# Safety Guide

by Richard R. Strickland

# RF Personal Monitors Facts and Fallacies

*RF personal monitors are important tools for ensuring RF safety. In order to maximize their value in this regard, users must understand how they operate and what are their limitations.*

RF personal monitors are a pretty common sight at many broadcast facilities. They can be valuable tools for controlling the amount of RF energy to which a person might be exposed.

Like any tool, it is important to start by selecting the correct monitor to do the job and then make sure you are using it correctly.

## MONITORS PROMOTE SAFETY

In addition to standard RF personal monitors, there are several low-tech detectors being touted as low-cost alternatives to the standard monitors. People often ask why a monitor has to cost $1,500 and why a $10 detector will not do the job just as well.

The purpose of an RF personal monitor is to indicate when the wearer is exposed to RF fields that may exceed the FCC's Maximum Permissible Exposure (MPE) limits for Occupational/Controlled (occupational) exposure.

Personnel who use monitors should be trained RF workers. They must satisfy the FCC criteria for being fully aware workers who are able to exercise control over their exposure. Otherwise, they should not be exposed to RF fields that exceed the FCC MPE limits for General Population/Uncontrolled exposure.

## NOT COMPLICATED

Monitors are not really complicated from the user's point of view. The user does not have to know how to design one in order to use one successfully.

However, it *is* important to have a basic level of understanding of how they work in order to recognize what is happening in potentially hazardous environments. I often find that people who wear monitors do not understand what the monitor is telling them. That is why I now ship out a training CD that I developed with each monitor order.

What are the important things to consider when selecting and using an RF personal monitor? Can RF personal monitors be used with RF protective garments? How do different monitors compare to each other? These are important questions and anyone who uses or is considering the use of RF personal monitors should know the answers to these questions.

## PERSONAL RF MONITORS

Narda Safety Test Solutions, a division of Narda Microwave, supplies more than 95 percent of all RF personal monitors sold worldwide. Narda offers two different monitor designs – the Nardalert XT and the RadMan.


**Two of the most common personal RF monitors.**

At least a dozen models of each family are offered, but of the approximately 25 models, only seven are designed for use when one is attempting to comply with the FCC Regulations.

There is a basic model, a data-logging model, and what is referred to as an ELF-immune model for each family. The seventh option is a high-power Nardalert XT that is designed to be worn outside of an RF protective garment. It is set to alarm at much higher field strengths so that the individual wearing the suit is warned when the strength of the RF field might be too high even with the RF suit on.

The remaining models are designed for use by those individuals and organizations complying with standards and regulations other than the FCC's.

## MODEL CHOICES

The basic monitors are fine for most applications. However, as we all know, most engineers like their toys, and reviewing logged data can be useful, so the data-logging models are also fine.

The ELF-immune models are designed for use when in very close proximity to very high voltage power lines. They are essentially the same as the data-logging models except that the outer case is coated with a conductive film that functions much like a high-pass filter.

However, in order to kill the monitor's response to high 60-Hertz fields, the sensitivity of the monitor is degraded well into the HF band. Since these models are more expensive and do not work at AM frequencies, they are not appropriate for broadcasters.

## SPECIFICATIONS

The Nardalert XT accurately operates from 100 kHz to 100 GHz. The RadMan is rated up to 40 GHz, but in reality is only functional from about 40 MHz to 4 GHz. Its diode-based dipole sensor does not work on the body at lower frequencies and it has extreme variations in sensitivity at higher frequencies.

While this frequency range seems adequate for most applications in communications other than AM radio, the RadMan is far less accurate and offers far fewer features than the Nardalert XT. Furthermore, even in the band in which it functions reasonably well, it generally overestimates the field level by a factor of two to one or more (3 to 4 dB).

Since equivalent models in each family sell for exactly the same price, it is easy to see why the Nardalert XT outsells the RadMan by about three to one in the United States.

## COMPARISONS

In contrast to the RadMan's simple diode-based dipole detection scheme, the Nardalert XT uses diode-based dipoles primarily for the VHF/UHF frequency bands. It uses a displacement-energy sensor design that works very well on the body down to 10 kHz.

Higher frequencies are detected using strings of thermocouples that function as a combination of dipole and detector. These handle any waveform, including extremely sharp pulses that a diode detector would peak detect and greatly overestimate, at frequencies up to 100 GHz and higher. At frequencies above about 26 GHz they function as traveling wave detectors.

Both the Nardalert XT and the RadMan have a "shaped" frequency response in which the sensitivity of the sensor is a function of frequency.

## DESIGN CONSIDERATIONS

The design technique is similar to that of a filter. The goal is to have the frequency response mirror one of the standards, such as the FCC Regulations, as closely as possible.

For example, the FCC's MPE limit for Occupational/Controlled exposure at VHF frequencies (30-300 MHz) is 1 mW/cm², while the MPE limit below 3 MHz is 100 mW/cm². Take any simple site with one AM and one FM antenna and you can see the advantage of having a shaped sensor that responds in terms of percentage of the MPE, or "percent of standard."

If you are exposed to a 20 mW/cm² field, with 19.9 mW/cm² coming from the AM and 0.1 mW/cm² from the FM, you are only at about 30 percent of the MPE limit (19.9/100 + 0.1/1). Of course, if half the field were coming from each antenna, then you would be at 1,010 percent of the MPE limit (10/100 + 10/1).

The wireless industry faces the same type of problem when PCS systems are collocated with VHF two-way radios. In this case, the difference in exposure limits is only five to one but the issues are the same.

The shaped response automatically weights each signal and determines the total exposure in terms of percent of standard. Users do not even need to know the operating frequency of the systems that they are working near. Monitors are typically set to alarm at 50 percent of the MPE occupational limit to allow for measurement uncertainty.

## MONITORS VS PROBES

While monitors employ the same sensor technology as the probes used in survey instruments, there is one important difference.

Probes use three sensors arranged in a mutually orthogonal design so that they are omnidirectional. You cannot do that with a monitor, as the human body functions as both an RF absorber and an RF reflector. So monitors use two sensors and detect fields in roughly the forward hemisphere but do not pick up energy from behind the wearer.

Although the monitors do not detect what is behind you, they are generally very effective providing you do not stay motionless. The danger in RF fields is heating, so as long as you move occasionally, the monitor should pick up any fields before you have a significant time-averaged exposure.

What about the very simple, very low-cost detectors? They generally are made up of a tiny printed dipole and a diode tied to some form of indicator. They will pick up RF energy under some conditions, but are highly directional, crude, and inaccurate devices. One should expect accuracy – something quite important – when one's health and well-being is at stake.

## SHOULD I USE AN RF PERSONAL MONITOR?

This is an important question, to which there are many opinionated answers. Here is what I tell my clients:

If a person is going to enter any area where there is a chance of exposure to RF field levels above the MPE limits for Occupational/Controlled exposure, a monitor is almost always the best solution. These areas include any tower on which one or more television or FM radio antennas are located and on towers within 500 feet of a broadcast antenna.

In fact, I would not recommend anybody being allowed on a broadcast tower without a monitor, even when the systems are supposedly shut down. There have been many instances when systems have been turned on while climbers are on towers.

Consider the situation for which an FCC Notice of Apparent Liability for Forfeiture (NAL) was issued last year. A climber wearing a suit had been told that all three FM stations on the tower had been shut down. For some inexplicable reason, the climber shut off the monitor that he had.

However, when his legs got very warm and his RF suit started to smoke, he knew something was wrong!

## WEAR THE MONITOR PROPERLY

Wearing monitors on your belt over the back pocket brings new meaning to the concept of CYA, but it is not the correct place to wear a monitor. And RF personal monitors do not work underneath RF protective garments.

Wearing an RF personal monitor under a RF protective suit may make sense to those who are not familiar with the personal monitors and suits; they might think that the monitor would simply detect what is getting through to the wearer, when this is simply untrue. *This is a very dangerous practice!*

RF personal monitors can be very useful tools when dealing with potentially high RF field levels. But you need to select the correct monitor for the job and use it correctly.

Finally, anyone who uses a monitor should be a trained RF worker in accordance with the FCC criteria for workers that are fully aware and able to exercise control.

*Richard Strickland has more than 15 years of experience in the field of RF safety. He heads RF Safety Solutions LLC, which focuses entirely on RF safety issues for companies and government agencies. In addition to consulting, the company supplies RF personal monitors and RF safety signs. Richard may be contacted at RStrick@RFSafetySolutions.com or 631-698-6765*