



R900® Radio Frequency (RF) Emissions

This document provides general information about radio frequency (RF) electromagnetic fields from R900® wireless communication equipment. This information has been provided by Neptune Technology Group, which has evaluated this equipment for RF emissions. R900 equipment has been certified by the Federal Communications Commission (FCC) and Industry Canada (IC).

What frequencies are used by the meter/radio equipment being installed?

R900 wireless communication equipment operates within the Industrial, Scientific, and Medical (ISM) band which includes frequencies from 902 MHz to 928 MHz.

The Food and Drug Administration (FDA) and the FDA's Center for Devices and Radiological Health (CDR) have classified radiation emitted by devices operating at these RF frequencies as "non-ionizing". Other types of non-ionizing radiation devices include televisions, radios, remote controls, and other devices that use visible light and infrared light.

Have the meters/radios been certified by the FCC and Industry Canada?

Yes. Radio endpoints being installed have been tested in accordance with Title 47, Part 15 of the Code of Federal Regulations and have been certified by the FCC.

The R900® is also certified by Industry Canada who has adopted Health Canada's "Safety Code 6: Limits of Human Exposure to Radio Frequency Electromagnetic Fields in the Frequency Range of 3KHz to 300GHz".

Where can I go to learn more about regulatory compliance?

The FCCs document *OET Bulletin 65 Edition 97-01*, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", details how to measure or calculate levels of RF radiation and to determine compliance of RF facilities with exposure limits.

Additionally, FCC *OET Bulletin 65 Supplement C Edition 01-01* provides further guidance on determining compliance for portable and mobile devices.

These documents may be found at <http://www.fcc.gov/encyclopedia/radio-frequency-safety>

What is the power output from the R900 devices when they are transmitting data?

The effective radiated output power (ERP) for the R900 devices is less than 100 milliwatts (mW) for Standard Mobile Messages sent every 14 seconds. Fixed Network Messages are transmitted at just under 1 Watt every 7½ minutes. In comparison, portable transmitters used by consumers typically operate over this output power range, and in fact, may operate with output power up to several thousand milliwatts.



Are there any health hazards associated with this technology?

The World Health Organization (WHO) notes:

“A number of studies have investigated the effects of radiofrequency fields on brain electrical activity, cognitive function, sleep, heart rate and blood pressure in volunteers. To date, research does not suggest any consistent evidence of adverse health effects from exposure to radio frequency fields at levels below those that cause tissue heating. Further, research has not been able to provide support for a causal relationship between exposure to electromagnetic fields and self-reported symptoms, or “electromagnetic hypersensitivity”.

The WHO Fact Sheet may be found at <https://www.who.int/en/news-room/fact-sheets/detail/electromagnetic-fields-and-public-health-mobile-phones>

Are there RF exposure standards for the R900 devices?

The FCC has established rules requiring transmitting facilities to comply with RF exposure guidelines. The limits established in the guidelines are designed to protect the public health with a very large margin of safety. These limits have been endorsed by federal health and safety agencies, such as the Environmental Protection Agency (EPA) and the FDA.

The FCC has established exposure guidelines for RF devices operating in the 300 kHz to 100 GHz range. These safety guidelines are outlined in the publication, *OET Bulletin 65 Edition 91-01*, “Evaluating Compliance with the FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Field,” and can be found at <http://www.fcc.gov/encyclopedia/radio-frequency-safety>

The general-population exposure limits set by the FCC for the frequency range utilized by the meters/radios and other devices such as cordless phones and baby monitors is 0.6 milliwatts per centimeter squared (mW/cm^2) at 902 MHz.

The R900 device transmits for less than one minute total per day and for seven milliseconds at a time. The exposure to radio frequency energy at a distance of one foot from the meter is never more than 0.08 mW/cm^2 for the Fixed Network Messages. This is approximately eight times lower than the exposure limit set by the FCC. Standard Mobile Messages are an order of magnitude lower.

For more information on the effects of RF energy exposure, please visit:

- **FCC:** For information regarding potential RF hazards from FCC regulated transmitters, please contact the Federal Communications Commission, Consumer & Governmental Affairs Bureau, 445 12th Street, SW, Washington, DC, 20554; Phone: 1-888-225-5322; E-mail rfsafety@fcc.gov; or go to <http://www.fcc.gov/encyclopedia/radio-frequency-safety>
- **FDA:** For information about radiation from microwave ovens and other consumer and industrial products, contact Center for Devices and Radiological Health (CDRH), Food and Drug Administration or go to <http://www.fda.gov/Radiation-EmittingProducts/default.htm>
- **OSHA:** The Occupational Safety and Health Administration’s (OSHA) Health Response Team has been involved in studies related to occupational exposure to RF radiation.
https://www.osha.gov/SLTC/radiation_nonionizing/index.html
- **WHO:** The World Health Organization’s Electromagnetic Fields information page is located at <https://www.who.int/peh-emf/en/>

Does Health Canada have RF exposure standards for the R900 devices?

Health Canada's Safety Code 6 outlines and specifies maximum levels of human exposure to RF energy at frequencies between 3 kHz and 300 GHz, to prevent adverse human health effects. Safety Code 6 also specifies maximum allowable RF contact and induced body currents to prevent the physical perception of internal currents resulting from RF energy in uncontrolled environments, and to prevent RF shock or burns to personnel in controlled environments. The code also serves to provide guidance for evaluation RF exposure levels, to ensure that personnel in controlled and uncontrolled environments are not exposed at levels greater than the limits specified in this code.

For more information on Health Canada's Safety Code 6, please visit <https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/radiation/fact-sheet-what-safety-code-6.html>

Will installation of the new meter/radio interfere with my security systems, pacemaker, cell phones, or other RF electronics?

The transmitting devices operate in compliance with FCC 47 CFR Part 15 regulations, which require coexistence with other Part 15 certified devices. Within the 902-928 MHz frequency band, operation is limited to frequency-hopping, direct-sequence, spread-spectrum, and digital modulation intentional radiators. This rule facilitates multiple devices operating in the same location. This includes devices such as security systems, pacemakers, cell phones, and cordless phones. The meter/radio's transmit signal is of very short duration (seven milliseconds), which further decreases the potential for interference with other devices. For comparison, seven milliseconds equates to approximately one minute total transmission time per day.

How long has this meter/radio equipment been manufactured?

The R900 radio devices have been in production since 1999.

How many radio devices have been installed in residential applications?

Over seventeen million Neptune R900 radio devices have been deployed on water meters today throughout North America. In addition, over 100 million 900 MHz radio devices have been deployed on water, gas, and electric meters across North America.

Throughout the life of the R900 product, have there been any cases of interference caused by the R900 radio devices?

There have been no documented cases where the R900 devices have interfered with third-party devices.



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Health Effects of Radio Frequency Based AMR/AMI Systems

A WHITE PAPER BY NEPTUNE TECHNOLOGY GROUP INC.

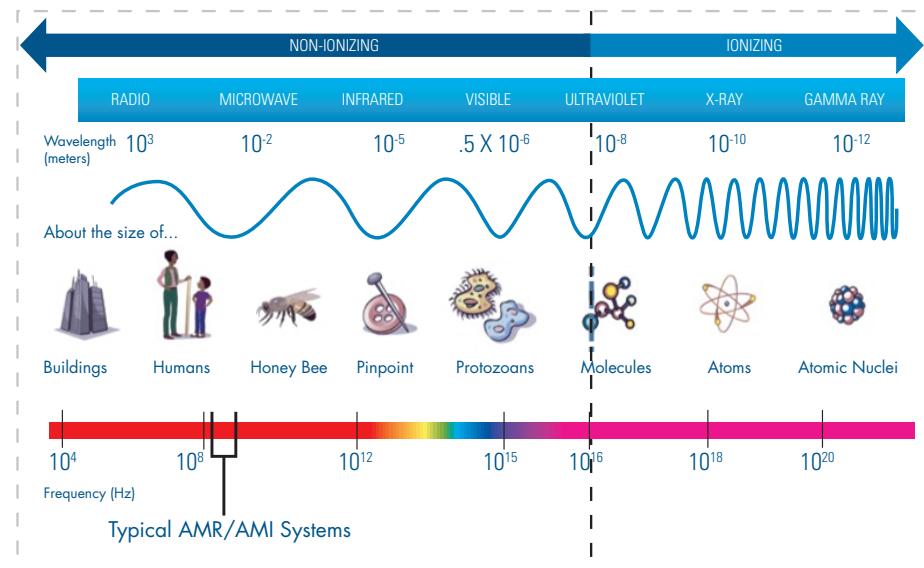
Millions of radio frequency devices have been installed in North America to gather usage data from water, gas, and electric meters. Utilities of all sizes and types have realized the operational and customer service benefits of automating their data collection processes. But as the use of these systems has grown, some have raised questions over public safety. Have the health effects of these devices been adequately considered?

In this article, we'll address the issue of these health effects, and try to distinguish fact from fiction in the process.

BACKGROUND

First, we need to provide some background on the physics of radio frequency (RF) systems. For the purposes of brevity, we'll only hit the high points in this article, but we've added more information on our website at www.neptunetg.com.

Radio frequencies are part of a broad range of energy phenomena called the "electromagnetic spectrum." Everything in the electromagnetic spectrum consists of waves of energy that are measured in terms of their frequency and magnitude. The electromagnetic spectrum includes not only radio waves but also visible light.



Frequencies are measured in Hertz and 1 Hertz = 1 cycle per second. We use metric prefixes kilo, mega, giga, and so on to designate multiples of 1 thousand, 1 million, and 1 billion Hertz respectively. So a device operating at 900 MHz, which is commonly used for RF devices in many automatic meter reading systems, is oscillating at 900,000,000 (or 9×10^8) times per second.

The diagram above illustrates the different types of waves that make up the electromagnetic spectrum. The human voice (not shown on the diagram) typically has a frequency range of 85 to 255 Hz and would be at the far left of the chart. As the diagram shows, the electromagnetic spectrum is often subdivided into

two categories: ionizing radiation and non-ionizing radiation.

The EPA provides the following definitions:

Radiation that has enough energy to move atoms in a molecule around or cause them to vibrate, but not enough to remove electrons, is referred to as "non-ionizing radiation." Examples of this kind of radiation are sound waves, visible light, and microwaves.

Radiation that falls within the "ionizing radiation" range has enough energy to remove tightly bound electrons from atoms, thus creating ions. This is the type of radiation that people usually think of as "radiation." We take advantage of its properties to generate electric power, to kill cancer cells, and in many manufacturing processes.¹

Automatic meter reading (AMR) and advanced metering infrastructure (AMI) systems typically operate in the 450MHz to 2.4GHz frequency range. And there are many other devices we use every day that operate using radio frequencies including: baby monitors, remote car keys, smart phones, cellular networks, cordless telephones, AM and FM radio broadcasts, garage door openers, radio-controlled toys, television broadcasts, satellite communications, police radios, and the list goes on and on.

With the explosion in social media, smart phones, WiFi, mobile streaming, GPS systems, and a myriad of other applications, the use of RF has grown exponentially. As of June 2011, the number of connected devices with wireless subscriptions was 396 million², which exceeds the estimated U.S. population³. Unless you live in a specially designed shielded room like an anechoic chamber, you're exposed to RF signals 24/7.

HEALTH EFFECTS

So, what is the impact of RF-based AMR and AMI systems on our health?

We'll use the terms previously identified to start the discussion. We are all aware that some levels of ionizing radiation as found in Gamma Rays, X-Rays, and certain types of ultraviolet light are harmful to our health. RF systems that are used for AMR and AMI systems fall into the category of non-ionizing radiation, as they do not have sufficient energy to change the structure of molecules with which they come in contact.

Within the non-ionizing group of frequencies, where do AMR- and AMI-equipped smart meters fall? The table on this page shows the relative power density in microwatts per square centimeter ($\mu\text{W}/\text{cm}^2$)

Comparison of RF Power Density in the Everyday Environment

(microwatts per square centimeter, or $\mu\text{W}/\text{cm}^2$)⁴

Adjacent to a gas Smart Meter (1 foot)	0.00166
Adjacent to an electric Smart Meter (10 feet)	0.1
Adjacent to an electric Smart Meter (1 foot)	8.8
Microwave oven nearby (1 meter)	10
Wireless routers, laptop computers, cyber cafés, etc. maximum (~1 meter for laptops, 2-5 meters for access points)	10 to 20
Cell phone (at head)	30 to 10,000
Walkie-Talkie (at head)	500 to 42,000

so that the various devices can be compared. Although water devices were not specifically measured in this independent study, they would tend to operate like gas smart meters which are also dependent on battery power and therefore can't transmit as often or at an output power as high as electric smart meters.

As we can see, the level of exposure to RF emissions is much less for smart meters (gas and water being the lowest of these) than our typical exposure to laptops, WiFi networks, and cell phones.

While there are many published opinions on the topic, the following summary from Health Canada seems to be one of the most concise:

As with any wireless device, some of the RF energy emitted by smart meters will be absorbed by anyone who is nearby. The amount of energy absorbed depends largely on how close your body is to a smart meter. Unlike cellular phones, where the transmitter is held close to the head and much of the RF energy that is absorbed is localized to one specific area, RF energy from smart meters is typically transmitted at a much greater distance from the human body. This results in very low RF exposure levels across the entire body, much like exposure to AM or FM radio broadcast signals.

Survey results have shown that smart meters transmit data in short bursts, and when not transmitting data, the smart meter does not emit RF energy. Furthermore, indoor and outdoor survey measurements of RF energy from smart meters during transmission bursts were found to be far below the human exposure limits specified in Health Canada's Safety Code 6.

Based on this information, Health Canada has concluded that exposure to RF energy from smart meters does not pose a public health risk.⁵

So there does not appear to be a link between RF emissions in AMR and AMI systems and concerns about public health.

PERSONAL EXPERIENCE

And beyond the studies, we at Neptune[®] have some rather unique personal experience to add to the discussion.

Located at our factory and headquarters in Tallahassee, Alabama, Neptune has its "meter farm" which is used for testing meters and RF devices in various environmental conditions. At any given time, there are some 1,300 operational radios located about 100 feet from our engineering office. In addition, every day thousands of new radios are manufactured,

activated, and tested onsite. This is a level of RF saturation that would be very uncommon even in the densest urban settings.

We ran two twenty-minute tests at our office to determine the power density in the area of our engineering office (where we work every day). It should be noted that in addition to the signals from the radios manufactured and tested on site, there are several WiFi routers, cellular boosters, and countless cell phones. These tests were not intended to isolate the source of the radio frequency signals but were designed to show the amount of ambient exposure that could be encountered in an area saturated with RF signals.

As we can see from the data, the radio frequency exposure that we measured during these tests was far below the levels that would be encountered by a typical cell phone or walkie-talkie when held to the user's head.

Neptune is very conscious of employee health as illustrated by the fact that we switched all bronze-body meter production to lead free alloys in 2001, over a decade before legislation was enacted to mandate use of lead free materials. Although this put Neptune at a cost disadvantage, one of the primary drivers was the concern that lead exposure might have to our employees' health.

If we thought RF was bad for us, or others, we wouldn't subject ourselves to the possibility of harm.

THE COST OF OPT-OUT PROGRAMS

There will always be people who, for whatever reason, prefer not to have a "smart meter" installed at their residence. For this small group, the



Results of Test at Neptune's Engineering Facility (microwatts per square centimeter, or $\mu\text{W}/\text{cm}^2$)⁶

	Indoor Test	Meter Farm Test
Normal Range	0.01 to 0.20	0.01 to 0.20
Peak Level	1.1	7.6

utility may want to consider an opt-out program.

One of the primary benefits to the utility and the community at large in implementing an AMR or AMI system is the reduction in meter reading costs by reducing the time required to gather the readings. Since the cost of reading meters is borne by all of the utility's customers, homeowners who opt-out should recognize that they will need to pay for the option to have their meters read manually. It would be unfair to expect neighbors who have embraced the automated system to pay the added costs of reading meters of the people who have chosen to opt-out.

These costs may be considerable because of the inherent inefficiency of reading a few meters scattered throughout the service area.

Typically, opt-out programs result in a one-time charge to the homeowner that covers the initial cost to remove and replace the meter and an ongoing charge per reading to cover the added cost of sending someone to read the meter manually.

Some examples of opt-out proposals include:

- > City of Penticton, BC – at the time of writing this article, the City was developing an opt-out program that would offset the added cost of manual meter reading of "\$25 for an isolated spot, and \$6 for a manual read as part of a route."⁷
- > City of Glendale, CA – "city council unanimously voted on charging customers a fee of \$59 per billing period for having electric and water smart meters with the radios turned off."⁸
- > Central Maine Power, ME – "a) smart meter with transmitter off will carry an initial charge of \$20.00 and a monthly charge of \$10.50; b) existing analog meter option will carry the initial charge of \$40.00 and a monthly charge of \$12.00."⁹

CONCLUSION

It's not a stretch to make the claim that the proliferation of wireless technologies has changed the world. Think of your life before cell phones. Or looking at it another way, when was the last time you used a payphone? Smart phones, satellite navigation systems, wireless tablets, remote controllers keep us connected, without a physical connection.

Similarly, radio frequency-based systems have taken hold and changed the way utilities provide safe and cost-effective service to their constituents; and, to repeat the conclusion of the Health Canada study that is echoed in many other such reports, "exposure to RF energy from smart meters does not pose a public health risk."¹⁰

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