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PLANNING ADVISORY NOTICE

RF Safety

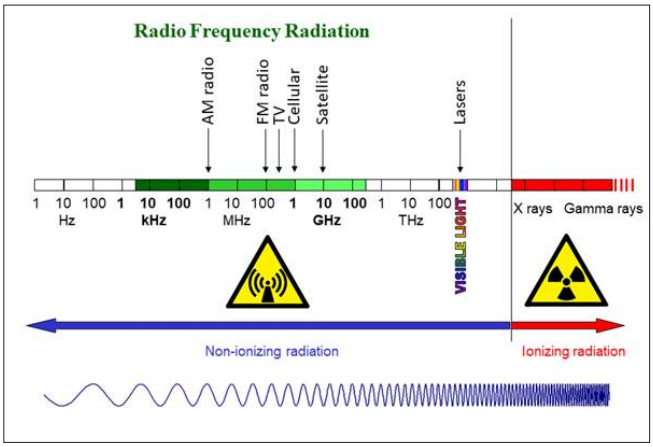
The FCC has established guidance for occupational and non-occupational exposure to Radiofrequency Energy (RF). In fact, the FCC has not just established "guidance" related to RF exposure, but specific requirements. FCC rules in Title 47 of the Code of Federal Regulations (47 CFR) include limits for exposure to RF in Section 1.1310, and required mitigation measures for areas where limits could be exceeded in Section 1.1307(b)(4). This PAN is focused on occupational exposure for individuals engaged in the deployment of the telecommunication infrastructure. There is a myriad of hazards on a telecommunications worksite. RF is one of those hazards, however, there are times where it has been inappropriately enunciated. The intent of this PAN is to show that with proper training, planning, communication, and equipment, this hazard can be effectively mitigated.

RF safety is a rather broad topic which can be very technical and difficult to comprehend, especially when one is only looking for a quick multistep program to ensure all those involved are safe from the associated risks. This PAN will focus on the RF hazards employees encounter on a day-to-day basis, covering the information in detail and finishing with a simplified approach that a company can utilize as part of an overall plan to keep their workforce safe.

The policy of the FCC with respect to RF emissions was developed to ensure that FCC-regulated transmitters do not expose the public or workers to levels of RF energy that are considered by organization experts on human health and safety to be potentially harmful. The U.S. Food and Drug Administration (FDA) maintains that the available scientific evidence to date does not support adverse health effects in humans due to exposures at or under the current FCC limits.

The FCC posts RF exposure safety information online at **http://www.fcc.gov/rfsafety**, including guidelines for determining compliance with FCC limits on RF exposure in OET Bulletin 65 and its supplements at **https://www.fcc.gov/general/oet-bulletins-line**, and answers to frequently asked questions at **https://www.fcc.gov/engineering-technology/electromagnetic-compatibility-division/radio-frequency-safety/faq/rf-safety**. FCC Office of Engineering and Technology (OET) staff are available to answer additional questions related to RF exposure as part of their RF Safety Program at **rfsafety@fcc.gov**.

RF is a subset of the Electromagnetic (EM) spectrum spanning from 3 kHz to 300 GHz. Electromagnetic radiation consists of electric (E) and magnetic (H) fields emanating from a source and traveling with wave-like characteristics. In short, RF is radio waves that are transmitted from antennas to other antennas, satellites, phones and TVs that we use all day, every day. In today's world RF is constantly all around us. Below is a picture of a simplified graph of the RF spectrum and the frequencies and associated wavelengths.



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Is all radiation dangerous? To a degree, yes. However, some frequencies would require very high dosages to become dangerous. This PAN will be focus on the RF range of 3kHz to 300GHz as these are the ranges that telecom employees will encounter and be exposed to in their line of work.

Potential Effects of RF Exposure

On the lower end of the RF spectrum, below 100 kHz, the primary effects of exposure are electrostimulation of the nerve and muscle. Moving higher up to the low single digit MHz region, it is a combination of electrostimulation and heating. Beyond that, effects of exposure can be body heating.

This heating occurs as a result of polar molecules within your body trying to orient themselves to the incident RF field. As the field is oscillating, the molecules are trying to follow the field with this constant reorientation causing the heat. A great example of RF heating is heating food and beverages in microwave ovens, which typically operate at 2.4 GHz, transmitting approximately 1 kW of power into the shielded chamber. This is non-ionizing radiation, which means that its effects are limited to heating and the damage that can be caused by heating, not a molecular change as would occur when exposed to ionizing radiation.

All RF discussed in this PAN is non-ionizing. While ionizing radiation can be harmful even at low levels, scientific consensus shows that exposure to non-ionizing radiation at or below FCC limits has not been shown to cause any harm to people. A good discussion of this topic is provided by the FDA at: **https://www.fda.gov/radiation-emitting-products/cell-phones/radio-frequency-radiation-and-cell-phones**.

Generally, there are 3 groups that we can use to define the effect that RF exposure will have on the human body.

Quasi-Optical Resonance

Wavelengths that are smaller than the human body, frequencies from 300MHz and higher. Typical wavelengths are 2 feet or smaller and are made by microwaves, cellular antennas and satellites. Quasi-optical frequencies create localized heating or burns and can affect your eyes, brain and testes.

Human Resonance

Wavelengths that are between 150 MHz and 200 MHz where the wavelength is between 4.92 feet and 6.56 feet (the height of the average person). We call this range "Human Resonance." This is the most dangerous for humans due to the body absorbing almost all of the RF energy.

The frequency range to consider body resonance is larger than this due to resonances occurring at fractions of a wavelength. The standards also consider body sizes from infant to large adults. Body resonance can have an effect from tens of MHz up to GHz.

Sub-Resonance

Wavelengths that are larger than the human body are frequencies 150MHz or lower. These sub-resonant wavelengths create very little absorption within the human body as the wavelengths will often be much larger than a humans height. We find these wavelengths with shortwave radios, maritime navigation equipment and AM towers. Over-exposure to sub-resonant frequencies can result in electrocution, RF burns, and contact burns.

RF over-exposure symptoms are: flu-like symptoms, heat stress, confusion, vertigo, blurred vision, headaches, sore throat, nausea, cramps, and/or a bad taste (metallic). These symptoms are the result of the body heating caused by the RF.

Assessing Site Hazards

RF Site Assessment

To identify the RF dangers, an assessment of all the potential RF hazards on site needs to be completed.

An RF assessment should take into account the scope of work to be performed, the types of antennas in the work area, access and egress areas, and unique structure requirements that may create additional exposure hazards. It should also identify the presence or lack of presence of signage or placards; however, one should not rely solely on the signage.

The following Antenna Types and Structure Type sections are non-exhaustive lists of commonly found types to illustrate what might often be encountered. Other antenna and structure types can exist, and it is important to be aware of the equipment at any particular site.

A proper RF site assessment should include, but not be limited to:

1. Scope of Work
    a. Will the work be performed in the path of the RF?

b. Is there a need to climb in front of the RF path?

c. Is there a way to avoid the RF all together?

d. Can the transmitter on site be turned down to minimize dangers (Lock Out Tag Out)?

e. Can any extra prep work be done on the ground or a sheltered area, so that less time is spent in the 'danger area'?

f. What is the duration of the work?

g. What are the frequencies and output power of the RF at the site?

h. Is a designated RF monitor required?

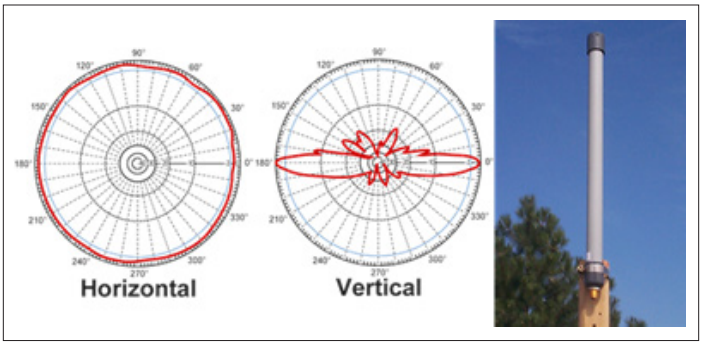
i. Is an RF meter required?

j. What are the employee RF PPE requirements for the work area?

2. Antenna Type – RF levels are generally highest close to and directly in front of the antenna, with RF levels decreasing with separation distance and lower outside the pointing direction of directional antennas.

a. Omni Antenna

i. Omni antennas can radiate in a 360 degree direction on the horizontal axis. See example below

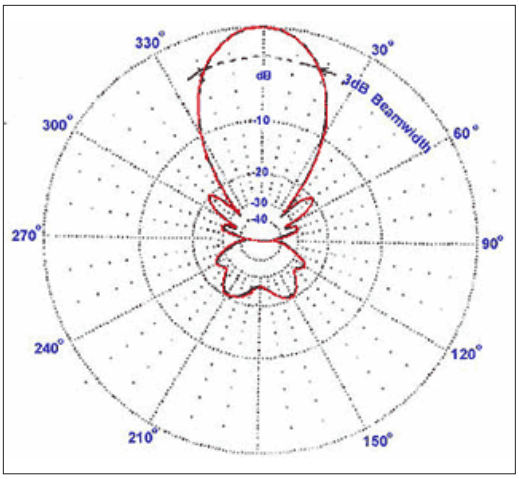


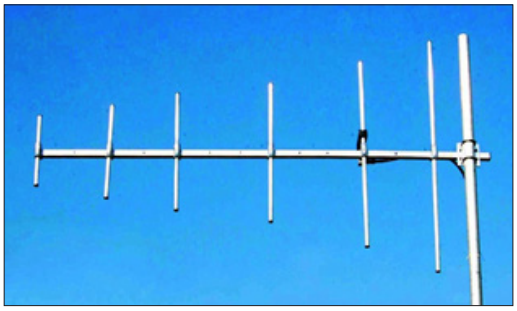
b. Directional Antenna

i. Directional antennas can be a lot easier to identify the direction in which the RF is traveling. Examples of directional antennas are abundant on 'traditional' telecom structures.

ii. Yagi Antenna

1. Single or multi-element directional antennas that are typically line of sight





iii. Panel Antenna

1. Single or multi-element direction antennas and are designed for radiation up to 180 degrees

2. Panel Antennas are adjustable in power levels (both locally and remotely) which increases the hazard of exposure.

iv. Microwave Antenna

1. Line of sight antenna, has a very focused beam increasing the exposure when directly in the path.

v. Dipole

1. Multiple radiating element that can vary in the radiation pattern of the horizontal and vertical axes

vi. FM Antenna

1. Radiates 360 degrees

3. Structure Type

a. Monopole

i. Climbers may be forced to pass directly in

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front of the antenna

b. Lattice Tower

   i. Climbers may be forced to pass directly in front of the antenna

   ii. Is there an alternate climbing path to avoid the hazard?

c. AM Considerations

   i. Is the tower an AM structure? Is it powered down?

   ii. Is the structure in close proximity to an AM station?

   iii. Is there a detuning skirt on the structure?

   iv. Is everyone aware of potential electrical hazards from an AM structure or detuning skirt?

d. Rooftop

   i. One of the primary concerns on rooftops is when work is occurring in an area at the same elevation of existing antennas. There may be multiple radiating sources at any location on the roof, and it is imperative that employees be cognizant of all radiating sources in the vicinity of their location and the potential hazards that they pose. There may be areas where the employee is in the direct field created by a directional antenna. For example, employees performing work on a ballast mount should be aware of other antennas located on the roof that are behind the ballast mount on which they are working. These antennas can be directional or omni directional exposing the employees to elevated RF fields. This includes the roof that they are working on, but also neighboring rooftops that are also on the same level. If possible, keep antennas above head level as the antennas will transmit over the head and not through the body.

   ii. When on rooftops with antennas present, always carry the appropriate RF monitor that will notify you if you are at risk of over-exposure.

      1. RF monitors are useful tools for alerting to the presence of higher RF levels. Anyone using RF monitors needs to understand the monitor they are using including its functionality and limitations. Personal RF monitors are not always perfectly reliable, usually due to body shielding or differences between the RF exposure location and the monitor location. Also, many monitors have a built-in margin causing them to alert at a level significantly below the FCC limit.

RF Plan

After we have assessed the site and understand the possible dangers in the area, it is time to develop an RF plan.

In order to develop an RF plan it is essential that the competent person performing an RF assessment be on site as there are always changing conditions and these conditions must be addressed as part of the on-site planning. The plan must identify the employees working in the area of the hazard, ensure that they have received proper RF training, and have identified the types of equipment to be utilized as a part of the RF plan. This may involve the use of properly calibrated RF meters or additional PPE for the employees. One needs to know and understand what types of controls will be used to keep employees safe from the RF hazards.

Following FCC rule changes effective May 3, 2021 (see Public Notice DA 21-363), specific mitigation measures are required at sites where RF exposure above FCC limits could occur, with increasing requirements for higher possible levels of exposure. These measures can include signs, positive access control, and RF safety training and

plans. Specific mitigation requirements are detailed in 47 CFR 1.1307(b)(4). The FCC has published a Small Entity Compliance Guide (DA 21-574) that includes a brief description of these mitigation requirements and other recent rule changes. See: **https://www.fcc.gov/document/human-exposure-radiofrequency-electromagnetic-fields-0**.

Avoiding Overexposure

Once the site assessment is complete and it is determined that it is not possible to avoid exposure, a plan must be developed that considers the appropriate PPE for the amount of exposure. Such PPE would include anything from an RF meter to a full body RF suit. As with any PPE, training on inspection, care, and use is required.

At any time, an employee needs to be aware of whether the RF to which they are potentially exposed to exceeds the Maximum Permissible Exposure (MPE) level. Personal RF monitors can be a part of the employee's PPE, and provide a warning of exposure levels that can be addressed as a part of the RF plan. This may involve exiting the RF field, requiring turndown of equipment, or seeking additional support to modify the plan to ensure employee safety.

The majority of the RF meters currently available display exposure as a percentage of the MPE for the 6-minute window. This percentage display is referred to as a "shaped" response. Anything which is displayed under 100% of the MPE does not require abatement. For everything 100% and above, the employee should exit the field and consult with their competent/qualified person as defined in their company's RF hazard mitigation program. For additional information, please see the RF Safety FAQ online at **https://www.fcc.gov/engineering-technology/electromagnetic-compatibility-division/radio-frequency-safety/faq/rf-safety**.

FCC limits apply to the time-averaged exposure. The six-minute window is specific to occupational exposure and trained occupational persons may make behavioral adjustments (e.g., leave the area) to keep their time-averaged exposure below the limit.

Equipment manufacturers calibrate their devices so that these percentages are associated with the MPE's for the countries in which they will be used. If you are using an RF meter, be sure to refer to the manufacturer's instructions to understand the reading the device provides and how to work safely based on those readings. In addition, it is critical that the proper meter is selected for the RF fields and frequencies to be encountered. RF Meter training needs to provide every user with the RF Meter manufacturers recommended operating procedures and have the means to inspect them to ensure proper functionality of the RF meter.

If at any point while working you believe that you or a co-worker may be suffering from over-exposure you should immediately remove yourselves from the RF source, move to a cool dry area, loosen any heavy clothing, drink plenty of room temperature water and, depending on severity, possibly seek medical attention. Until the employee is fully recovered someone should always stay with the effected person.

Once the effected employee has fully stabilized, make sure to report the incident in compliance with the company's RF mitigation policy. ●

Please note: This Planning Advisory Notice originally appeared in the November-December 2019 issue of Tower Times. This version has been updated.