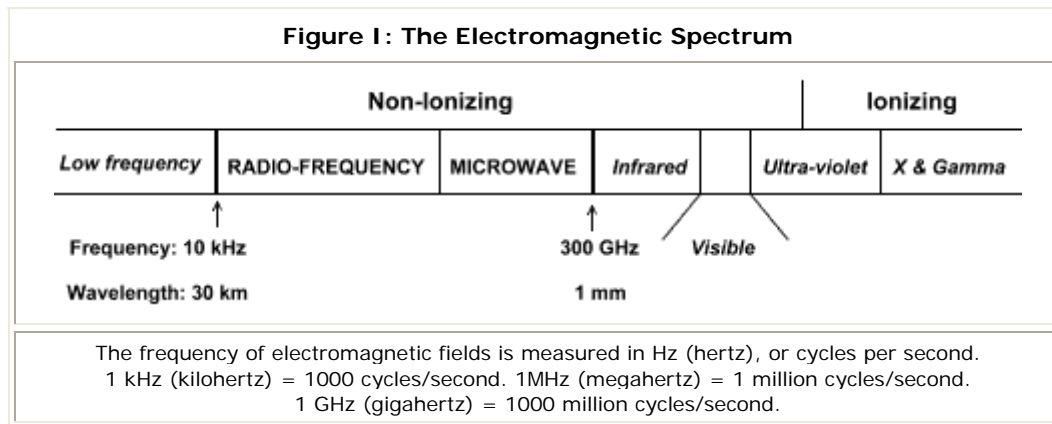


RADIOFREQUENCY AND MICROWAVE RADIATION IN THE WORKPLACE

1. INTRODUCTION

“**Radiofrequency (or RF) Radiation**” refers to electromagnetic fields with frequencies between 300 kHz and 300 MHz, while “**Microwave (or MW) Radiation**” covers fields from 300 MHz to 300 GHz. Since they have similar characteristics, RF and MW radiation are usually treated together. As well, the lower-frequency boundary of RF radiation is often extended to 10 kHz, or even to 3 kHz, in order to include emissions from commonly used devices.



RF radiation is produced by devices such as radio and TV transmitters, induction heaters, and dielectric heaters (also known as RF sealers). MW radiation is produced by microwave ovens, parabolic (dish) antennas, radar devices, and diathermy applicators. See Table III, “Sources of RF/MW Radiation”, on page 4 for more examples.

This guideline gives advice on preventing overexposure to RF/MW radiation in the workplace and sets out Occupational Exposure Limits which are enforced in Ontario workplaces by the Ministry of Labour under the general duty clause (section 25(2)(h) of the Occupational Health and Safety Act). However, this guideline cannot cover all possible situations. The requirements set out in the Occupational Health and Safety Act must be complied with, and they should be referred to when this guideline is used.

2. HEALTH HAZARDS

The nature and the degree of the health effects of overexposure to RF/MW fields depend on the frequency and intensity of the fields, the duration of exposure, the distance from the source, any shielding that may be used, and other factors.

The main effect of exposure to RF/MW fields is heating of body tissues as energy from the fields is absorbed by the body. Prolonged exposure to strong RF/MW fields may increase the body temperature, producing symptoms similar to those of physical activity. In extreme cases, or when exposed to other sources of heat at the same time, the body's cooling system may be unable to cope with the heat load, leading to heat exhaustion and heat stroke.

Localized heating, or "hot spots," may lead to heat damage and burns to internal tissues. Hot spots can be caused by non-uniform fields, by reflection and refraction of RF/MW fields inside the body, or by the interaction of the fields with metallic implants, for example, cardiac pacemakers or aneurism clips. There is a higher risk of heat damage with organs which have poor temperature control, such as the lens of the eye and the testes.

Other hazards include contact shocks and RF burns. These can result from the electric currents which flow between a conducting object and a person who comes into contact with it while they are exposed to RF fields. (These effects should not be confused with shocks from static electricity.)

Some laboratory studies have reported biological effects from RF/MW radiation at field levels which are too low to cause tissue heating. To date, these non-thermal effects are not known to result in health hazards in workers. Although we are constantly exposed to weak RF fields from radio and television broadcasting, no health risks have been identified from this low-level exposure.

3. EXPOSURE LIMITS

Exposure limits for RF/MW radiation are designed to keep the RF/MW energy absorbed by the body well below the lowest levels associated with demonstrated adverse effects, and to reduce the likelihood of contact shocks and burns.

Since the RF/MW energy absorbed by the body varies with the frequency of the fields, and since the rate of energy absorption is difficult to measure directly, the exposure limits are expressed in terms of frequency-dependent, root-mean-square (RMS) electric and magnetic field strengths, or in power density units (W/m^2). Power density measures the amount of radiating energy crossing a given area in a given period of time.

Occupational exposure of the whole body to RF/MW fields should not exceed the values in Table I.

Table I: Exposure Limits for RF and Microwave Exposed Worker

Frequency (MHz)	Electric Field Strength; RMS (V/m)	Magnetic Field Strength; RMS (A/m)	Power Density (W/m ²)	Averaging Time (min)
0.003 - 1	600	4.9	--	6
1 - 10	600/f	4.9/f	--	6
10 - 30	60	4.9/f	--	6
30 - 300	60	0.163	10*	6
300 – 1 500	3.54f ^{0.5}	0.0094 f ^{0.5}	f/30	6
1 500 - 15 000	137	0.364	50	6
15 000 – 150 000	137	0.364	50	616 000/f ^{1.2}
150 000 – 300 000	0.354 f ^{0.5}	9.4 x 10 ⁻⁴ f ^{0.5}	3.33 x 10 ⁻⁴	616 000/f ^{1.2}

* Power density limit is applicable at frequencies greater than 100 MHz.

Notes: 1. Frequency, f, is in Mhz.

2. A power density of 10 W/m² is equivalent to 1 mW/cm².

3. A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (uT) or 12.57 milligauss (mG).

In addition, workers should not be subject to RF contact shocks or burns. This can be achieved by reducing stray fields and installing appropriate insulation and grounding, or by ensuring that the electric current flowing between a worker and an object energized by electromagnetic fields does not exceed the values in Table II.

Table II: Induced and Contact Current Limits for RF and Microwave Exposed Workers

Frequency (MHz)	Induced Current (RMS) (mA) Through		RMS Contact Current (mA) Hand Grip and Through Each Foot	Averaging Time
	Both Feet	Each Foot		
0.003 - 0.1	2000f	1000f	1 000f	1 s
0.1 -110	200	100	100	0.1 h (6 min)

Note: The limits in Tables I and II are based on Health Canada “Safety Code 6”, 99-EHD-237 (1999).

Table III shows which sources of RF/MW radiation may expose workers to levels in excess of Occupational Exposure Guidelines. Measurements of RF/MW levels should be carried out around sources with the potential to cause overexposure, in order to ensure compliance with the Occupational Exposure Limits. Measurements are not necessary for sources which do not have the potential to produce exposures in excess of the Occupational Exposure Limits.

Table III: Sources of RF/MW Radiation		
Source	Frequency (MHz)	Potential for Over-exposure?
Video Display Terminal (VDT)	0.015 - 0.3	No
Dielectric Heater	1 - 100 (typically 27.12)	Yes
Diathermy Applicator	13.56, 27.12, 915, 2450	Yes
Communications Transmitters: AM Radio	0.535 - 1.605	Yes
Communications Transmitters: FM Radio	88 - 108	Yes
Communications Transmitters: VHF TV	54-72, 76-88, 174-216	Yes
Communications Transmitters: UHF Radio	470 - 890	Yes
Communications Transmitters: Dish Antenna	800 - 15,000	Yes
CB Radio	27.12	Yes
Cordless Telephone	46 - 5800	No
Cellular Telephone	824 – 850, 900, 1800, 1900	No
Traffic Radar	10,500 and 24,000	No
Microwave Oven	915 and 2,450	No*
*Federal legislation requires that microwave ovens be constructed to meet stringent microwave leakage limits and to have safety interlocks. When these interlocks are defeated, for example, during repair work, there is a risk of overexposure to microwave radiation.		

4. CONTROLLING RF/MW RADIATION

Engineering Controls

- Sources of RF/MW radiation should be properly shielded to minimize stray radiation.
- Devices which can produce acute thermal injuries (e.g., industrial MW ovens) should have interlocked doors
- Devices which produce high levels of stray RF radiation (e.g., induction heaters and dielectric heaters) should be operated remotely whenever possible.

Administrative Controls

- Exposure of workers to RF/MW radiation should not exceed the recommended exposure limits.
- Areas where worker exposure to RF/MW radiation is suspected to exceed the recommended limits should be surveyed to determine the exposure levels.
- Needless exposure to RF/MW fields should be avoided.

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- Exposure times should be kept as short as reasonably possible.
 - Potentially hazardous RF/MW devices should be appropriately labeled, and areas of excessive exposure around them clearly demarcated. Notices with warnings and the necessary precautions should be posted.
 - Electrically-activated explosive devices should not be placed near sources of RF/MW radiation.
 - RF/MW devices should not be used in flammable or explosive atmospheres.
 - Equipment sensitive to RF/MW radiation, such as telephone switchboards or control panels, should not be installed near sources of RF/MW radiation.
 - Maintenance of devices used to produce RF/MW radiation should be done by qualified personnel following standard safety procedures. The equipment should be turned off whenever possible.

Personal Protection

- When exposures cannot be reduced by the above methods, RF/MW protective suits, including head and eye protection, can be used. Suits should be tested to ensure that they reduce worker exposure to levels below the occupational exposure limits and that they do not pose any safety hazards (e.g., overheating, shocks, or fire).

Controlling RF Shocks and Burns

- Metallic structures producing contact shocks should be electrically grounded and/or insulated.
- Insulating platforms or shoes (e.g., rubber-soled shoes) can be used to reduce energy absorption and currents to ground.
- When the above measures are ineffective or not reasonably possible, workers should wear insulating gloves.

First Aid

- Remove worker from exposure area to a cool environment and provide cool drinking water.
- Apply cold water or ice to burned areas.
- Seek immediate medical attention.
- Severe MW or RF overexposure may damage internal tissues without apparent skin injury, so a follow-up physical examination is advisable.

For more information about radiation protection in the workplace, please call the Radiation Protection Service at (416) 235-5922.

Remember that while complying with occupational health and safety laws, you are also required to comply with applicable environmental laws.

For further information or assistance, please contact your local office of the Ministry of Labour.