

The Facts and Dangers of Rooftop Transmitting Devices on High-Rise Buildings

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In the past several years, there has been tremendous growth in the use of roof-mounted transmission devices. This topic is little understood within the fire suppression community. Until recently, some fire departments were completely unaware of this “new-age” communication tool, yet they have been scattered throughout their cities for years.

It is important for all firefighters and chief officers to be aware of what these tools are and how they might affect their safety during any type of rooftop operation. The devices in question are microwave transmission dishes, “whip antennas” (vertical rods) and broadcasting towers. The presence of these transmitters can alter the ways fire departments function on a roof. For instance, some departments automatically send a team to the roof on any working high-rise fire. The firefighters’ pre-designated assignment is to stand by and await further instruction from the incident commander in the event any type of action needs to be taken at roof level. This assignment should now be approached with considerable caution.

Transmission devices include:

- **Microwave dish antennas.** Most fire departments are already aware of cell phone antennas and their related risks, which are commonly found on low-rise buildings. However, high-rise office buildings have begun adding rooftop microwave transmitters to transmit data (for banking, trading or other business purposes). When these business

entities send data out, it is usually done through fiber optics, microwave links or both.

Most microwave dishes are relatively safe and ironically, the bigger and more intimidating the dishes, the less power they emit and the safer they are. Large dishes (see photo 1) typically emit only a few watts of power, so you can stand right in front of them and not put yourself in harm’s way. The smaller dishes (see photo 2) can produce a more concentrated beam of microwave radiation and, hence, can lead to a higher level of exposure to personnel operating near them. Beyond several feet from the antenna, the radiation exposure dissipates quickly and is usually within applicable human exposure standards. These dishes are pointed at other (reception) dishes (see photo 3) on other roofs and are, in a sense, “speaking to each other,” albeit one way.

Photo 1



Photo 2

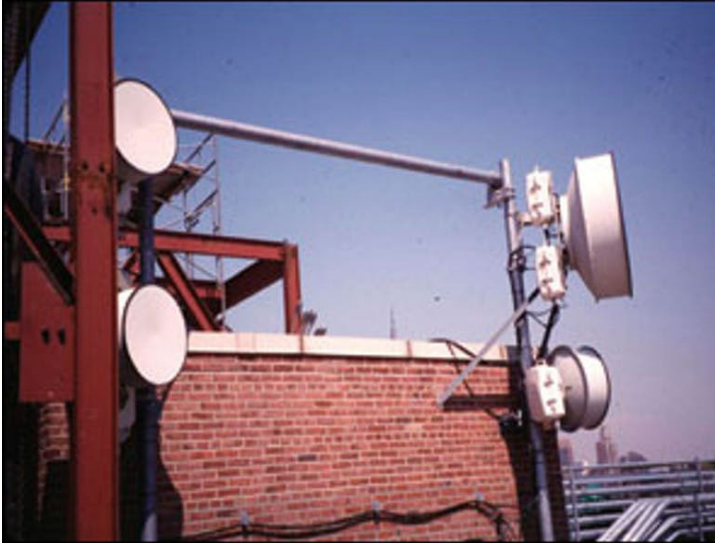


Photo 3



These devices are not always on the main roof level. They may also be found on roof setbacks on taller buildings with decreasing-sized floor plates on upper floors. Reception dishes are completely harmless, but normally can't be discerned by simply looking at them. "High-intensity" microwave transmitters are sometimes mounted up high on elevator penthouses (see photo 4) or by other means, away from potential human exposure. These can emit up to 1,000 watts of effective radiated power (ERP). Although Federal Communications Commission (FCC) regulations require

roof signage warning of potential danger areas (see signs on page 76), the author has personally seen many roofs with little to no signage to that affect. The FCC rules apply only to its licensees and do not apply to building owners and managers. FCC limits for human exposure are based on a safety factor of 10, so even if a rooftop transmitting site exceeds FCC limits, while this could represent a regulatory breach, it still may be safe for firefighters to operate (depending upon signal strength) and how long one is exposed.

Photo 4



- **"Whip antennas."** The more deceiving and more intense exposure sources are represented by "whip antennas," or vertical transmitting rods. There are two types – bare element and fiberglass rods. Bare element rods are typically used in two-way radio applications. These are rods you do not want to touch, as your skin can be burned by making direct contact. The fiberglass rods are the safer of the two, due to their insulating properties. These rods can be mounted virtually anywhere on a roof (see photo 5) and unlike the microwave dishes, they emit radio frequency (RF) energy uniformly 360 degrees (known as omni-directional).

Photo 5

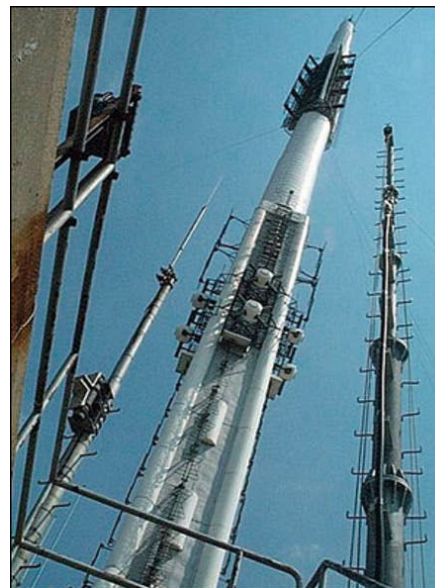


What separates the microwave dishes from the “whip antennas” is the difference in wavelength. Microwave dishes and panel antennas operate at higher frequencies with shorter wavelengths, while “whip antennas” operate at lower frequencies with longer wavelengths. The more intense RF fields are usually from antennas that transmit signals for pagers. Cell phone and two-way radio transmitters are typically lower power. Pager, cellular telephone base station and two-way radio antennas often emit RF radiation in short “bursts.” The strength of the signal surges when these devices are utilized. For instance, RF exposure can only occur when a radio is keyed. Otherwise, the transmitter is inactive. A pager antenna can emit up to 500 watts of effective radiated power. The ERP with microwave dishes is less concentrated than with rod antennas, thus are safer despite the higher power range. Some buildings run these rods along the perimeter of the roofline, which can prove to be an issue if a window-washer rescue may need to be performed using rappelling techniques.

- **Broadcasting towers.** The larger, permanently mounted antennas are known as broadcasting towers (or masts) and can be found on some of the tallest buildings in North America. They are the most potentially hazardous. These transmit television and FM radio signals to surrounding

communities for many, many miles (see photo 6). The higher the power level, the greater the potential for exceeding established safe limits for exposure. They range from one to five megawatts of effective radiated power. These are the strongest sources of RF energy found on rooftops and particular caution should be used if required to access regions near the actual antennas.

Photo 6



Understanding RF Signals

All transmitters emit low to high levels of RF radiation. Personnel exposure to these fields takes place when a person is in close proximity to the active antenna. From the FCC’s regulatory perspective, two sets of maximum permissible exposure (MPE) limits apply. Upper limits are established for “controlled environments” (referred to as occupational/controlled exposure) and lower limits are applied to public/uncontrolled exposure. The term “uncontrolled” refers to the fact that no controls over the exposure are deemed necessary.

A “sectored site” is one in which directional antennas are used to provide communications service, such as a cellular telephone base station within a particular geographic region, commonly shaped like a sector of a

circle. Normally, a series of antennas are employed that serve two to three sectors, thereby providing signal coverage throughout the geographic region. Commonly used cellular base station antennas are of the panel type, usually around one foot wide by four to six feet tall, and may be arranged in a triangular formation as a cluster of antennas to serve three sectors.

A “hot zone” is a location where a high RF field exists that exceeds FCC limits for exposure. These are areas where caution must be exercised. The “hot zone” may be one or more particular areas of a given roof, or the entire roof may be designated a “hot zone.” Only personnel who must access the area as a consequence of their employment and have received RF safety awareness information are allowed in “hot zones.” Typically, besides appropriate RF safety awareness training, individuals entering areas that exceed the public MPE should make use of a personal RF monitor to alert them to the presence of RF fields that exceed occupational limits.

It is not uncommon to find “hot zones” on rooftops of tall buildings in large cities in North America. There are some areas (such as previously mentioned TV and radio broadcasting sites) where no one should go, unless the equipment is powered down and taken off-line due to the hazards of being in close proximity to the broadcast antennas.

Effects of RF Radiation

The principal effect of exposure to intense RF radiation is tissue heating. Similar to the action of a microwave oven heating a cup of water, the rotation of molecules creates friction and, in turn, heating of the exposed mass. With humans, the absorption of RF energy at sufficiently high rates can lead to an elevation of body temperature. This may be manifest, in cases of very intense exposure to RF fields in the 30-300 MHz frequency range as a slight increase in body temperature. More often, such exposures will be perceived as a warming of the surface of the skin. Virtually all exposure limits that have been developed

are based on controlling the rate at which RF energy can be absorbed by the body and therefore, limiting the extent at which body or specific tissues can be heated.

The most obvious hazard associated with exposure to high intensity RF source is the so-called RF burn. As previously noted, bare element antennas can burn skin on contact if an active transmitter is connected to them. Microwave dishes and “whip antennas” can create heating of the body, if the intensity of the RF field is sufficient. Unlike X-Rays, however, the radiation is not cumulative and damage to body tissue occurs only while a person is exposed above the hazard threshold and remains in this region for a prolonged time; the longer the time of exposure above the hazard threshold, the greater the probability of sustaining a thermal injury. The rule of thumb should be, “If you feel any heating of body tissue – get away from the field!” The higher the signal strength, the greater the danger can be.

Unfortunately, no one will be able to tell just by looking at an antenna how strong the signal is and when it is transmitting and when it isn't. High exposure levels, significantly above the federal standards for exposure, have been associated with cataract formation and increased sterility in laboratory animals. RF fields can also adversely affect the operation of various types of medical devices such as cardiac pacemakers and stimulators. Under ideal conditions, the best options would be to wear a personal RF monitor and receive relevant RF safety training that is keyed to the specific site prior to the fire. However, that most likely will not be the case when a fire breaks out in a high-rise building with rooftop transmitters.

Also be aware of eye trauma hazards that may exist with antenna “trees” that have multiple “branches” of antenna hanging off the main vertical “trunk.” This would be an even greater concern at night or in heavy smoke conditions. Wear your visor down whenever possible.

Listed in order of higher to lower danger are:

Oddities of special concern include:

- **“Secret” antennas.** There are some buildings where government agencies have procured roof space to use for their proprietary transmitters. Building chief engineers have told the author that they have no idea how strong the signal strength is and what the potential exposure levels are when working in close proximity to those devices, since they have no control over them. Unless a “roof audit” (a survey which determines MPE) is done to measure the areas that should be deemed “hot zones,” there is no practical way to tell where the hazard areas might be.

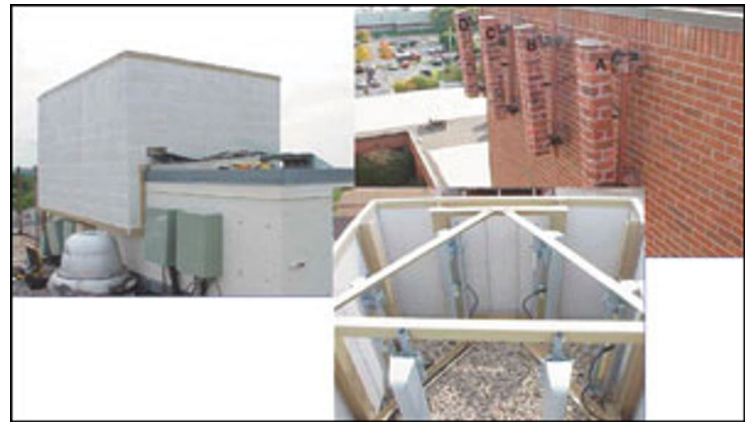
As mentioned previously, FCC regulations dictate warning signage for roofs with high RF fields which may or may not be implemented. However, the author was advised that no signage at all is required in areas where compliance is addressed (i.e., regular roof audits being done, radiation monitors being worn by workers accessing the roof and roof access restrictions in place).

Firefighters or SWAT team members performing rooftop assignments who circumvent these guidelines will be subjected to the dangers of operating in potentially high RF fields. Firefighters performing roof venting, handling “jumper incidents,” fighting rooftop fires, or dealing with climbing daredevils or window-washer rescues should be especially aware of their surroundings, exercising caution to avoid operating near any transmission device that is not confirmed as being a low power transmitter. Staying stationary in high RF fields will generally lead to greater exposure than moving through them. A guideline is to assume that all antennas are active unless you have information to the contrary.

- **“Stealth” antennas.** These are transmitters that are cloaked to hide their presence, by blending in with their surroundings (see photos 7A, 7B

and 7C). These can be sources of unknown exposure levels. They may be aesthetically pleasing, but they can create even greater confusion for firefighters who may not recognize them or even be aware that one exists in their vicinity.

Photo 7A, 7B, and 7C



Helicopter Operations

In any city, whether the fire department possesses its own helicopters or not, the possibility exists where helicopters may be called in to assist the fire department on a major event, as in a fire, natural disaster or terrorist attack. If firefighters have to be airlifted to the roof to perform certain duties, or an attempt must be made at rooftop for rescue operations involving civilians or firefighters, any helicopter may be called to the scene to assist – police, military, fire (in some cities), EMS, news or privately owned. (Helicopters were used during the MGM Grand and DuPont Plaza hotel fires, as well as the First Interstate and Meridian Plaza office building fires and World Trade Center bombing of 1993.) Helicopter pilots may not be intimately familiar with these high-rise roofs and related dangers.

It is vitally important to note that there is a potentially dangerous interference phenomenon called high-intensity radiated field (HIRF) that exists around transmitters with very high signal outputs. HIRF can sometimes be intense enough to cause interference to

an aircraft's flight controls and navigational instruments and may lead to an aviation accident with newer aircraft. Modern helicopter avionics are becoming more computerized, including stabilization and engine input commands. One helicopter technician stated that a 10-watt radio can interfere with instruments. As stated earlier, roof transmitters can easily emit 500 to 1,000 watts of energy, with broadcast towers reaching into the megawatt range.

There have been cases where military aircraft have crashed flying into a HIRF. It should be strongly considered by any incident commander on a high-rise disaster that this potential exists. The author was told that government helicopter cockpits are now "hardened" to prevent this problem from occurring. However, this will likely not be the case with civilian, police, fire, EMS and news aircraft.

A thorough check of the roof to determine the presence of rooftop transmitters should be made prior to attempting a helicopter operation. This should also apply to roofs of nearby buildings that are in close proximity to the incident building, as RF fields may be sufficiently intense to create a dangerous flying environment for helicopters hovering in their vicinity. These roofs are extremely dynamic and change so frequently that a consistently updated roof audit of a high-rise district is paramount to a relatively safe attempt of helicopter use during major emergencies. Given rooftop obstructions, thermal air currents and smoke from fires, fog, high winds, low-level clouds, darkness and other obvious hazards, they are plenty dangerous enough as it is and require incredibly deft skill on the part of the pilot.

A greater danger would be at night when relying more on instruments. RF fields can definitely interfere with aviation radios. Another concern is that if warning signage of high RF fields does exist, it is usually mounted on the door or access hatch leading to the roof from below. How will firefighters know this danger

exists if they attempt roof access to enter the building from the opposite direction – by helicopter?

Summary

Most fire departments are just now being made aware of this important issue and even fewer SWAT teams are aware of any danger involving rooftops or setbacks. According to the experts, a general rule of thumb for occupational safety/proximity for these transmission devices should be at least three feet for most antennas, except large, high-power broadcast antennas, which require greater distances.

The challenge for managing personal exposure to RF fields is that these devices can vary greatly in signal strength, which cannot be determined without input from personnel familiar with each device or array, or reference to a roof RF survey. Time of exposure in relatively close proximity to antennas should be limited to short durations, unless a prior study has determined that the occupational exposure limit is not exceeded at that location. Avoid direct contact with antennas.

Antenna farms (see photo 5 again) should be approached with extra caution until it can be determined that the roof area is deemed safe to operate. Since this requires the assistance of the licensee of the radio transmitting equipment, as well as building engineers, this may present a problem if an incident occurs when there is no staffing present. Building engineers may have limited knowledge in this area, since they did not install these devices, nor do they maintain them. This presents an obvious problem in locating and isolating power during an emergency.

Setbacks crowded with transmitters represent another caution area. Proprietary transmitters, such as those operated by government agencies, present significant concerns as to how they can be shut down when on-site engineers may not be able to assist in gaining access to the power source. Further, many modern communications transmitter sites operate with uninterruptible power supplies (UPS) and killing the

electrical power to the equipment room may not stop the transmitters from operating.

Warning signage at roof access points AND near devices is essential, as is yellow caution stripes bordering off “hot” areas (see photo 8). Also be aware that RF fields can interfere with the operation of fire department (or police/EMS) radios, inhibiting their ability to receive or transmit. Maydays or evacuation orders may not be heard.

Photo 8



Cable trays on roofs are simply trip hazards when moving about rooftops. The only time that cable trays could potentially become an RF hazard would be if they became damaged and the cables were cut, broken, etc., such that a person could come into contact with the bare internal conductor of the various transmission lines (coaxial cables). High-voltage junction boxes are not RF hazard sources. They are junction points for AC power distribution and carry with them the obvious issues associated with electrical shock.

Many people think that a site that has RF fields that exceed the FCC MPEs is “out of compliance.” This is not so. Compliance is related to whether people are able to get exposed to the fields exceeding the MPEs. Many transmitter sites have RF fields that exceed the MPEs but have appropriate RF safety programs in place to control the exposure of individuals who may have

reason to enter these areas. This, of course, would not apply to first responders or fleeing civilians who find themselves on a roof where these antennas may be present. Current standard operating procedures (SOPs)/standard operating guidelines (SOGs) should be revisited to address this new-age issue affecting firefighter safety. Pre-planning and caution should always be the first line of defense. Be knowledgeable, be aware of your surroundings and be careful.

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