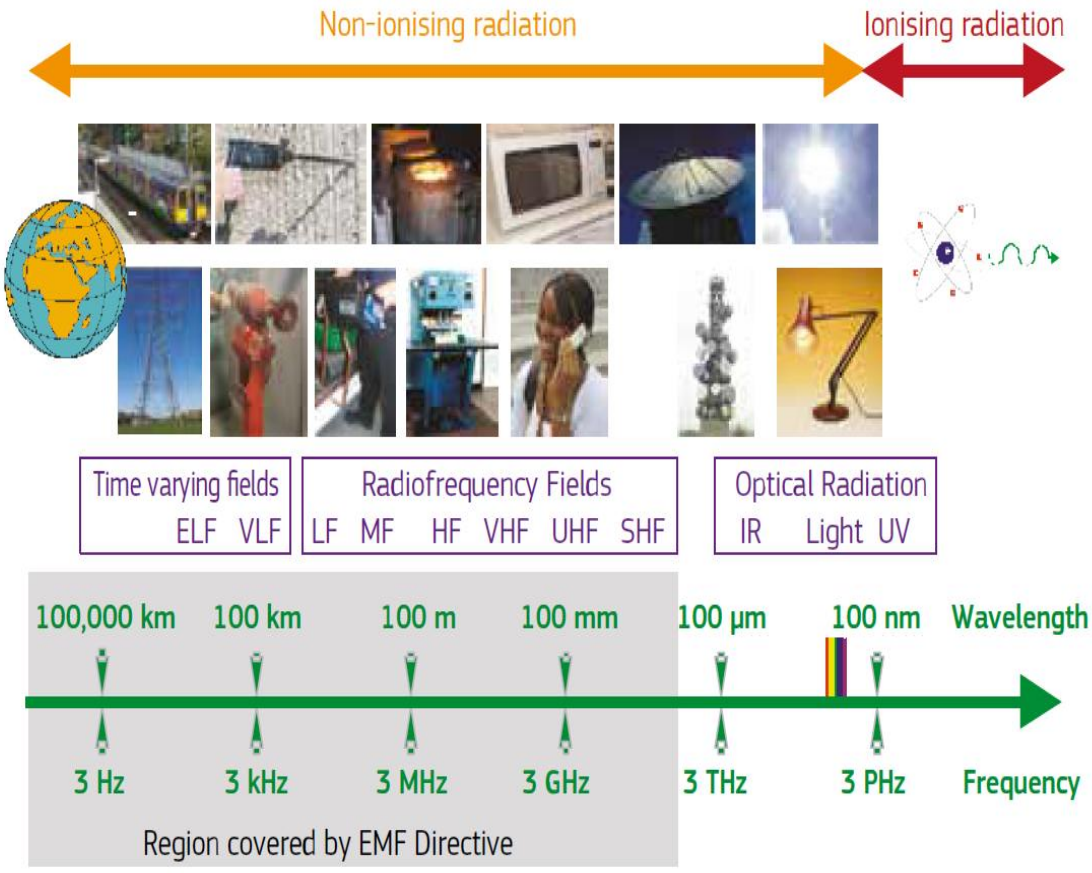
19BME308 - Medical Radiation Safety

UNIT I - INTRODUCTION TO RF AND MICROWAVE RADIATION

1.7 Direct & Indirect Effects of EMF

Figure A2 — The electromagnetic spectrum



Definition:

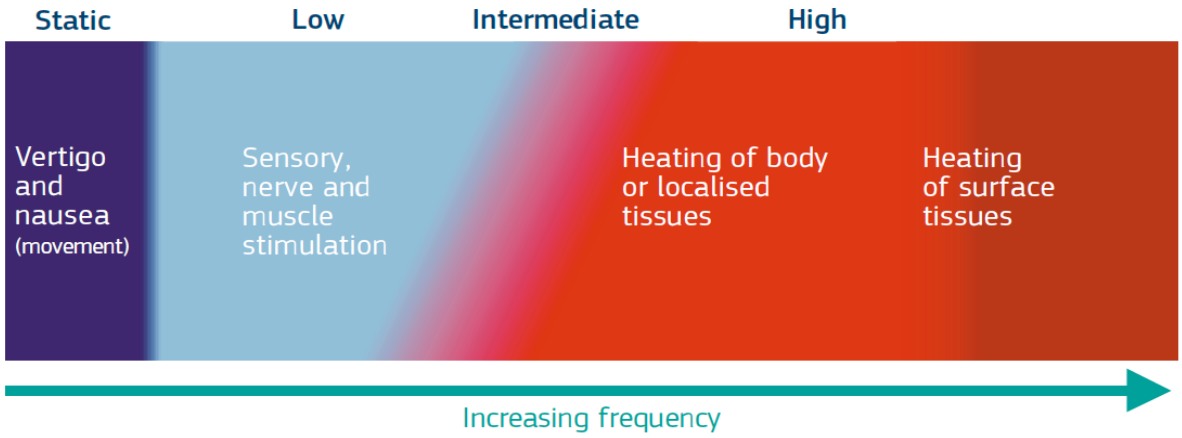
- EMFs are static electric, static magnetic and time-varying electric, magnetic and electromagnetic (radio wave) fields with frequencies up to 300 GHz.

Health Effects:

Two Categories of health effect

1. Thermal Effects – a body absorbs the radiation leading to localised tissue heating
2. Non-thermal Effects – more subtle effects

Direct Effects:



Indirect Effects

- Interference with active or passive medical devices
- Projectile risks from ferromagnetic objects
- Electric shocks or burns from a conductive object in an EM field
- Ignition of electrical detonators / fires / explosions

Field and frequency range	Effects	Examples of activities and equipment
Static electric and static magnetic fields 0–1 Hz	**Indirect effects:** Uncontrolled attraction of ferromagnetic objects, ie the risk of injury from objects in a large static magnetic field being attracted to magnets in the workplace and hitting anyone in the way **Sensory effects:** Nausea, vertigo, metallic taste in the mouth, flickering sensations (magnetophosphenes) in peripheral vision **Health effects:** Micro shocks	MRI scanners (main magnet) Electrochemical processes, eg industrial electrolysis, aluminium extraction Nuclear magnetic resonance spectrometers Electromagnetic lifting cranes Electric vehicles (cars, underground trains)

Field and frequency range	Effects	Examples of activities and equipment
Low frequency magnetic and electric fields: 1 Hz–10 MHz	**Indirect effects**: Interference with active or passive implanted or body-worn medical devices (more information is provided later in this guidance), electric shocks, causing electro-explosive devices to initiate, ie when used in close proximity to explosives that have an electrical means of initiation Sparks caused by induced fields triggering fires or explosions where flammable fuels, vapours or gases are present **Sensory effects**: Nausea, vertigo, metallic taste in the mouth, flickering sensations (magnetophosphenes) **Health effects**: Nerve stimulation, effects on the central and peripheral nervous system of the body: tingling, muscle contraction, heart arrhythmia Contact currents caused by a person touching a conductive object in an EMF where one of them is grounded and the other is not, which can result in shocks or burns	High voltage power lines Production and distribution of electricity Welding (arc and spot) Electrical arc furnaces Industrial induction heating (eg large coils used around the site of a weld) AM radio Electric hand-held tools Electric vehicles (cars, trains, trams, metros) Magnetic resonance imaging (MRI) (switched gradient fields)

Intermediate frequency fields: 100 kHz–10 MHz	The health effects of both high and low frequencies can be experienced as detailed above and below (see also Annex 1)	Surgical diathermy Broadcasting systems and devices (AM radio) Anti-theft devices Military and research radiofrequency systems
High frequency fields: 100 kHz–300 GHz	**Indirect effects:** Interference with active or passive implanted or body-worn medical devices (more information is provided later in this guidance), electric shocks, causing electro-explosive devices to initiate, ie when used in close proximity to explosives that have an electrical means of initiation Sparks caused by induced fields triggering fires or explosions where flammable fuels, vapours or gases are present	MRI (RF coils) Broadcasting and TV antennas Radar and radio transmitters Diathermy Dielectric heating (eg vulcanising, plastics welding or microwave drying) Anti-theft systems

Field and frequency range	Effects	Examples of activities & equipment
100 kHz–300 GHz	**Sensory effects:** Auditory effects such as perception of clicks or buzzing caused by pulsed radar systems **Health effects:** Thermal stress, heating effects leading to a rise in core body temperature or localised limb heating (eg knees or ankles) Contact with charged conducting bodies can lead to RF shock or deep tissue burns (see also Annex 1)	Broadcasting and TV antennas Radar and radio transmitters Diathermy Dielectric heating (eg vulcanising, plastics welding or microwave drying) Anti-theft systems

Reference: *Ronald Kitchen - RF and Microwave radiation safety handbook.*