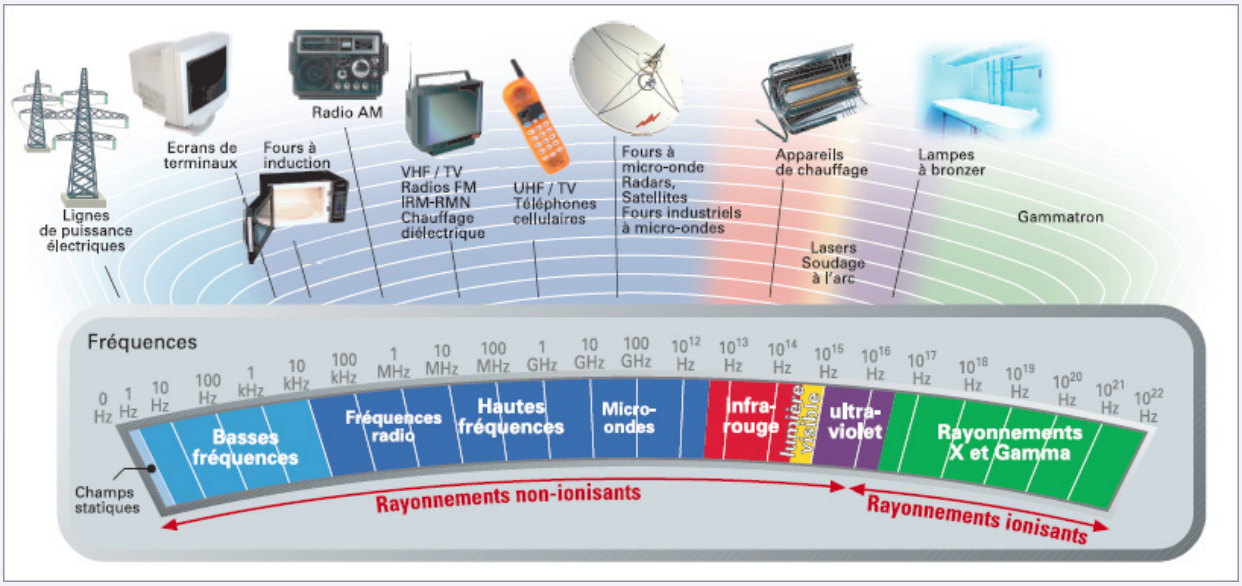
NON-IONIZING RADIATION



source : AFSSET

An electromagnetic field is the combination of an electrical fiel with a magnetic field generated by a stationary charge of electricity in the vicinity.
Electromagnetic fields are generated in all situations where machinery is operated under high power or with superconducting magnets, such as: induction furnaces, video-display terminals, MRI spectrographs...

Electromagnetic radiation is characterized by :

- the intensity of the electrical field (amplitude of E-field vectors in V/m) and the magnetic field (amplitude of H-field vectors in A/m) ;
- the wavelength (I) measured in meters ;
- the frequency (f) expressed in Hz ;
- the energy (E) expressed in eV ;
- the B-flux density, expressed in Tesla T ;
- the magnetic flux, expressed in Weber Wb - T = $Wb/m^{2.}$

Radiation is classified as :

- very low frequency q in the band from 3 Hz to 3 kHz; e.g. alternating current ;
- low frequency in the band from 3 kHz to 30 kHz; e.g. computers ;
- radio frequencies in the band from 30 kHz to 300 MHz; e.g. mobile phones GSM ;
- superhigh frequencies or microwaves in the band from 300 MHz to 300 GHz; e.g. NMR, MRI, microwaves ovens.

The earth's magnetic field varies with geographical position, ranging from 30 µT on the equator to 70 µT at the poles.
Values for field density are much higher when measured in the close vicinity of devices such as RIM spectrographs (up to 2 T) and NMR spectrometers (up to 15 T).

Individuals do not all respond in the same manner when exposed to electromagnetic fields.

Direct effects :

- frequency between 0 and 10 MHz : depending on the density, a current applied to a living organism can stimulate the nervous system ;
- frequency between 100 kHz and 10 GHz: heat is conducted into tissues, and upon high intensity, can cause superficial or deep burns.

Indirect effects:

- current generated by a conductor entering the field ;
- effects on implants acting as passive or active conductors ;
- sparks produced by induced current or by direct contact ;
- moving a metallic object through magnetic field of over 3 mT.

Very short-term exposure to an intense electromagnetic field may constitute a danger for health. Adversely, long terms effects of exposure below the minimum values have, to date, not yet been scientifically proven to cause any acute biological reactions.

Prevention

Recommandations:

- create clearly identified zones, demarcated so as to restrict access to sources of electromagnetic radiation ;
- reduce the emission at its source: design of equipment, settings of devices, maintenance of machinery ;
- reduce exposure to personnel by increasing the distance from the source of the emissions and by reducing the duration of high frequency exposure.

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Persons who actively or passively carried ferromagnetic implants, such as prostheses, vascular clips, body staples... must not enter areas where electromagnetic fields register over 3 mT.

A laser produce and amplifies a luminous, monochromatic, unidirectional light wave. It can be propagated in the infrared, visible, or ultraviolet light bands. The maximum amount of energy can reach 10^{10} watts. The European EN 60825-1 standard defines 7 classes of lasers:

- **class 1**: no specific danger, even during direct observation through optical instruments with a concentrated laser beam
- **class 1M**: no specific danger for emissions in the band from 302.5 nm to 4,000 nm to the extent that the optical instrument does not concentrate the laser beam ;
- **class 2** includes lasers emitting in the visible range (400 < **I** < 700 nm) with a power of < 1 mW. The beam can be viewed with the naked eye for a duration of < 0.25 second ;
- **class 2M** includes lasers emitting in the visible range (400 < I < 700 nm) with a power of < 1 mW. The beam can be viewed with the naked eye for a duration < 0.25 second as long as an optical instrument does not concentrate the beam ;
- **class 3R** includes lasers with a power reaching 5mW that emit in the band from 302.5 to 400 nm and from 700 nm to 10^6 nm. **Direct viewing of this class of lasers is dangerous for the eye ;**
- **class 3B** includes lasers with a power reaching 5 mW to 500 mW. **This class of laser is dangerous for the eye, even while viewing through an optical instrument, and the laser may be potentially dangerous for the skin**. Viewing must be limited to a duration of 0.25 second in the visible range and 100 seconds in the visible range ;
- **class 4** is for lasers with a power of > 0.5 W. **A class 4 laser is extremely dangerous for the eye and for the skin**. Scattered reflections can also cause damage to the eye and skin, and constitute a risk of fire and explosion.

The main effects depend on :

- the type of laser ;
- the power of the beam ;
- the length of exposure ;
- the path of the laser in the room ;

As lasers have thermal, mechanical, photochemical, and photoablative properties, they can become high power electrical hazards.

Biological effects on humans depend on :

- the wavelength of the beam ;
- the concentration of energy directed at the relevant tissue ;
- the absorbing capability of the tissue.

Lasers can cause potentially severe eye and skin lesions.

Prevention

Equipment must be in compliance with EN 60825-1 standards. Equipment must be installed :

- in a specifically assigned room, marked off and posted in accordance with regulations ;
- where the walls have received fireproof and anti-reflective treatment ;
- where the entrance, well lit and treated with anti-glare and antireflective material, is out of the range of the laser beams ;
- Such that the laser's point of impact is situated on non-flammable material ;
- in compliance with electrical safety regulations. The alignment of the path of the laser beam and the handling of equipment are carried out relative to the degree of risk ;
- follow the instructions for installing and running equipment with the doors of the room closed from the inside ;
- ensure adequate safety protection for personnel : safety glasses (adapted for a specific wavelength and density of laser), and gloves, preferentially cotton loop types to be worn.

The **ultraviolet rays** are electromagnetic rays classified into 3 categories to their wavelength :

- far ultraviolet or FUV, in the wavelength range 100 to 280 nm ;
- middle ultraviolet or MUV, in the wavelength 280 to 315 nm ;
- near ultraviolet or NUV, in the wavelength 315 to 400 nm.

The main sources of UV rays used in a laboratory are described as having a coherent source of radiation, photons of identical wavelength, phase, and direction, but different levels of light energy. UV rays are employed in mercury and xenon vapor lamps for spectrophotometers and fluorescence microscopes, halogen lamps, transilluminators and epi-illuminators that detect or quantify fluorescent probes.

The severity of biological effects of UV's depends on :

- the wavenlength ;
- the intensity of the rays ;
- the length of exposure.

UV ray penetrating power is very weak. The manifestation of the effects may be subject to a long or short latent period.

Effects on the eye

- UVB and UVC rays cause inflammation of the cornea and conjunctivitis (keratoconjunctivitis) ;
- long-term exposure to UVA rays may induce lens opacity (cataract) ;

In the range from 300 to 315 nm, one single exposure may be sufficient to trigger this condition.

Effects on the skin

UVB and UVC rays are the most harmful: they are strongly absorbed by the skin. The effects they cause after long exposure

range from mild erythema to phlyctena. Repeated exposure to UVB rays and, to a lesser degree, to UVA rays may cause actinic keratosis that can develop into skin cancer. Only UVC rays have germicidal properties, even though. UVB rays with a wavelength of approximately 280 nm may induce DNA lesions.

Prevention

- workplaces must be delineated and ventilated ;
- sources of UV rays generated at workstations and from equipment must be switched off before work begins ;
- protective glasses and computer filters (specially-adapted with filtering lens : organic, proprionate and tinted) are mandatory in the case of direct exposure. UV filter contact lens do not cover the entire eye, and therefore can never be considered a substitute for safety glasses or computer filters. Equipment secured with an independent video display is to be preferred ;
- gloves and long-sleeved lab coats are to be worn for skin protection ;
- halogen lamps must always fastened with their protective hood ;
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