Aclara's Position on Radio Frequency Exposure and the STAR® Network

Introduction

Electromagnetic fields (EMF) are not new, nor are they an area of science that has gone without extensive study. They are naturally occurring when voltage and current are present, are part of our surroundings, and are observed in our everyday experience as magnetism, light, heat, and static-electricity. Electric fields, which are generated by the presence of voltage, may have varying strengths. The strength of an electric field is measured in volts per meter (V/m).

Taken together, all forms of electromagnetic energy, including radio frequencies (RF, the primary focus of this paper) are part of the electromagnetic spectrum. The total range of emissions in this spectrum is defined in terms of wavelength and frequency, with wavelength being the distance covered by one complete wave cycle and frequency being the number of times a complete wave cycle passes through a specific point in one second. The frequency of any electromagnetic signal is expressed in hertz (Hz), and by definition, one Hz equals one cycle per second.

The intentional use of radio frequencies to carry information wirelessly began in the late 1800's, and has culminated in the tightly defined, regulated, and constantly changing RF spectrum allocations that we observe today. Many services available worldwide employ RF, including radio and television broadcasting stations, GPS devices, satellite communications, paging systems, emergency services such as police, fire, and ambulances, private two-way radio, and fleet-management systems.

Most people use and are exposed to electronic devices that generate RF emissions, such as clocks, room lighting, automobiles or public transportation, cellular and cordless telephones, garage door openers, alarm systems, appliances such as microwave ovens, radios, televisions, video game consoles and controllers, computers, wireless networks and other wireless devices, and even household wiring and power-transmission lines. In fact, operating any electric device in the home, such as a clothes iron or an electric oven, produces some form of RF emissions. Similarly, as communications devices, Aclara's products generate some RF emissions.

Aclara's STAR Network products function in very narrow bands of the total spectrum–between 450 and 470 megahertz (MHz). The U.S. Department of Commerce has published a chart that illustrates the complete, usable spectrum as established in the United States, which can be found at http://www.ntia.doc.gov/files/ntia/publications/2003-allochrt.pdf.

As this chart shows, specific bands of the electromagnetic spectrum are tightly controlled, including the RF bands in which Aclara products operate. These controls are in place because the bands of spectrum devoted to communications are considered a precious resource. All products that utilize part of any controlled frequency spectrum must follow the rules established for specific and defined bands within this spectrum. Many countries or regions will differ in their use allocations based on their unique requirements.

In this document, we will briefly outline the facts regarding RF emissions and the standards and research-based guidelines that specifically govern them, and then relate these elements to the Aclara products that operate within the electromagnetic spectrum.

RF Energy

The RF bands employed by Aclara products are controlled frequencies licensed by the Federal Communications Commission (FCC). These frequencies, which collectively fall within the frequency ranges of 450 to 470 megahertz (MHz), are a very small portion of the overall controlled spectrum ranging from 3 kilohertz (3kHz) to 300 gigahertz (300GHz). These frequencies are also considered non-ionizing, which means they are not energetic enough to detach electrons from atoms.

It is important to note that non-ionizing frequencies do not behave the same way as ionizing radiation such as ultraviolet light or X-rays. Ionizing radiation may be harmful to humans depending on exposure intensity and duration. Common sources of ionizing radiation include sunlight, X-ray machines, cosmic rays, and the radioactive decay of elements found in nature like radon emitted from granite.

Even though RF energy is non-ionizing, there are federal regulations that manufacturers must follow with regard to RF exposure. The only known potential health impact of non-ionizing radiation is tissue heating. The regulations established define the limits of RF exposure in terms of a combination of: signal duration, signal strength, distance from the source, and for devices classified as mobile or portable, specific absorption rate (SAR) is evaluated to keep heating effects to safe levels.

Signal duration is the length of time one is exposed to a signal. More specifically, duration is calculated as the duty cycle, which is the fraction of total time that a device transmits during any given period of time. For instance, a duty cycle of one percent per day means that the device radiates for a little over 14 minutes a day, or one minute per hundred. This concept often is overlooked when calculating and comparing exposures from various devices. For example, exposure to radio frequencies from a cellular phone, television, wireless access point, or any equipment normally used for minutes or even hours per day, may be greater than exposure from a meter reading device which operates only a few tenths of a second per day.

Field strength is another indicator of the RF energy produced by a device, and is also factored into determining whether a device is safe. Field strength is usually defined in terms of milliwatts per square centimeter(mW/cm^2). Signal duration and field strength are considered together to determine the safety of specific devices. For example, a wireless headset utilizing Bluetooth technology produces a pulsed signal continuously but this signal is not strong enough to produce the energy needed to be considered harmful.

Distance from the source also affects the amount of exposure to RF. In other words, the further a person is from the source and the lower the energy strength of the transmission, the less exposure. Radio energy levels follow what is called the inverse distance-squared rule, meaning that doubling the distance reduces the energy by four times. As an example, if a device measures an output of 1.0 mW/cm^2 at 1 foot in distance, at 2 feet of distance the energy measures 0.25 mW/cm^2. At ten feet the energy will be one one-hundredth of the original level.

Specific Absorption Rate (SAR) is usually measured in watts per kilogram (W/kg) or milliwatts per gram (mW/g). Whole-body SAR, as well as the other elements of RF exposure, is regulated by the Federal Communications Commission (FCC). RF safety standards related to SAR are generally most restrictive for equipment transmitting on frequencies in the range of about 30 to 300 MHz, because at these frequencies whole-body SAR is at a maximum. In FCC CFR 47 section 2.1093, which relates to safety of portable devices and SAR, the following statement is made in 2.1093(b): “For purposes of this section, a portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user.” Aclara devices do not fit into this category because they are not handheld.

RF Exposure Limits

The FCC guidelines for human exposure to RF fields were adopted from limits recommended by the U.S. National Council on Radiation Protection and Measurements, and standards developed by the American National Standards Institute (ANSI) and the Institute of Electrical and Electronics Engineers (IEEE).

The relevant standards are:

- IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300GHz (IEEE Standard C95.1.1999)
- Code of Federal Regulations [Title 47, Volume 1] Section 1.1310 Radiofrequency Radiation Exposure Limits (CFR 47 Section 1.1310)
- Health Canada Safety Code 6 Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3 KHz to 300 GHz

CFR 47 Section 1.1310 describes RF levels considered safe for either controlled or uncontrolled environments. Controlled environments comprise occupational exposures where people exposed to RF as a part of their employment are fully aware of the potential for exposure and can exercise control over it. Uncontrolled limits apply to environments where the general public may be exposed, or where people exposed as a consequence of their employment are not fully aware of the potential exposure or cannot exercise control over it. Most concern regarding RF exposure centers on uncontrolled limits.

Exposure is calculated as an average of the power density for a 30-minute time period for a person who is at least 20 centimeters (about eight inches) from the device. The FCC’s OET BULLETIN 65, titled *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*, illustrates the FCC maximum limits for occupational and general exposure to RF and provides detailed calculations. This report is available at: http://transition.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65b.pdf.

STAR Network Overview

The Aclara STAR Network AMI system collects and manages water, electric, and gas-meter usage data. With over eight million endpoints deployed beginning in the early 90's, the STAR Network has helped electric, water, and gas utilities establish programs and processes that encourage resource conservation as well as providing efficiencies in planning, managing, and operating their utility systems.

The Aclara STAR Network is a communication system that delivers hourly meter data to the utility. Its radio topology consists of three components: meter transmission units (MTUs), data collector units (DCUs) and the network control computer (NCC).

The Aclara MTU connects to all major residential and commercial meter types. The MTU receives the usage information from the meter and transmits this data to a DCU via an FCC-licensed 450-470 MHz radio channel. The STAR Network MTU for water and gas installations is a reliable and energy-efficient radio transmitter that signals using a 20-year permanent battery capable of transmitting data reliably from the most challenging meter locations. Individual gas and water MTUs typically transmit meter readings four times a day for approximately 0.07 seconds (s) or less per transmission.

The STAR Network MTU for electric installations shares the same basic radio transmitter technology and characteristics. It receives power from the utility side of the meter and transmits unless power is lost. When utility power fails, the battery-operated unit transmits outage information to the utility, allowing effective analysis, quick response, and faster repairs.

STAR Network Measurements against US Standards

STAR Network MTU meter modules produce an extremely low-level pulse of RF energy when they transmit a meter reading. This pulse conforms to the limits set in IEEE STD C95.1.1999 and CFR 47 Section 1.1310, which are described above under the heading, *RF Exposure Limits*.

Both of these standards establish the exposure limit as:

$$\textit{Exposure Limit } S \leq 450/1500\ mW/cm^2 \approx 300\ \mu W/cm^2\ \textit{maximum}$$

According to the standards, exposure is calculated as an average of the power density for a thirty-minute time period for a person that is 20 centimeters (8 inches or further) from the device. FCC OET Bulletin 65, equation (5), recommends the following formula for determining compliance with the above exposure limits (ERP given in microwatts, R in centimeters):

$$\textit{Exposure (Time Averaged) in } \mu W/cm^2 = (33.4 \times ERP/R^2) \times \textit{OnTime/30 minutes}$$

The following table contains the power density for typical sample Aclara MTUs:

FCC ID	ERP (Watts)	Instantaneous power density	On time per 30 minutes	Aclara MTU exposure	FCC exposure limits
Standard unit LLB6327PWM	0.132 W	43.1 $\mu W/cm^2$	0.28 sec. max	0.007 $\mu W/cm^2$	300 $\mu W/cm^2$
Extended range unit LLB10051M	0.794 W	259 $\mu W/cm^2$	0.28 sec. max	0.041 $\mu W/cm^2$	300 $\mu W/cm^2$

STAR Network Measurements against Canadian Standards

STAR Network MTU meter modules produce an extremely low-level pulse of RF energy when they transmit a meter reading. This pulse conforms to the limits set in Health Canada Safety Code 6, which is described above under the heading, Canadian RF Exposure Limits.

Safety Code 6 establishes the exposure limit as:

$$\textit{Exposure Limit } S \leq 450/150 \text{ W/m}^2 \approx 300 \text{ } \mu\text{W/cm}^2 \textit{ maximum}$$

According to the standards, exposure is calculated as an average of the power density for a six-minute time period for a person that is 20 centimeters (8 inches or further) from the device. The following formula can be used for determining compliance with the above exposure limits:

$$\textit{InstantaneousPowerDensity} = ERP \times 1.64 / (4 \times \pi \times (20\text{cm})^2)$$

$$\textit{Exposure (Time Averaged) in } \mu\text{W/cm}^2 = \textit{InstantaneousPowerDensity} \times \textit{OnTime/6 minutes}$$

The following table contains the power density for typical sample Aclara MTUs:

Industry Canada ID	ERP (Watts)	Instantaneous power density	On time per 6 minutes	Aclara MTU exposure	Health Canada exposure limits
Standard Unit IC 4546A-6327P	0.170 W	55.5 µW/cm^2	0.28 sec. max	0.043 µW/cm^2	300 µW/cm^2
DCU-II IC 4546A-9975	2.820 W	920 µW/cm^2	2.00 sec. max	5.112 µW/cm^2	300 µW/cm^2

Sources and References

Federal Communications Commission (FCC): Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields
http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65.pdf

Federal Communications Commission (FCC): Radio Frequency Safety Website
http://transition.fcc.gov/oet/rfsafety/rf-faqs.html

SGCC Radio Frequencies and Smart Meters Fact Sheet
http://smartgridcc.org/best-practices-and-case-studies/community-health-concerns-and-the-smart-grid

World Health Organization: Electromagnetic Fields and Public Health: Electromagnetic hypersensitivity
http://www.who.int/mediacentre/factsheets/fs296/en/index.html

Environmental Defense Fund: Smart Grid Fact Sheet
http://www.edf.org/sites/default/files/EDF-smart-grid-benefits-fact-sheet_0.pdf

Utilities Telecom Council, UTC
http://www.utc.org/utc/no-health-threat-smart-meters-says-latest-utc-study

California Council on Science and Technology:
http://www.ccst.us/publications/2011/2011smart-final.pdf

