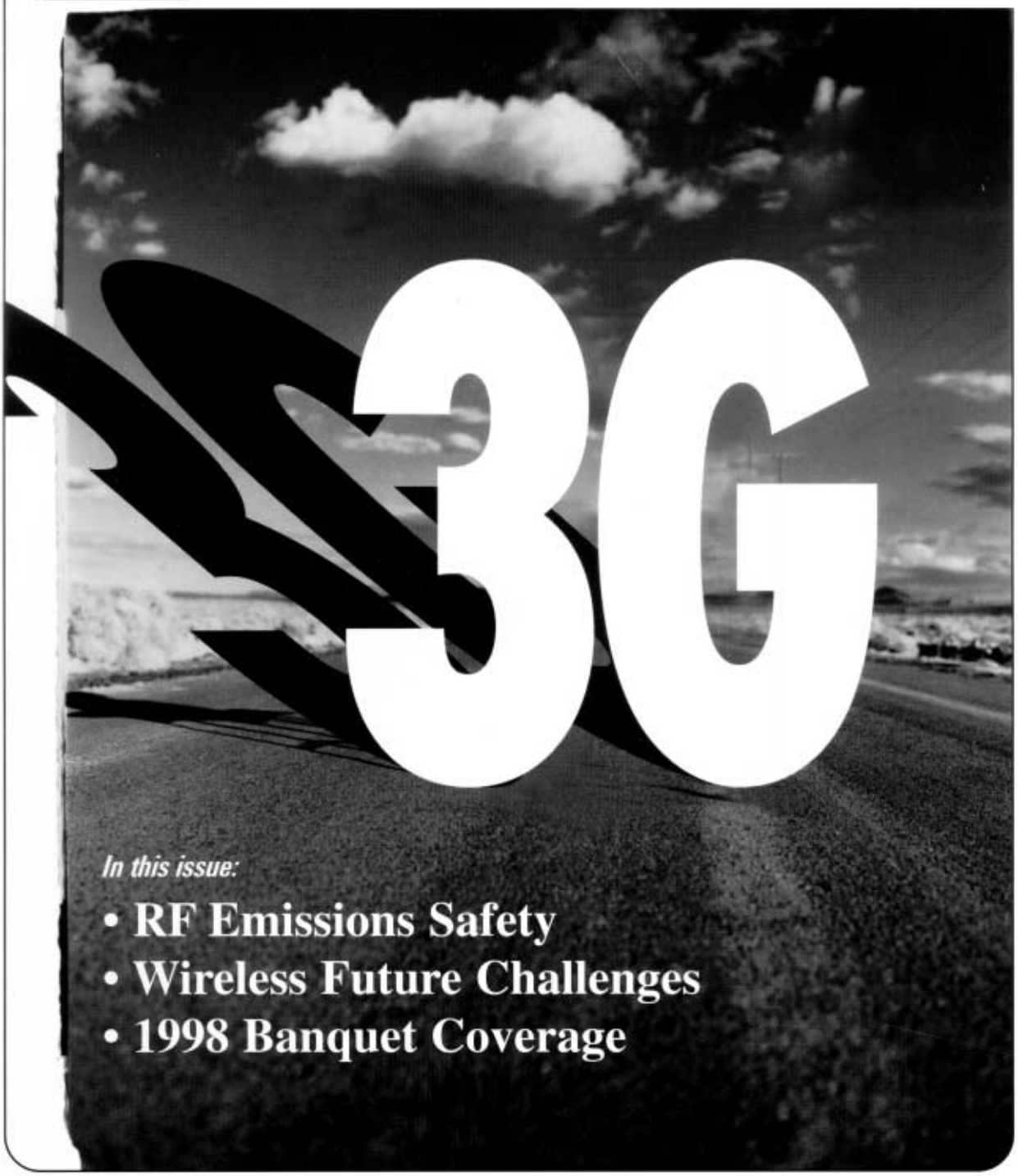
PROCEEDINGS of

THE RADIO CLUB OF AMERICA, INC.

Founded 1909, New York, U.S.A.

SPRING 1999



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RF Emissions Safety and Today's Regulations

Radio frequency (RF) radiation, RF emissions, electromagnetic energy, whatever you choose to call it — the new FCC regulations and increased awareness of non-ionizing radiation is a hot subject today. The most recent FCC regulations seemed to have caught many organizations by surprise, although it has taken years to get to where we are today.

Where are we? We have some reasonable regulations that are soundly based on well-documented biological hazards. At least some of the confusion is due to the conflicting messages sent out by the Occupational Safety and Health Administration (OSHA) – messages that only now appear to agree with the FCC and other regulatory agencies. But before we go into details, perhaps it is better to review how we arrived at the place where RF safety is making headlines.

RF History

Although there were some indications of the heating effects from the energy emitted by radio transmitters in the late 1930s, the phenomena became well known with the development of radar during the Second World War. Quite simply, people noticed that they got warm when they stood in front of radar antennas. Dr. Percy Spencer of Raytheon took note and ultimately developed the radar range – today's microwave oven.

Narda got involved in 1969 when two representatives of the Food and Drug Administration asked for help. Public Law 90-602 that regulated the amount of RF energy leaking out of a microwave oven was about to be passed and there weren't any instruments to measure the leakage. The only things that existed were extremely crude instruments to measure field strength. Ed Aslan, invented the first instrument to measure microwave oven leakage and received a patent and an IR100, or Industrial Research award as one of the top 100 new inventions. Today, he has 47 patents in this field while the rest of the world has four.

The first human exposure guidelines were developed by the U.S. military in the 1950s. The military funded most of the research in those days because they were the ones with most of the high power emitters. The American National Standards Institute (ANSI) issued the first general RF exposure standard in 1966. It was only four pages long and suggested limiting human exposure to levels no higher than 10 mW/cm2 from 10 MHz to 100 GHz.

Other than the military, broadcasters were the only ones who faced concerns over RF radiation. But most broadcasters focused on the concerns of the public. In reality, RF radiation is almost exclusively an occupational problem. It is rare for someone to be exposed to significant RF field levels outside of work, although the proliferation of wireless antennas is making public exposure more of a concern than ever.

Because a concerned public outcry can impact broadcast operations, it must be dealt with even if the fears are usually unwarranted. It is ironic that those dealing with some of the most dangerous RF exposure situations – broadcasters – almost totally ignored occupational exposure issues. Until recently, that is.

Biological RF Research Determined

- How do various RF fields affect the body?
- At what levels does the body suffer adverse effects?
- At what levels are the effects permanent?

Early on we knew that the primary concern was thermal. Quite simply the body heats up in the presence of significant RF energy. The first ANSI standard was a best guess and suggested limiting exposure to the same 10-mW/cm2-field level at all frequencies. But, as research continued, it became apparent that many factors impact how much the body heats up.

The concept of specific absorption rate (SAR) evolved. SAR designates heat absorbed into the body in units of watts per kilogram. Ultimately, it was determined that much of this follows basic antenna theory. In an ungrounded situation, the body represents a fat, lossy dipole. When well grounded, the body represents a grounded quarter wave antenna. Researchers consider the "standard man" to be 1.75 meters tall, about 5'9". That makes him resonant at about 86 MHz. So the average adult male makes a perfect antenna for channel six television. The biology is certainly more complicated than that but height, grounding and polarization are the most important factors in determining SAR level.

The next question is, how much heat can the body tolerate? It was determined that the most heat the human body can deal with is approximately 4 W/kg. Much of this research was based on exercise levels rather than on actual exposure experiments. These levels are averaged over the

body since our circulatory systems function much like a radiator. For this reason, an arm exposed to a strong RF field from a satellite uplink dish can tolerate about twenty times as much energy as the whole body. The eyes and a male's testes are particularly vulnerable, however, since the limited blood flow of these organs limits the benefits of the circulatory system.

Time is also a factor. Most standards average exposure over time, which only makes sense since we are dealing with heat. Six minutes is the average period for most occupational exposure limits.

How can RF energy hurt people? Moderate level exposures cause heat stress and behavioral changes. The effects often are mistaken for the flu because the symptoms are similar and as the level of exposure increases, the potential for harm increases. Human cells die at 107 degrees Fahrenheit. This is the reason that doctors get concerned if a person's temperature rises above 105 degrees.

The body is constantly replacing cells so the amount of damage that is done depends on how many cells are killed and what kind of cells are exterminated. Kill off some cells and the effects may pass in minutes or hours. Cook off a lot of cells, such as liver cells, and you will have liver damage.

Back to the Present

Today, we understand the biology fairly well and we have reasonable standards in place. Both the public and workers are much more aware of the issue of RF safety. However, the industry still is trying to come to grips with how to deal with the new FCC regulations, OSHA and a host of state and local government agencies.

Most of the RF exposure standards worldwide are remarkably similar because they are based on the same biological data. The U.S. standards are most restrictive from 30 MHz to 300 MHz. The 300 MHz represents a newborn infant in a crib. At the other end, the standards are designed to protect a well-grounded NBA center. The exposure limits are set for one-tenth of the known limits for healthy young adults – a SAR level of 0.4 W/kg. The safety factor can be greater than 10:1, depending on the polarization.

Factors That Influence RF Safety

- Not everyone fits in the category of an athletically fit, healthy young adult.
- The standards were all developed at room temperature but high heat and humidity lead to severe erosion of what can be considered your "heat budget" before one even factors in the RF energy.
- Workers are often engaged in strenuous activity, such as climbing a tower, which also produces heat.

So, the standards and the FCC regulations make sense. It is important to ask what does my company need to do to satisfy all of these standards and regulations? However, the first question really should be, what do we need to do to keep anyone from getting overexposed? Most of this is common sense once you understand the biology and the standards.

What the FCC Regulations Require

The new FCC regulations have a single objective to prevent all people from being overexposed to potentially harmful RF energy. The regulations are concerned with human exposure, not emission levels.

Two Ways to Achieve Compliance

- Make a site compliant by design.
- Develop and follow a RF safety program to insure that personnel do not risk exposure.

One common misconception is that low power wireless systems that are categorically excluded somehow relieve the operator from all responsibility for RF safety issues. Categorical exclusion does eliminate the legal need for an engineering evaluation. So, you do not need to complete an

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typically will include a site plan with hazard areas indicated.

Shared Sites

Operating companies should try to characterize all of their sites and use this information to achieve a safe work environment. At shared sites, where conditions change constantly, this is a difficult, if not impossible, task. The problem with many sites especially on rooftops, is the surprising number of organizations and people that need to access the site.

First and foremost, the goal should be to protect both a company's own personnel and all others who may visit a site. That also greatly reduces a company's liabilities.

Not only do you have all the communications people involved in installing and maintaining the electronic equipment, there are service personnel for elevators and HVAC equipment, window washers, building maintenance people, exterminators, painting and roofing contractors, and often a surprising number of other visitors. At many rooftop sites, RF energy is often not just an occupational problem. And although many of the typical visitors I have just described are there to perform work, those from occupations outside the communications industry rarely have any knowledge of RF radiation.

Service organizations have little control over their environment. Personal monitors are the only practical way for service organizations to protect their personnel. And many operating companies use monitors also since it is difficult to characterize all of their sites and keep up with the inevitable changes.

What is Next?

Now that many companies are in a mad rush to achieve compliance, what is next? There often is a big difference between what companies may do and what they should do. First and foremost, the goal should be to protect both a company's own personnel and all others who may visit a site. That also greatly reduces a company's liabilities. As business people, the goal should be to accomplish safety at minimum cost with the least amount of impact on operations.

Some things are a given. Most companies today would not even consider letting workers climb a tower without adequate fall protection equipment. Years ago, this was not the case. The very communications industry that we are working to build is enlightening more people so their tolerance of anything less than a RF safe environment is continually decreasing.

In the coming years the safety programs will become more rational and less reactive. There will be less of "let's do it so we can satisfy the FCC and OSHA" and more of "What works best for us?" Training issues will be resolved and annual refresher courses will become the norm. Employees will become more involved in developing and maintaining RF safety programs, much like they have become more involved in quality assurance issues.

In a few years, RF safety policies and procedures will be the norm, not a disruptive annoyance.

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