Radiation Safety Institute of Canada
Institut de radioprotection du Canada

EMF and Implanted Medical Devices: Why the Concern?

With Athena Wang, CRPA(R), RSIC Radiation Scientist

For information purposes only; not medical advice.

June 21, 2024

Good Science in Plain Language®

Webinar Functionality

Audio and video

- During the presentation, from the presenters only
- Captions: More>Language and speech>Turn on live captions

Use the Chat feature to talk to discuss with everyone

Use Q&A feature to ask questions for Q&A portion

Posted on webinar page

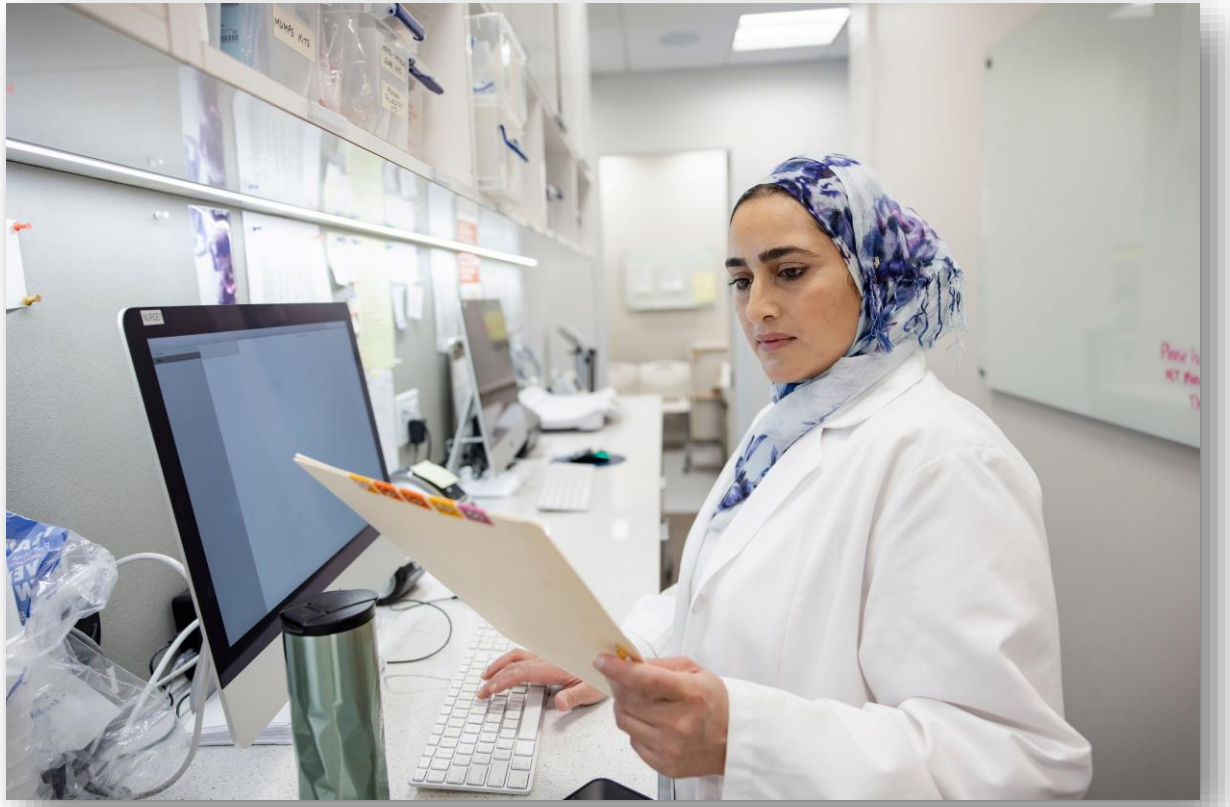
- Video, answers to questions, copy of the slides

Follow up email will be sent

- Topics covered, time of attendance

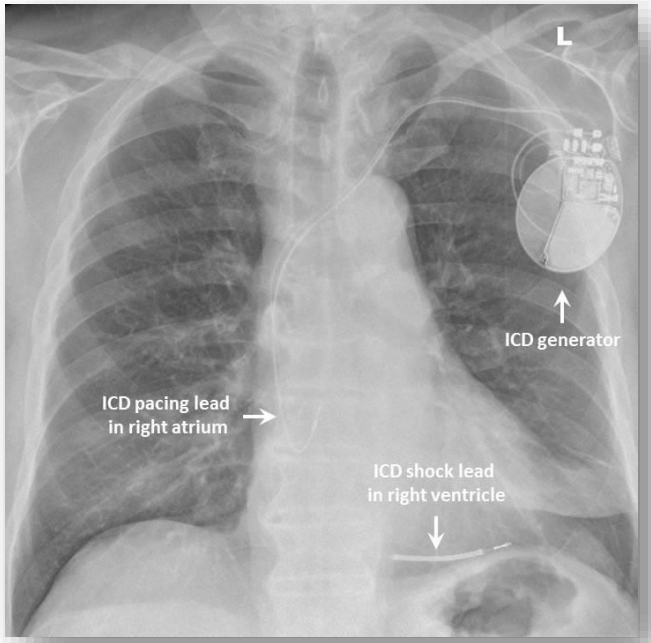
In This Session

- What is the issue?
- What are EMFs and how do they affect us?
- Regulations and guidelines?
- Implanted medical devices?
- Movement break
  - Charlmane Wong
  - Ji Hong Tai Chi & Qi Gong Richmond Hill



What Is The Issue?

- What are EMFs? What effects do they have on us?
- How do they interact with implanted medical devices?



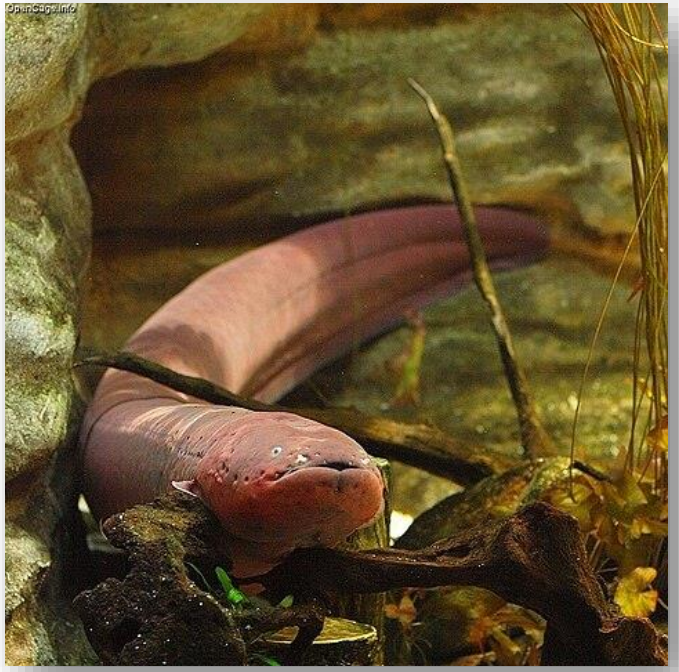
Short Forms

Many short forms are used when talking about electromagnetic fields:

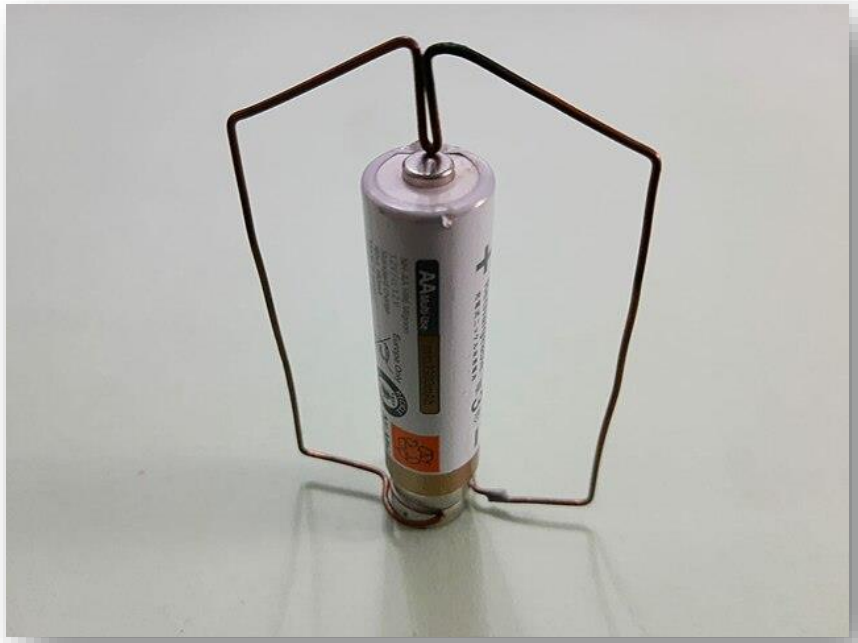
- AC is Alternating Current
- EMC is Electromagnetic Compatibility
- EMF is Electromagnetic Fields
- EMI is Electromagnetic Interference
- ELF is Extremely Low Frequency
- IMD is Implanted Medical Device
- RF is Radio Frequency

Electric Fields

- Electric fields surround objects that have an electric charge.

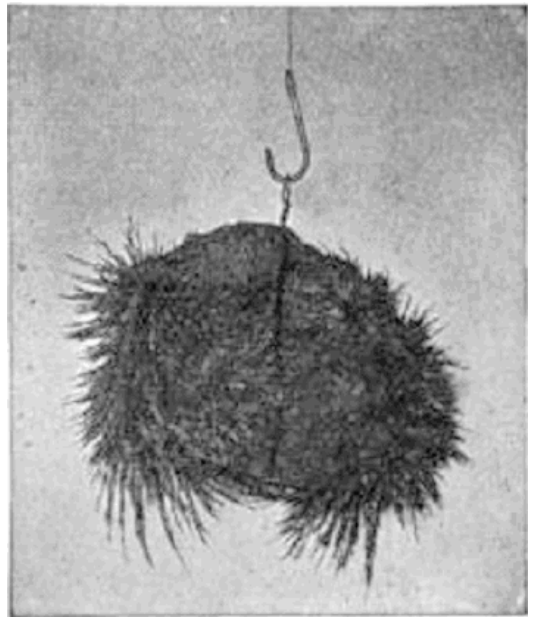


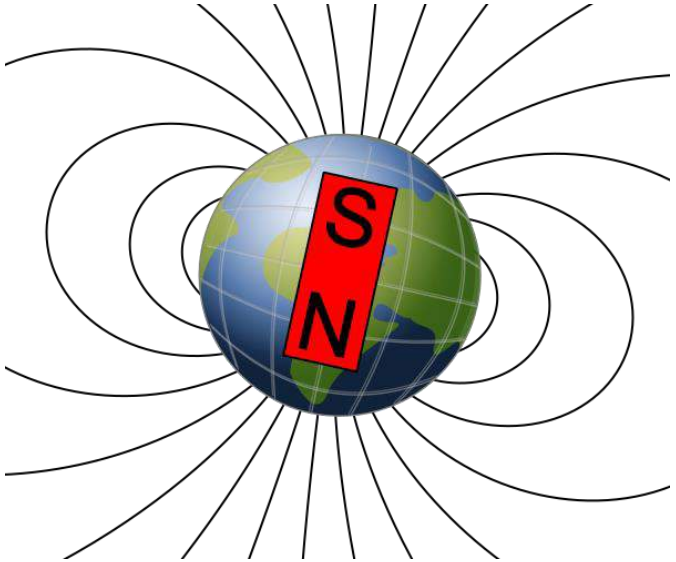
- Electric charges experience a force when inside an electric field.



Magnetic Fields

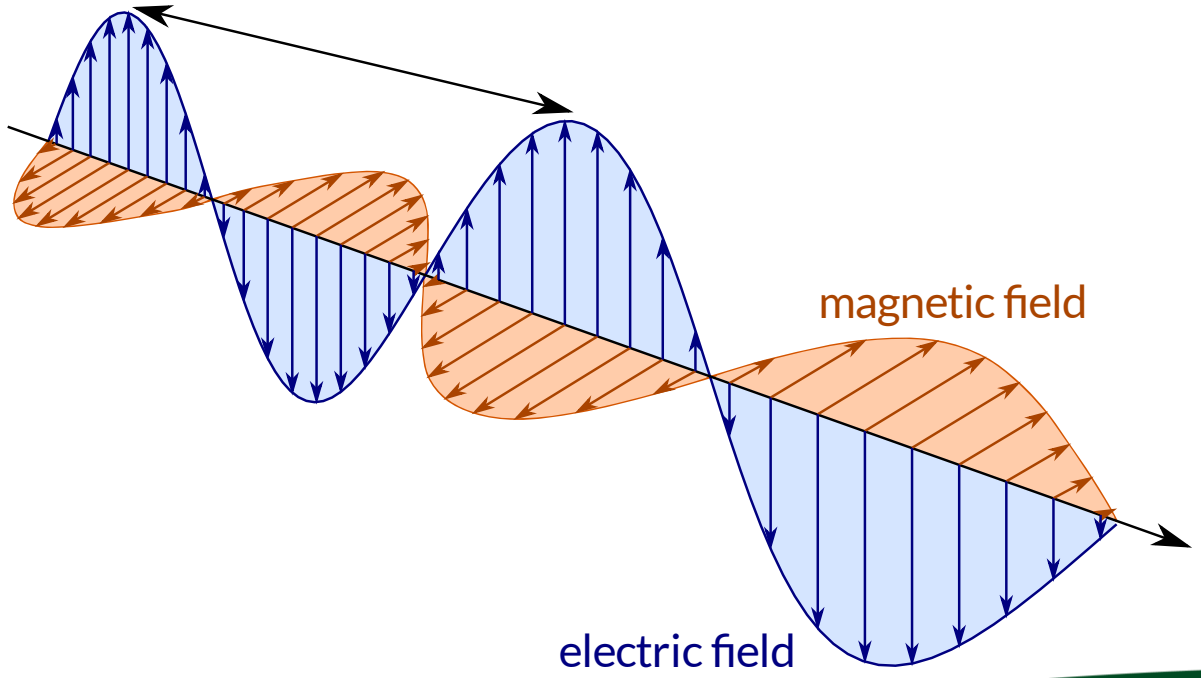
- Magnetic fields surround objects that are magnetized.
- Magnetic objects experience a force when inside magnetic fields.



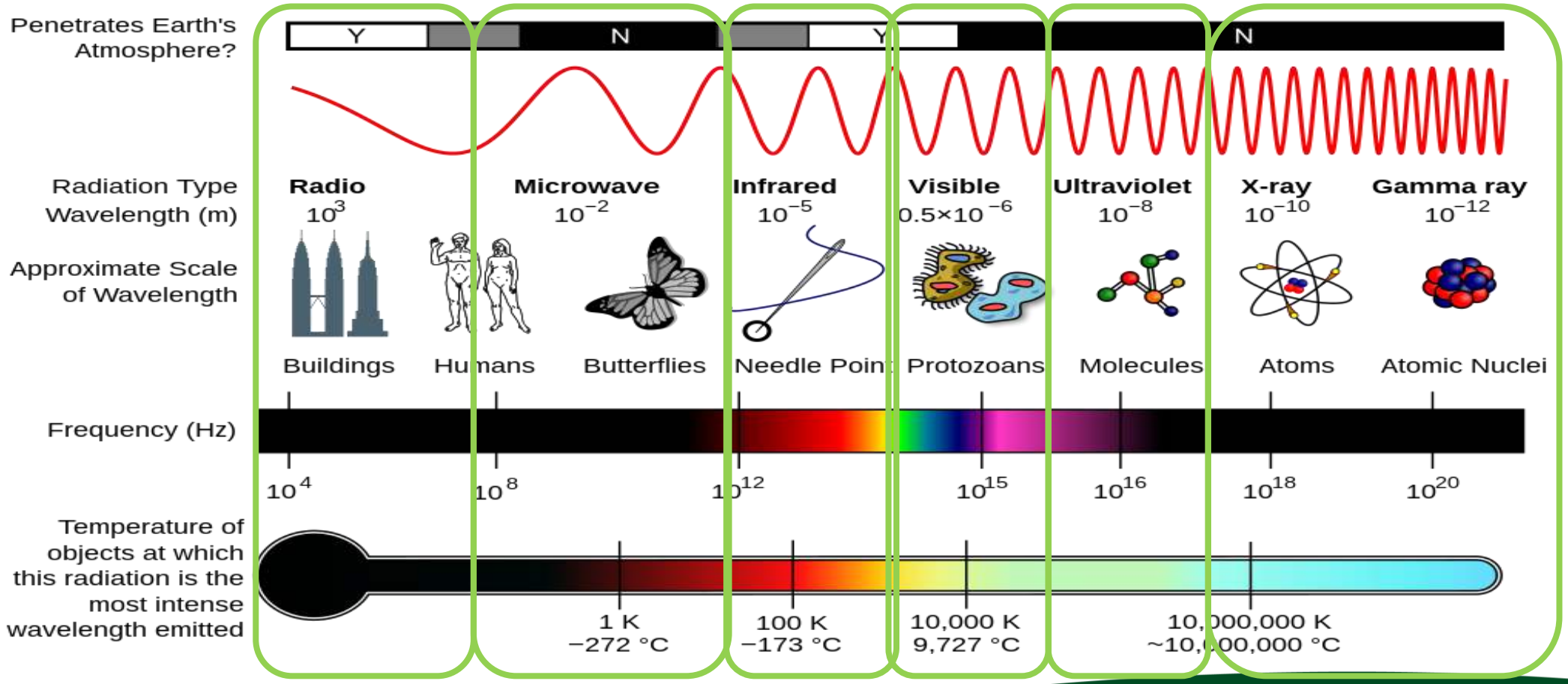


Electromagnetism

- Changing electric fields will create a magnetic field
- Changing magnetic fields will create an electric field



Electromagnetic Fields



Power Frequency and ELF

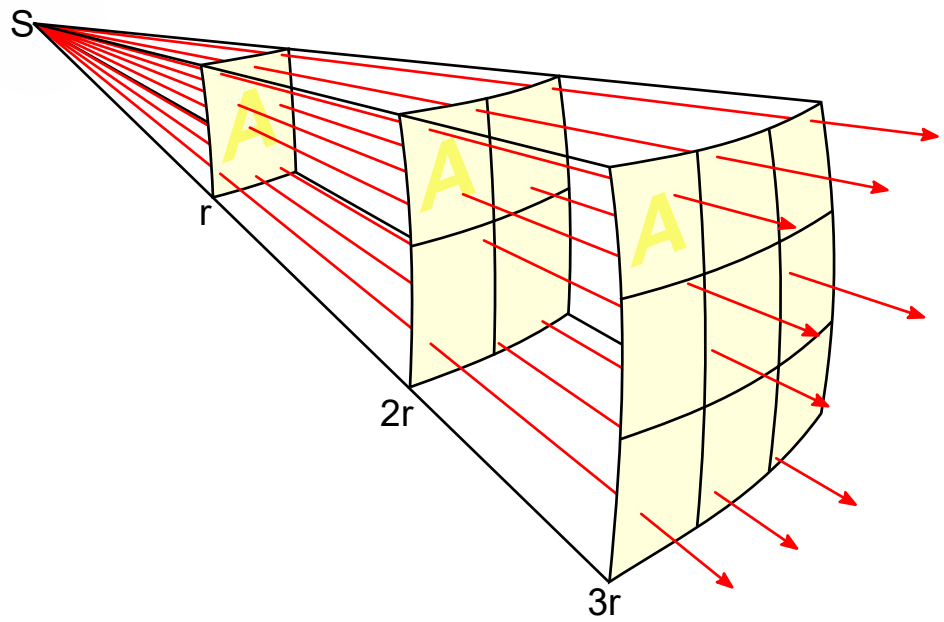
- The wall outlet in homes and offices use AC (alternating current)

- AC produces EMF at a frequency of 50/60 Hz
- This is a much lower frequency than radio waves (10000 Hz or 10 kHz)
- 50/60 Hz is also known as power frequency or ELF (extremely low frequency)

Properties of EMF

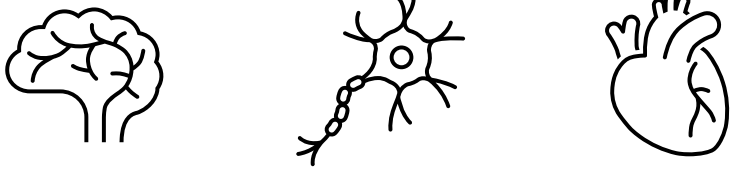
Electric field shielding

Decrease with distance



Biological Effects of EMF

- Because human tissue is conductive, EMFs can induce currents in the body.
- The currents induced by power frequency EMF are estimated to be smaller than currents produced by the brain, nerve cells, and heart.



- A person standing directly under a high-voltage line might get a mild shock when touching something conductive.
- Human tissue somewhat shields implanted medical devices from EMF.

Health Effects of EMF

Health effects from ELF exposure:

- IARC has classified 60 Hz magnetic field (and RF EMF) as possibly carcinogenic to humans (2B)

Weak association
Not causal
Small number of cases
No known mechanism
=
Inconclusive

IARC is the International Agency for Research on Cancer

Health effects from RF exposure:
(3 kHz–300 GHz)

- Below 10 MHz: peripheral nerve stimulation
- Above 100 kHz: tissue heating effects

Scientifically established

Implanted Medical Devices

- More and more people in Canada have implanted medical devices.
- Many of these devices are electronic and have circuitry.
- Some devices have moving metallic components like switches that activate magnetically.

Types of Implanted Medical Devices

- Cataract lens
- Knee replacement
- Hip replacement
- Coronary stent
- Ear tube
- Pacemaker
- IUD (Intrauterine Device)
- Spinal fusion and fixation hardware
- Transvaginal mesh implant
- Breast implant prosthesis
- Shoulder replacement
- Defibrillator

Sorted by volume. Source: https://secure.cihi.ca/free_products/implantable-medical-devices-report-en.pdf

EMF and IMDs

- Electric fields could cause currents in an IMD.
- Magnetic fields could cause a reed switch to activate.
- EMF could interfere with sensing, operation, or communication in an IMD.
- EMF interference is also called EMI.

- EMI can result in:
  - Abnormal or undesired functionality
  - Inhibited functionality
  - Device failure

Sources of Electromagnetic Interference (EMI)

Extremely Low Frequency (ELF)

Consumer electronics using AC power

- Microwaves
- Fridge

Electrical outlets

Surge protectors and power strips

Radio Frequency (RF)

Cell phones

WiFi

Bluetooth

Wireless equipment

RFID (Radio Frequency Identification)

Antitheft devices

Susceptibility to EMI

There are no universal guidelines on when a field is intense enough to cause Electromagnetic Interference in Implanted Medical Devices.

Threshold intensity varies greatly between manufacturers and even between units from a single manufacturer.

From a 1997 Electric Power Research Institute (EPRI) report

- ELF magnetic field: 0.2–1.2 μT
- Electric field: 1500–2000 V/m for some, unaffected at 20000 V/m for others

Levels are comparable to fields intensities under a 115 kV power line.

Standards and Guidelines (60 Hz)

There are no recognized Canadian federal or provincial standards or guidelines limiting exposures to power-frequency magnetic fields.

Agency	Public Exposure Limit	
	Magnetic Field	**Electric Field**
ICNIRP (International Commission on Non-Ionizing Radiation Protection)	83.3 µT	5000 V/m
IEEE (Institute of Electrical and Electronics Engineers, Inc.)	904 µT	5000 V/m
Council of the European Union	100 µT	5000 V/m

Standards and Guidelines (RF)

- Health Canada's Safety Code 6 sets limits to RF EMF exposure.
- Limits are set to prevent peripheral nerve stimulation (3 kHz–10MHz) and tissue heating effects (100kHz–6GHz).
- Many consumer electronics emit at 2.4 GHz, newer WiFi signals can emit at 5.8 GHz.

Safety Code 6 Limits	Electric Field	Magnetic Field	Power Density
2.4 GHz	45 V/m	0.14 µT	5.3 W/m^2
5.8 GHz	61 V/m	0.20 µT	9.8 W/m^2

Canadian Medical Standards

- ISO 14117:2019-Ed.2.0
  - Active implantable medical devices - Electromagnetic compatibility (EMC) test protocols for implantable cardiac pacemakers, implantable cardioverter defibrillators and cardiac resynchronization devices

https://www.canada.ca/content/dam/hc-sc/documents/services/drugs-health-products/medical-devices/standards/list-recognized-standards-medical-devices-guidance/list-recognized-standards-medical-devices-guidance.pdf

EMI: General Guidelines

- Read the manual
- Talk to your doctor/employer
- Distance to source

- Observe hazard symbols:

Questions?

- First addressing some questions sent during registration that weren't addressed in the presentation
- As time permits, we will address questions posted in the Q&A
- Questions we do not get to
  - Answers will be posted to our website and a link to resources emailed out

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Thank you for listening!

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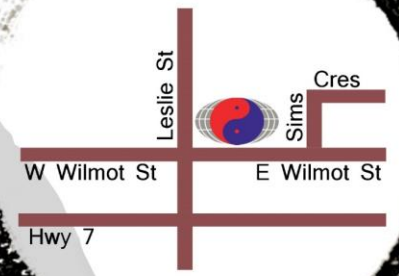

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