5: RF safety and health training to ensure that all employees understand the RF hazards to which they may be exposed and how the hazards are controlled.

- Measurement of worker exposures is necessary so that this information can be provided as part of employee hazard training. The scope of training, including reviews of potential biological effects, will be dependent on measured exposure levels.

Element 6: Employee involvement in the structure and operation of the program and in decisions that affect their safety and health, to make full use of their insight and to encourage their understanding and commitment to the safe work practices established.

- RF screening measurements should be made in the presence of employees to facilitate understanding and confidence in the program.

Element 7: Implementation of an appropriate medical surveillance program.

- Although the goal of this program is to minimize or eliminate any harmful exposure to RF, there is a slight risk of bodily injury. If an injury would occur, the BGSU Injury and Illness Report Form will need to be completed. If medical attention is needed, this will need to be noted in the form.
- Personnel who have implanted medical devices, such as pacemakers, are not permitted to perform work near RF generating equipment as the electromagnetic fields may interfere with such devices.

Element 8: Periodic (e.g., annual) reviews of the effectiveness of the program so that deficiencies can be identified and resolved.

- Periodic RF screening measurements are necessary to ensure conditions have not changed and that the RF Protection Program continues to be effective in preventing excessive RF exposures.
- The Department of Environmental Health and Safety annually reviews the RF inventory, policies, and procedures to ensure they are meeting regulatory requirements and are meeting the needs of interdepartmental operations.

Element 9: Assignment of responsibilities, including the necessary authority and resources to implement and enforce all aspects of the RF protection program.

- Although this element does not directly require RF measurements, it is included for completeness of the list of RF Program elements. Without the commitment to the Program, as demonstrated by the assignment of necessary responsibility, authority and resources, the previous elements will not be effective.

Definitions

Exposure: Exposure occurs whenever and wherever a person is subjected to electric, magnetic or electromagnetic fields other than those originating from physiological processes in the body and other natural phenomena.

Hertz (Hz): The unit for expressing frequency, (f). One hertz equals one cycle per second

Radiofrequency (RF) "hot spot": A highly localized area of relatively more intense radio-frequency radiation that manifests itself in two principal ways:

1. The presence of intense electric or magnetic fields immediately adjacent to conductive objects that are immersed in lower intensity ambient fields (often referred to as re-radiation), and
2. Localized areas, not necessarily immediately close to conductive objects, in which there exists a concentration of RF fields caused by reflections and/or narrow beams produced by high-gain radiating antennas or other highly directional sources. In both cases, the fields are characterized by very rapid changes in field strength with distance. RF hot spots are normally associated with very non-uniform exposure of the body (partial body exposure). This is not to be confused with an actual thermal hot spot within the absorbing body.

Wavelength (λ): The wavelength (λ) of an electromagnetic wave is related to the frequency (f) of an electromagnetic wave is related to the frequency (f) and velocity (v) by the expression $v=f\lambda$. In free space the velocity of an electromagnetic wave is equal to the speed of light, i.e. approximately 3×10^8 m/s

Works Cited

F. C. C. O. of Engineering Technology, Supplement C (Ed. 01-01) to OET Bulletin 65 (Ed. 97-01), Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields, Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions. Washington, DC: FCC, Jun. 2001.

APPENDIX A: NOTICES AND SIGNAGE



Figure 1: View of signage present that states safety guidelines while working near antennas that emit radio frequency.



Figure 2: View of signage present that is meant to inform that there are transmitting antennas present beyond the sign. This sign may not be located near every piece of RF equipment as it is non-required.



Figure 3: View of a Notice Sign which indicates that a RF producing device is nearby that may exceed general population limits but does not exceed occupational limits.



Figure 4: View of a Caution sign which indicates that RF producing equipment is nearby that may meet or exceed occupational exposure limits.

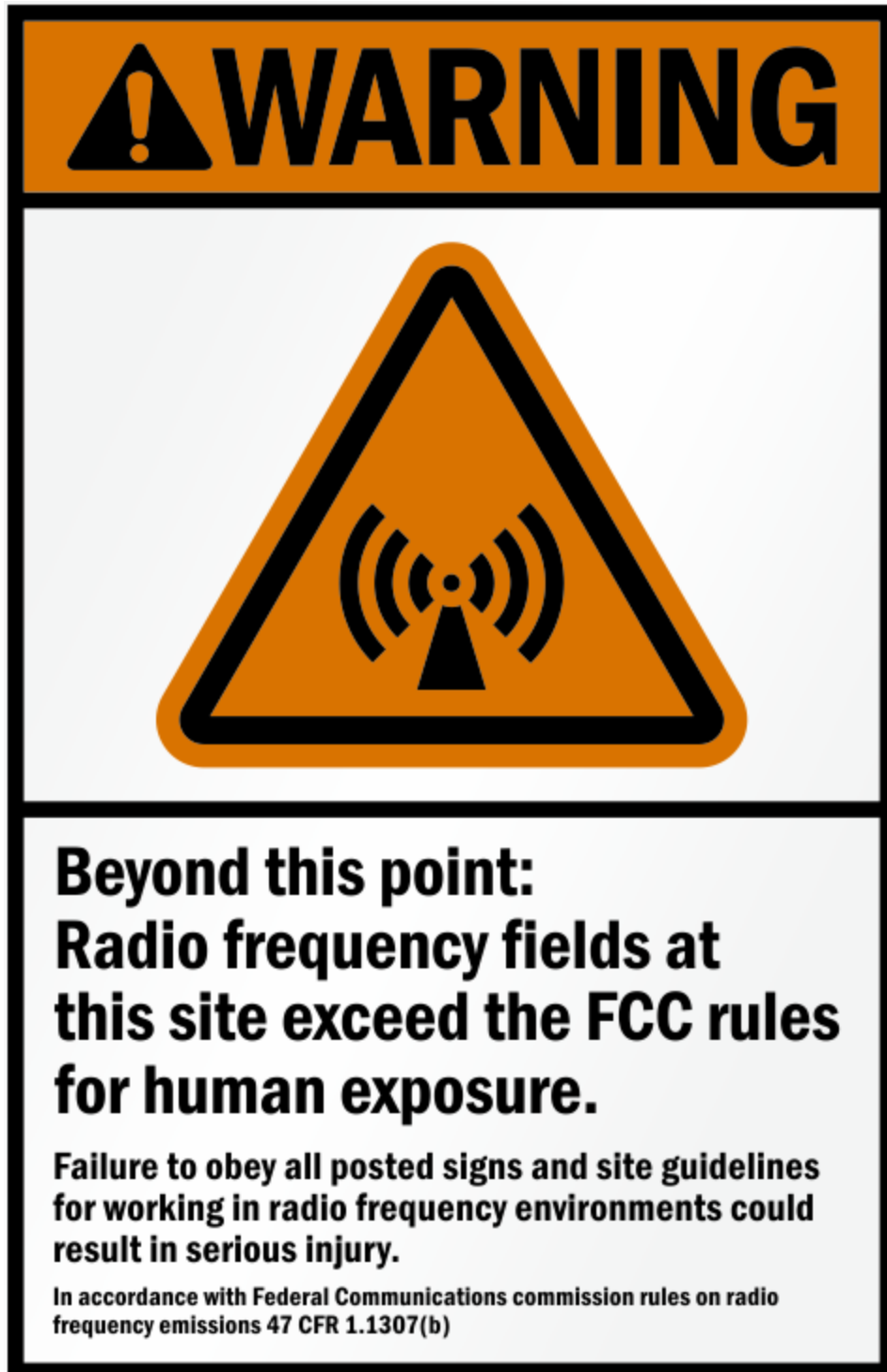


Figure 5: View of a Warning sign which indicates that RF producing equipment is nearby that exceeds occupational exposure limits by at least ten times the regulatory limit.

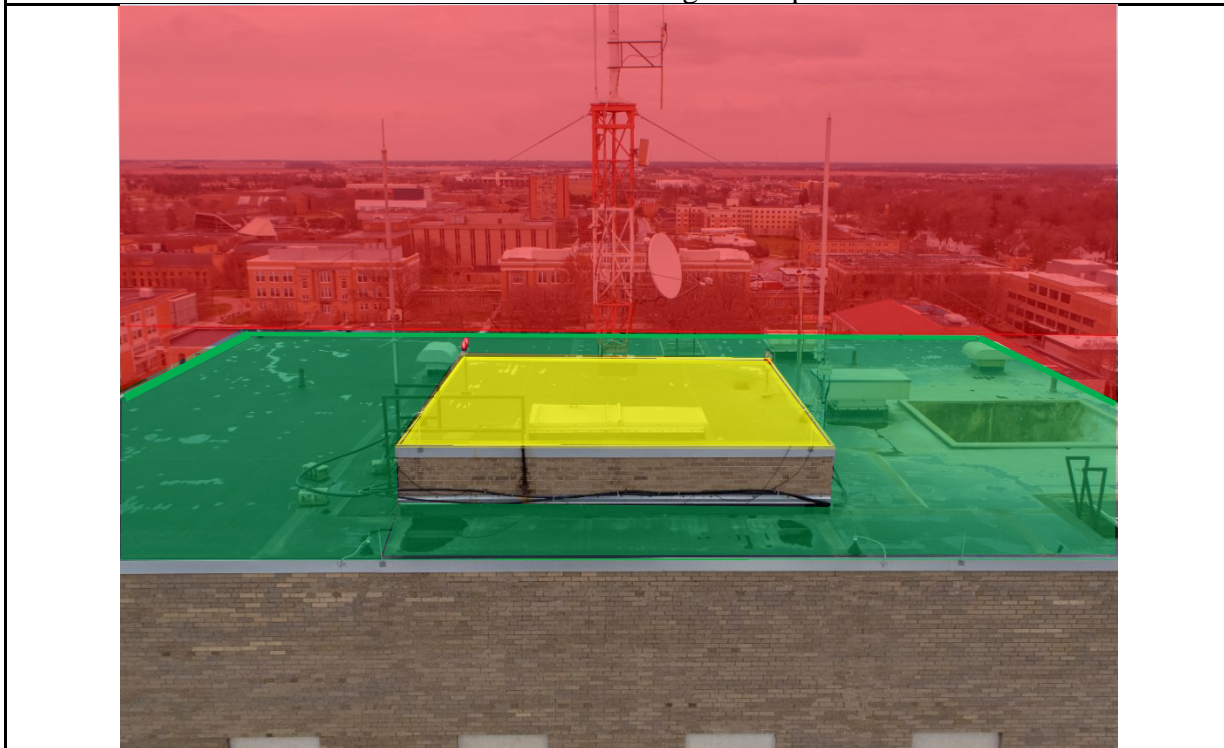
APPENDIX B: RF LOCATIONS AT BGSU – MAIN CAMPUS

RF Locations at BGSU-Main Campus

Administration Building



Aerial view of Administration Building rooftop with RF devices.



RF devices on Administration Building rooftop and directional RF energies. (Green = safe zone, yellow = caution zone, red (above the tower) = higher RF hazard)

East Hall

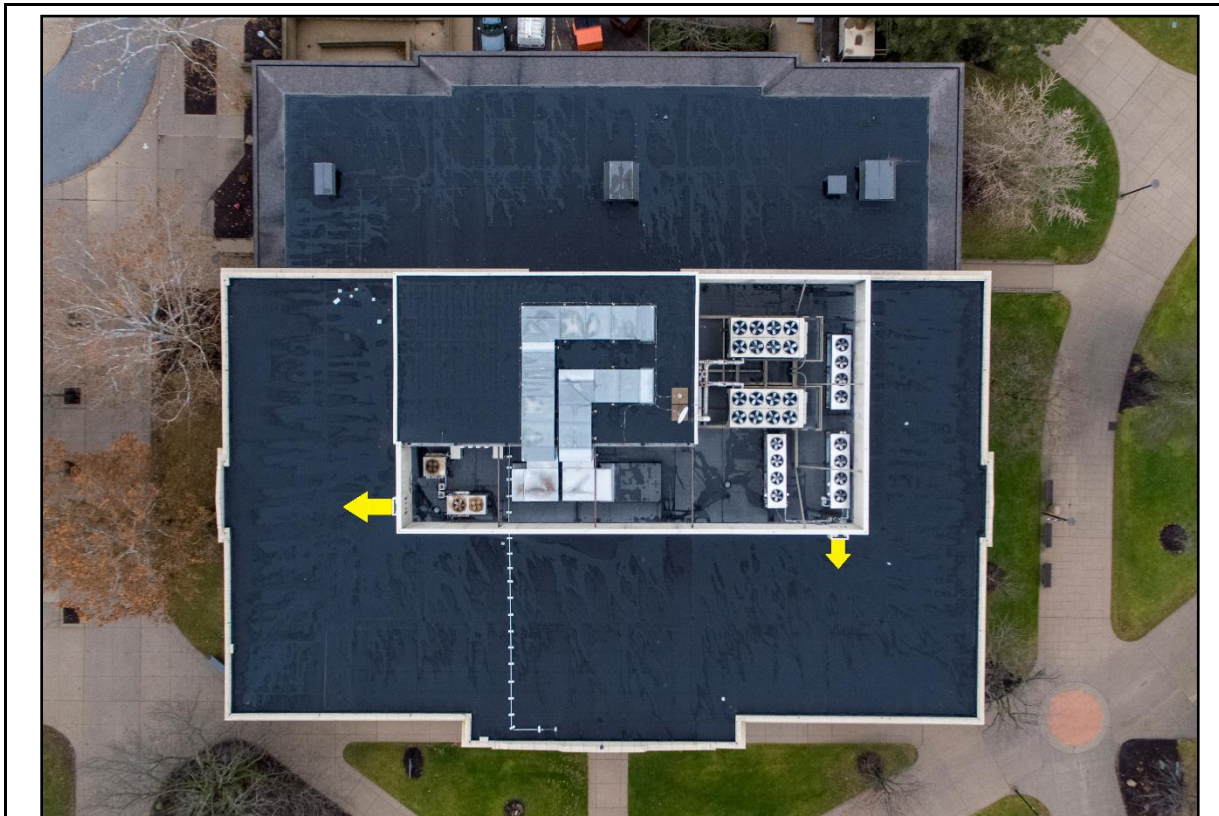


Aerial view of East Hall and the directional RF energy.



View of the RF source and spatial RF hazard area.

Hayes Hall



Aerial view of Hayes Hall and the directional RF energy.



View from the Northwest of the RF source (RF source is West facing)

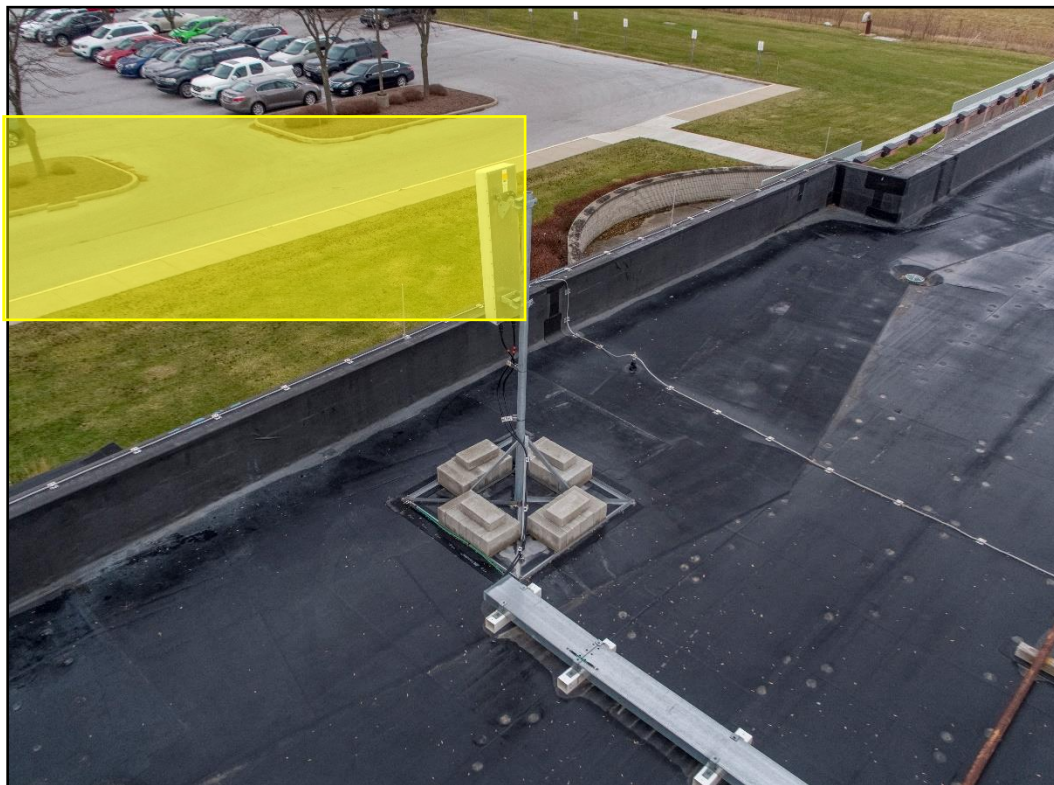


View from the West of the RF source (RF source is North facing)

Huntington Building



Aerial view of the Huntington Building and the directional RF energy.



View of an RF source facing the parking lot.



View of RF Devices and the spatial RF hazard area.

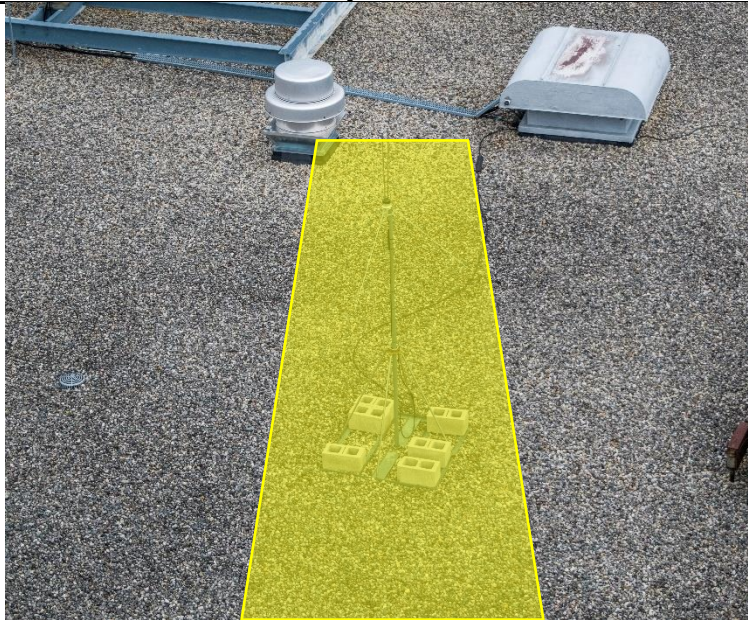


View of RF Device facing the North and the spatial RF hazard area.

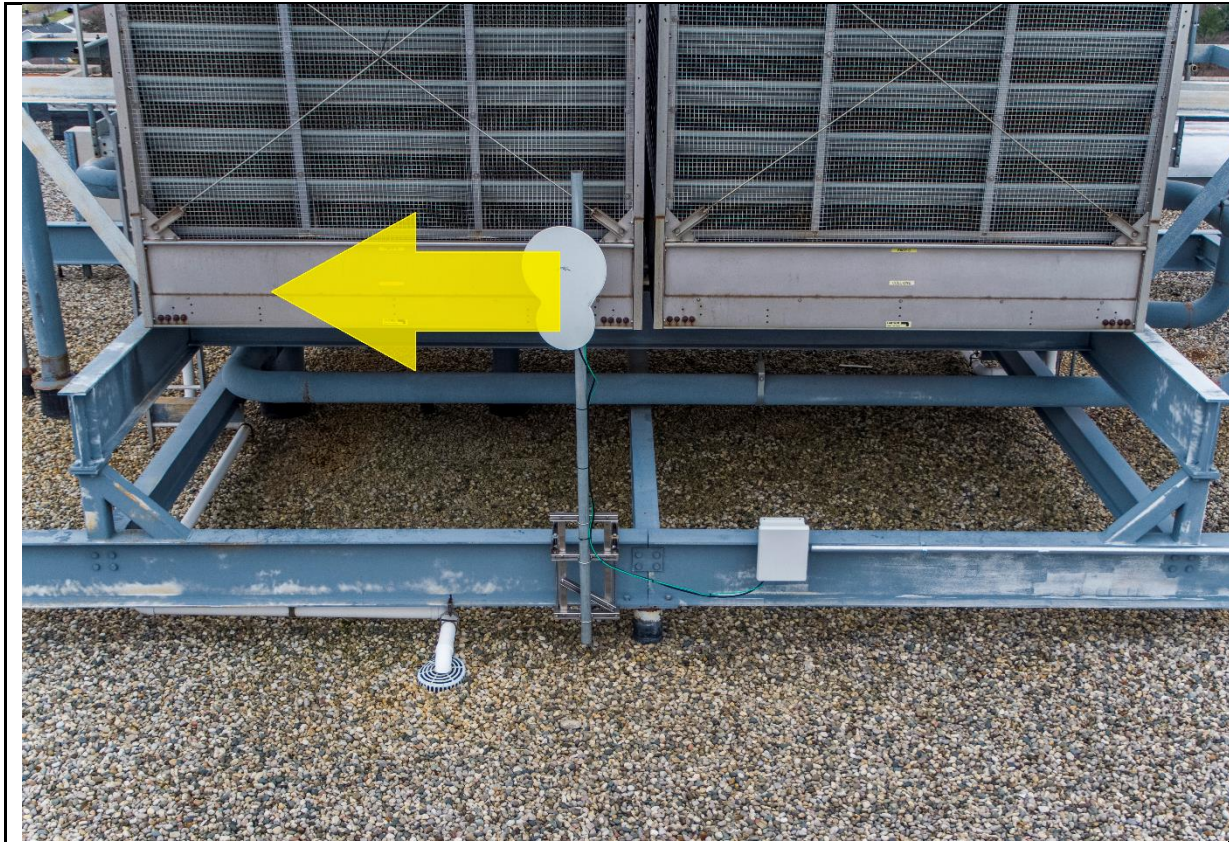
Jerome Library



Aerial view of Jerome Library and the locations of RF devices.

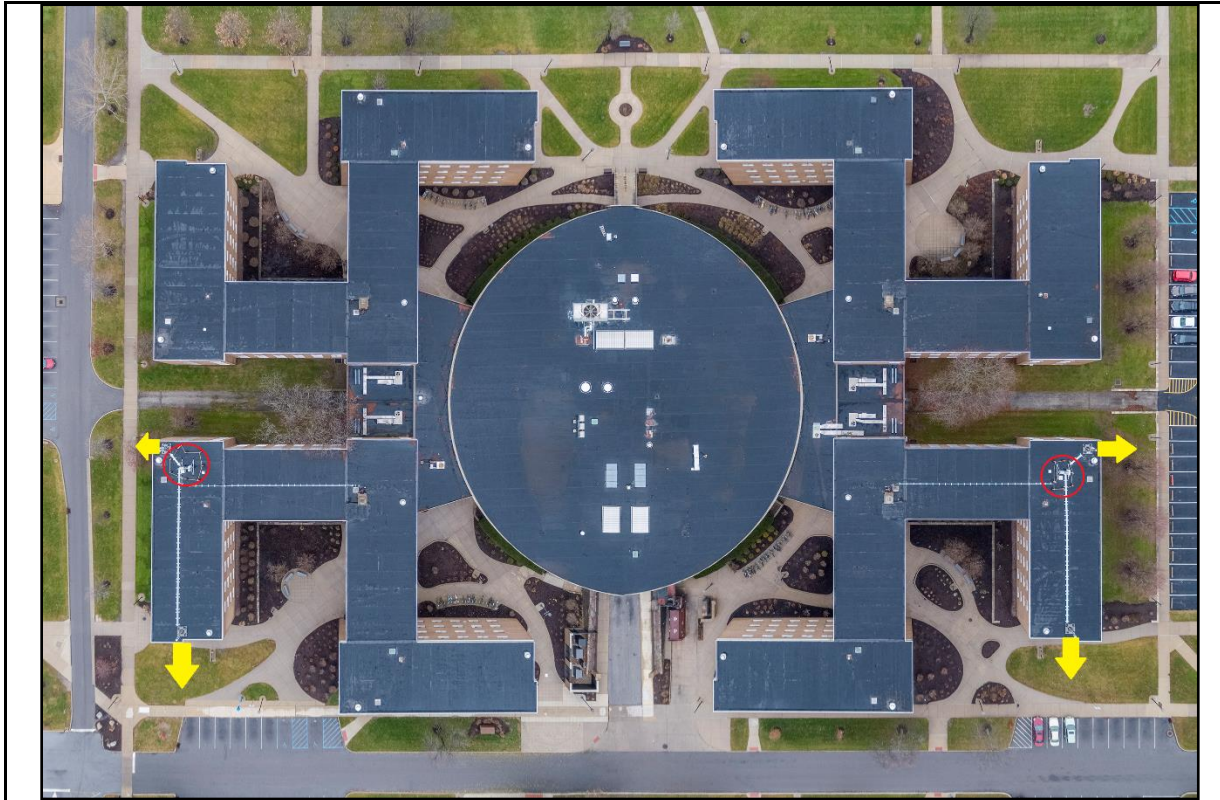


RF device on rooftop of Jerome Library and the spatial RF hazard distribution.

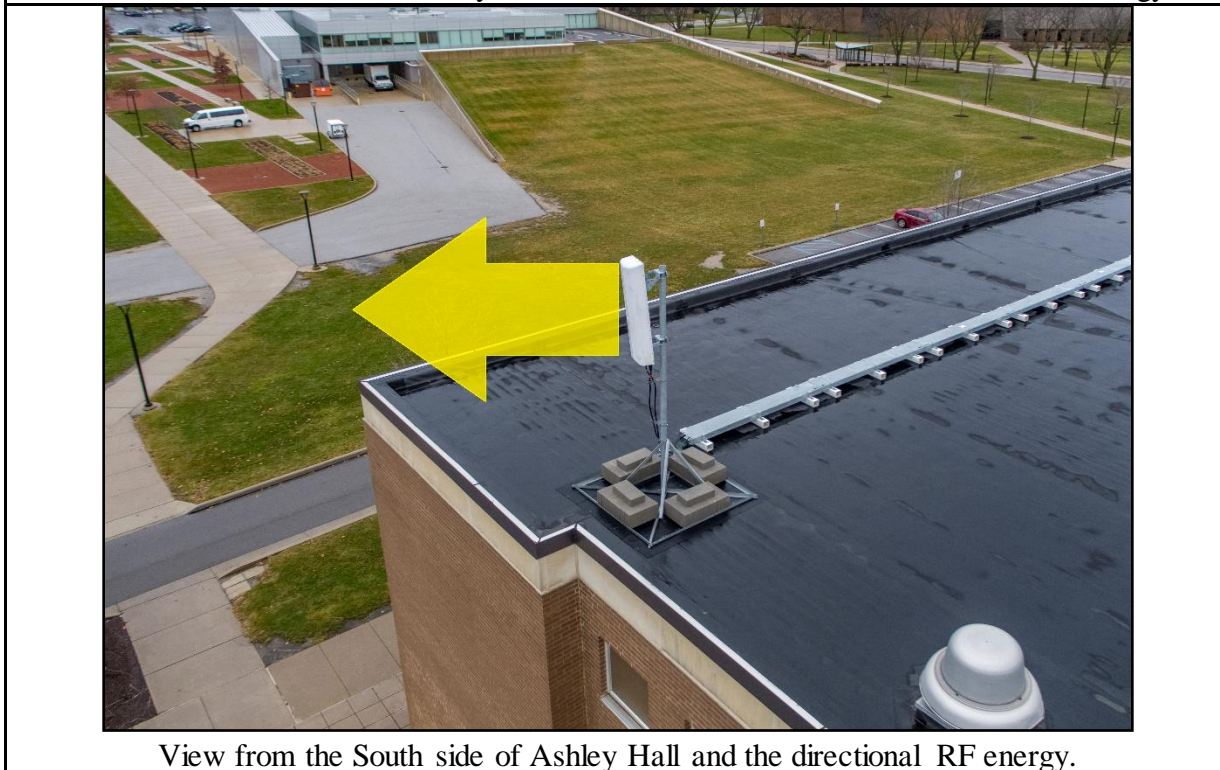


RF device on rooftop of Jerome Library and the spatial RF hazard distribution.

Kreischer



Aerial view of Kreischer - Ashley Hall and Darrow Hall and the directional RF energy.



View from the South side of Ashley Hall and the directional RF energy.



View of RF source at Kreisler- Ashley Hall and the directional RF energy.



View from the West of the RF source and the directional RF Energy.



View from the South-end of the RF sources and directional RF energy.

Mercer Road Facility

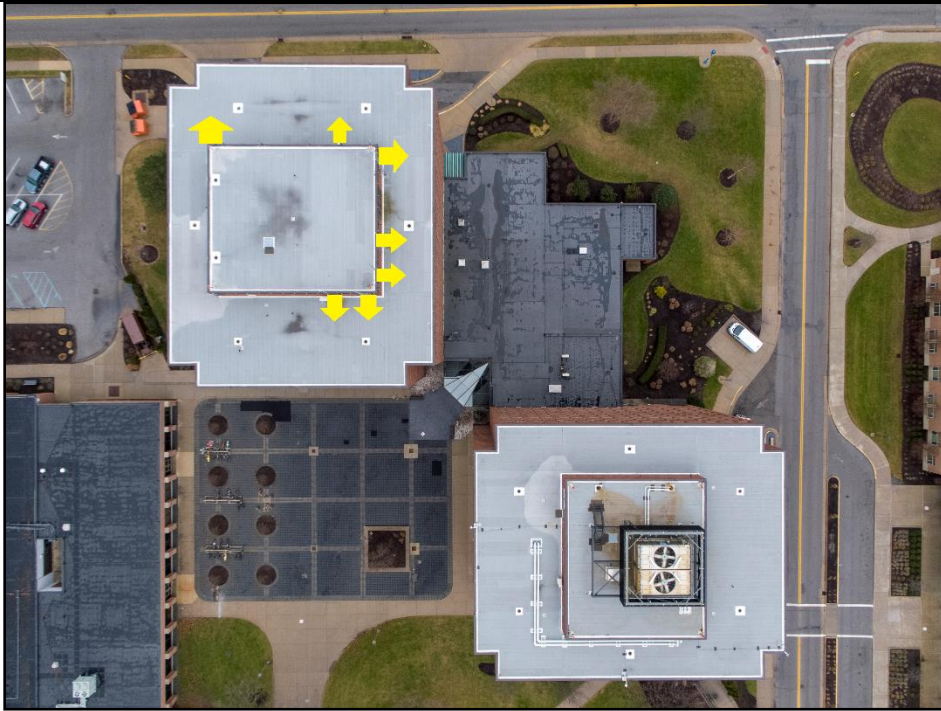


Aerial view of Mercer Road Facility and the location of RF device.

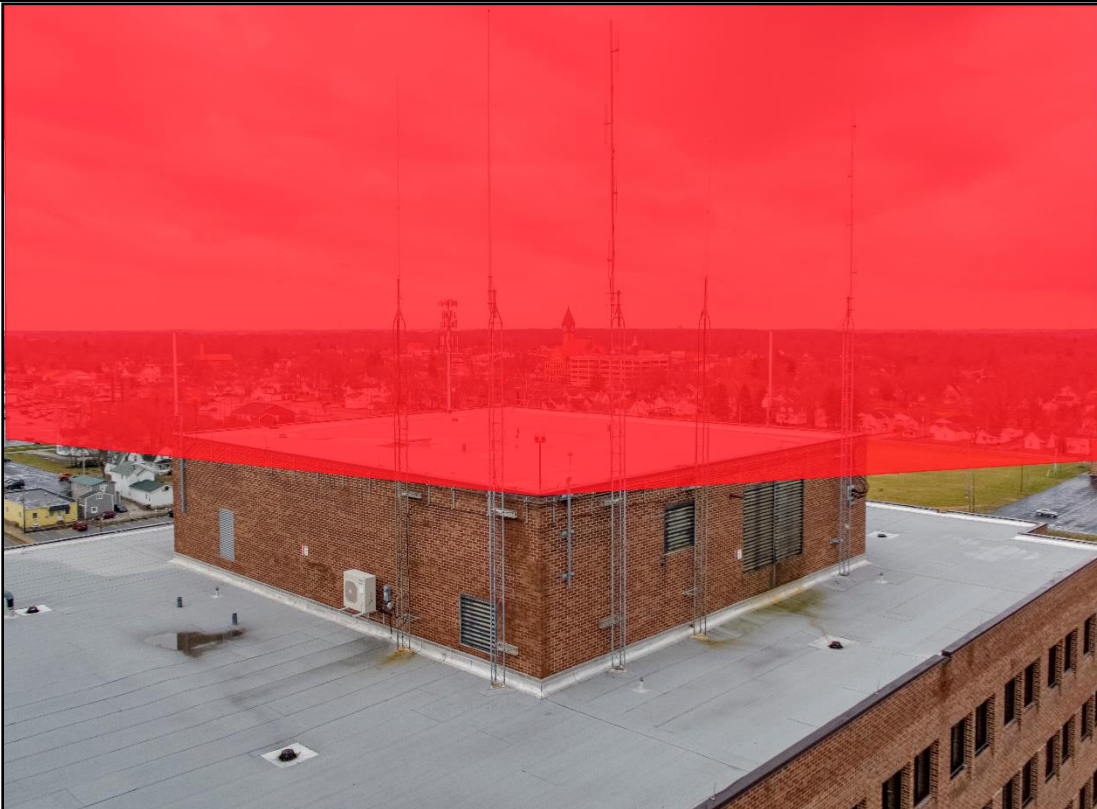


RF device on side of Mercer Road Facility and directional RF energy.

Offenhauer Tower (West)



Aerial view of Offenhauer Tower and the sources of RF energy.



View of Northwest corner (from the West side) and spatial RF energy distribution.



View of the RF devices from the Southwest corner (from the West side)



View of RF devices from the South side (from the Southwest corner)

Perry Field House



Aerial view of Perry Field House and locations of RF devices.

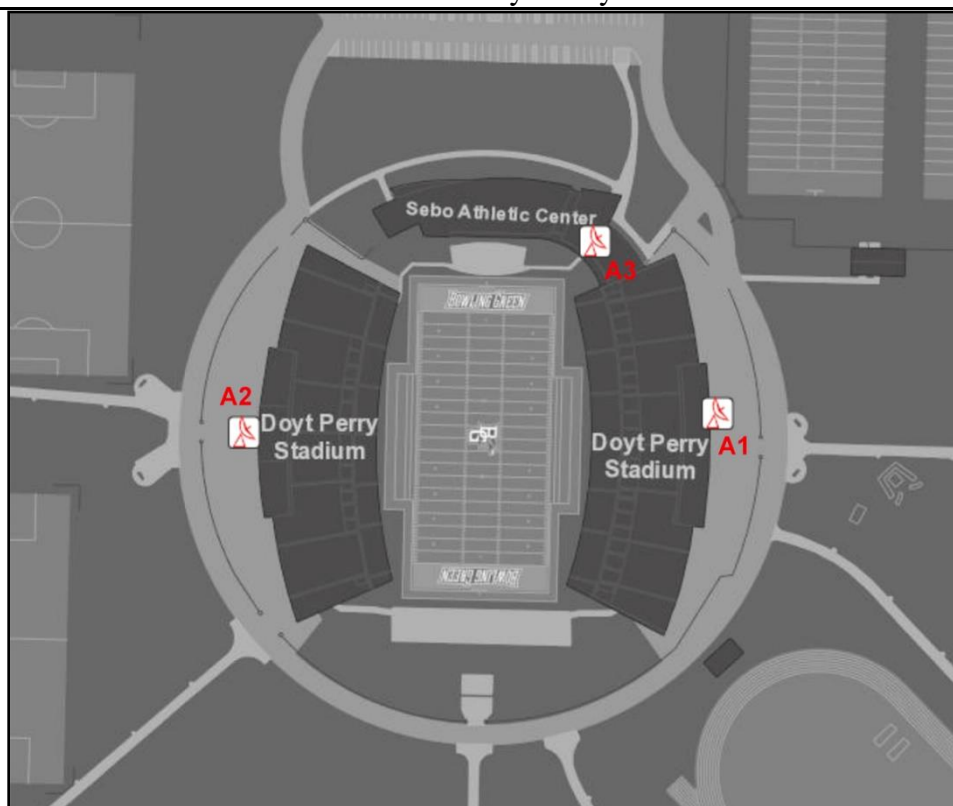


RF device furthest south on the rooftop and directional RF energy.



RF device furthest north on the rooftop and directional RF energy.

Sebo Center and Doyt Perry Stadium



Aerial view of Doyt Perry Stadium and the locations of RF devices.



View of the East side of the stadium and the directional RF energy (from the East).



View of the Sebo Center RF device on the side of the building and the directional RF energy.

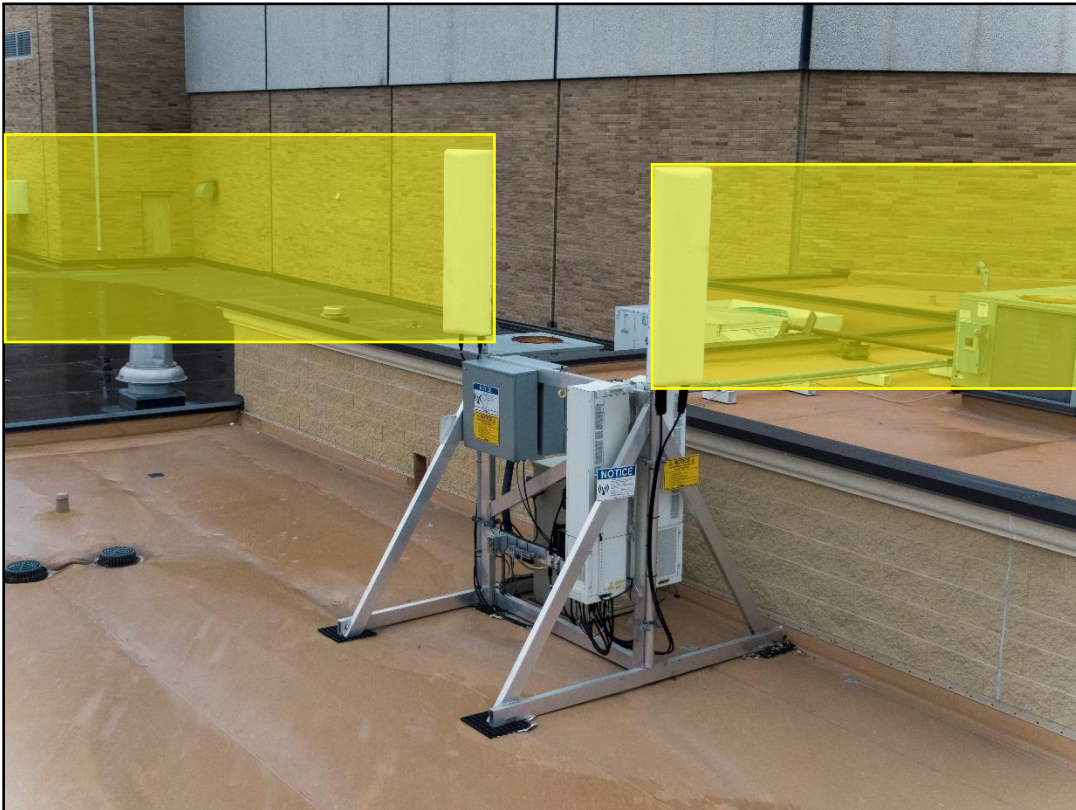


View from the West side of the stadium and the directional RF energy (from the West).

Slater Ice Arena



Aerial view of Ice Arena and the directional RF energy.



View of the RF sources (on the South side of the Ice Arena) and their spatial RF hazard area.

Student Recreation Center



Aerial view of Student Rec Center and the directional RF energy.



View of RF device and the directional RF energy.

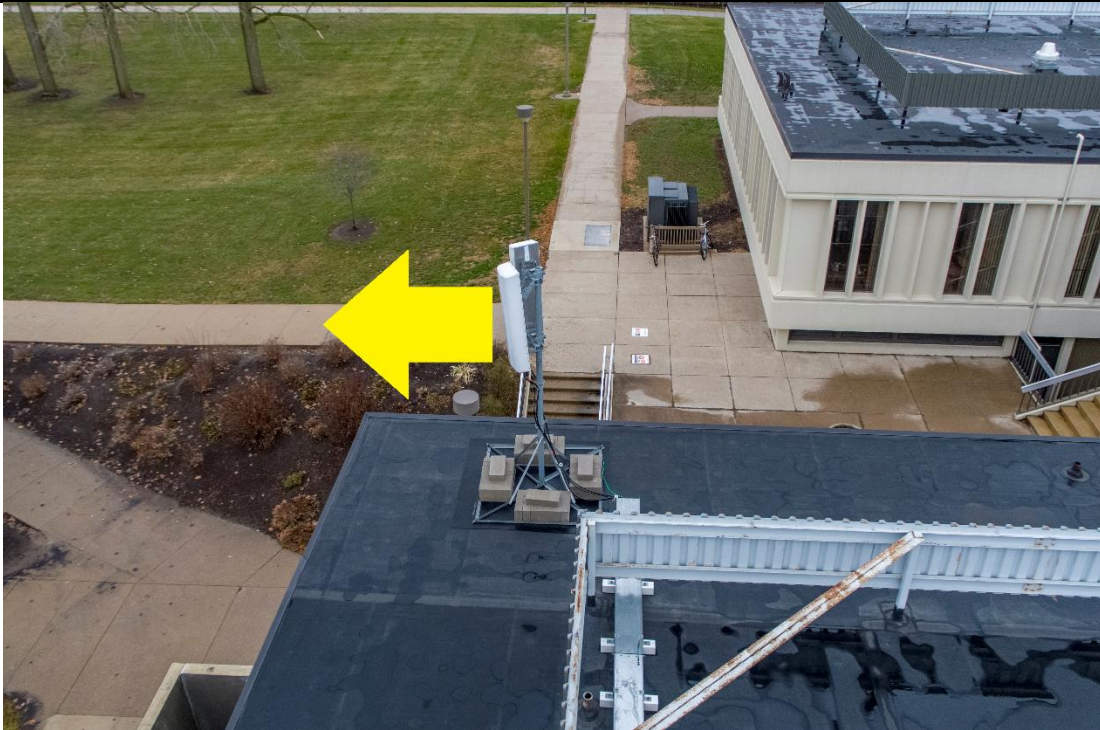
Technology Building



Arial view of Technology Building and the directional RF energy.



View of East Side of Technology Building RF device and directional RF energy.



View of South Side of Technology Building RF device and directional RF energy.

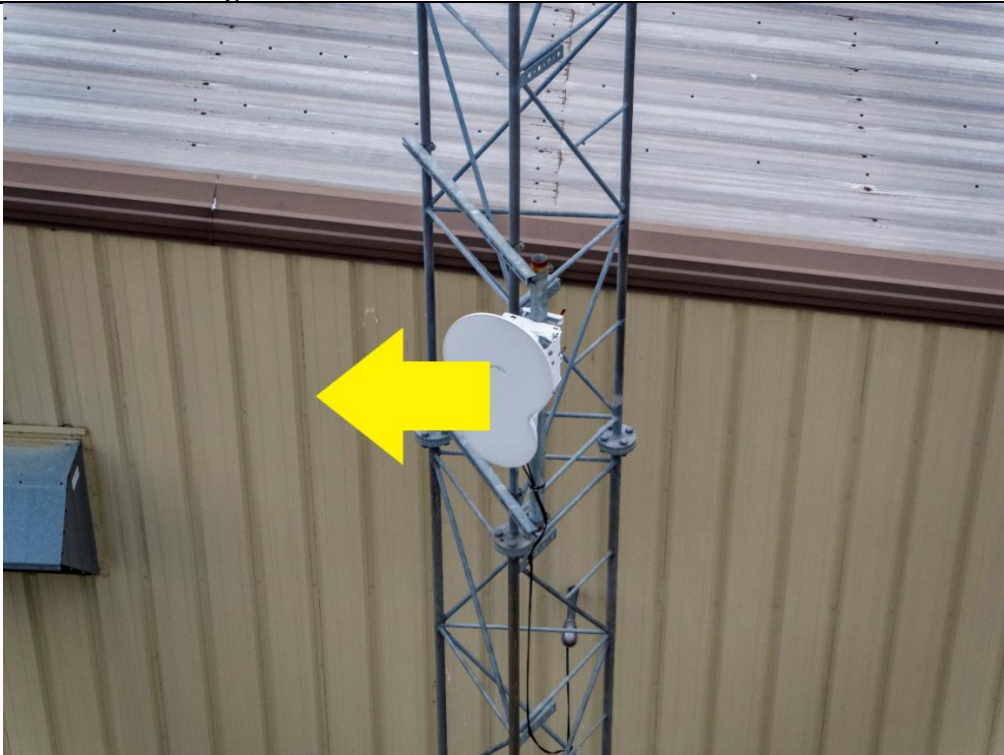


View of North Side of Technology Building RF device and directional RF energy.

Woodbridge Warehouse



Aerial view of Woodbridge Warehouse and location of RF device and directional RF energy.



RF Device on tower and directional RF energy.