Assessment of the occupational risks in the workplace (multiplicative method):

Appendix 4: Physical risk inducing long-term effects

Foreword	This English version is translated from the original French reference version.

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1 ASSESSMENT OF PHYSICAL RISKS INDUCING LONG-TERM EFFECTS

1.1 Assessment of risk associated with noise

The noise scale is not linear with time. Example: 112 dBA over 1 min equates to 85 dBA over 8 hours. The noise level should also be calculated in accordance with the GM-GR-HSE-401 guide or the calculator at : http://www.inrs.fr/media.html?refINRS=outil24 (in French, English and German)

to calculate the noise level over 8 hours.

1.1.1 Severity rating G

Rating G	Noise level over 8 hours (EU directive 2003/10/EC)	Examples
15	> 87 dB(A) OR Peak sound pressure > 140 dBC	Conversation impossible.
7	85-87 dB(A) OR Peak sound pressure: 137-140 dBC	Working in conditions in which you have to shout to be heard at a distance of less than one meter from the other person, difficulty or inability to hear alarms.
3	80 à 85 dB(A) OR Peak sound pressure: 135-137 dBC	Working in conditions in which you have to speak loudly to be heard at a distance of one meter from the other person.
1	> 80 dB(A) OR Peak sound pressure < 135 dBC	Working in conditions in which you do not have to speak loudly to be heard at a distance of one meter from the other person.

Table 1: Matrix - Severity G.

1.1.2 Potential exposure probability rating P

The potential exposure probability P of exposure to noise when working in or close to a noisy workplace is **10**.

1.1.3 Residual potential exposure probability rating P'

Reduction of P	Means/measures of prevention/protection against noise
-1	**At least two procedural or organizational measures from:** - See Mp-type matrix, - Signage, regular audit, inspections, calls to order, etc. - Earplugs
-2	- Wearing appropriate PPE and training on use and maintenance, helmet and earplugs for exposure above 120 dBA, etc.
-3	- Insulation and enclosure, etc.

Table 2: Matrix - Reduction in potential exposure probability.

1.2 Assessment of risk associated with vibrations

1.2.1 Severity rating G

Rating G	Vibrations (EU directive 2002/44/EC)	* Examples
7	Arm-hand > 5 m/s²	Hammers, jackhammers, perforators, brush cutters, power saws, etc.
	Whole body > 1.15 m/s²	Loader, etc.
3	Arm-hand 2.5-5 m/s²	Rotating machines (drills, grinders), etc.
	Whole body 0.5-1.15 m/s²	Forklifts, trucks, road tractors (semitrailers), utility vehicles, clippers, (manual/electric) transpallets, etc.
1	Arm-hand < 2.5 m/s²	Electric screwdrivers, etc.
	Whole body < 0.5 m/s²	Metro train, train, bus, car on road in good condition, etc.

Table 3: Matrix - Severity G.

* The rating for vibrations depends on many factors:

- Type of equipment
- Condition of the equipment or tool
- For vehicles: state of the roads, driving behaviour, distribution of the load (especially for partially filled tank trucks), seat type and setting, state of the suspension, tire pressure, etc.

The OSEV calculator (arms-hands and whole body) can help you work out the vibration level of your equipment. See annex 4.4.1.

1.2.2 Potential exposure probability rating P

The potential exposure probability P of exposure to vibrations when working with a vibrating tool and when driving a truck, forklift or machinery, etc. is **10**.

1.2.3 Residual potential exposure probability rating P'

Reduction of P	Means/measures of prevention/protection against vibrations
-1	**At least two procedural or organizational measures from:** - See Mp-type matrix (generic table 4 of the method (generic part)), - Servicing of the vehicle, equipment, etc.
-2	- Mechanical or pneumatic seat suspension - Tire pressure check, vehicle speed adapted to the surface, maintenance of the road surface... for vehicles - Anti-vibration mats under vibrating machines, etc.

Table 4: Matrix - Reduction in potential exposure probability.

1.3 Assessment of risk associated with extreme temperatures and thermal radiation

In this chapter we assess the risks associated with these risk factors for tasks requiring physical activity. Annex 3 on ergonomics of the GM-GR-HSE-300 guide deals with these parameters for stationary tasks.

1.3.1 Severity rating G

Rating G	Extreme temperatures and thermal radiation	Remarks
15	The thermal environment and ambient environment make the task painful: ▪ T° < -10°C or T° > 40°C ▪ Wearing special coveralls with gloves, balaclava, special shoes (e.g. coveralls for blast furnaces) Thermal radiation: Immediate burning sensation Thermal flow* > 10.4 kW/m²	- Negative cold room (-18°C), blast furnace, etc.
7	The thermal environment and ambient environment make the task difficult: ▪ - 10°C < T° < 10°C or 32°C < T° < 40°C ▪ High relative humidity: major perspiration ▪ Bad weather: monsoon, storm ▪ Wearing clothing that considerably hampers the work or clothing specially treated against radiation or humidity (e.g. SCBA, waterproof coveralls for high-pressure cleaning, chemical coveralls) Thermal radiation: Impossible to hold hands/face exposed to radiation for 2 mins. 2.5 kW/m² < Thermal flow* < 10.4 kW/m²	- Hot or cold barren zone - Steam cracking and refinery furnace - Frost, heatwave, etc.
3	The thermal environment and ambient environment make the task more difficult: ▪ 10°C < T° < 18°C or 25°C < T° < 32°C ▪ Relative humidity: < 30% or > 70% (sweaty skin) ▪ Wind > 35 km/h ▪ Bad weather: rain, etc. ▪ Wearing clothing that slightly hampers the work (e.g. disposable coveralls, cartridge-type respirator or powered air respirator, dust mask, airtight goggles, etc.) Thermal radiation: Hot sensation on the hands and face after 2-3 mins 1.6 kW/m² < Thermal flow* < 2.5 kW/m²	- Workplaces exposed to draughts, in front of a window, close to a heat source (catering, etc.), temperature variation, etc.

Rating G	Extreme temperatures and thermal radiation	Remarks
1	The thermal environment and ambient environment are comfortable when wearing standard workwear: ▪ 18°C-25°C ▪ Relative humidity 30%-70% or little discomfort ▪ No draught. Thermal radiation: appreciable but no effect. Thermal flow* < 1.6 kW/m²	-

Table 5: Matrix - Severity G.

*: Hoschke diagram (1981).

Regarding exposures to **extreme temperatures**, it is important to consider more factors such as humidity, air speed, task, clothes... It may be necessary to use specific assessment methods such as the WBGT or Wet Bulb Globe Temperature (thermal stress), the Wind Chill temperature method or the determination of required clothes isolation in case of exposure to cold temperatures. See calculator in Appendix 4.4.3.

1.3.2 Potential exposure probability rating P

The potential exposure probability P of exposure to extreme temperatures or thermal radiation when working in these conditions is **10**.

1.3.3 Residual potential exposure probability rating P'

Reduction of P	Means/measures of prevention/protection against extreme temperatures and thermal radiation
-1	**At least two procedural or organizational measures from:** - See Mp-type matrix (generic table 4 of the method (generic part)) - Warm or cold water fountain - Adapted work schedule - Adapted breaks (number and duration) - Provision of drinks with a high mineral content - Technical clothing adapted to the conditions
-2	- Site roofing, ventilation, air-conditioned break room, curtains between workshops, etc. - Technical clothing adapted to severe cold (multiple layers) - Technical clothing adapted to thermal radiation or heat
-3	- Air conditioning, heating, etc. - Technical clothing adapted to very severe cold (multiple layers) - Technical cooling clothing for severe heatwaves - Moving away or insulation from the thermal radiation source

Table 6: Matrix - Reduction in potential exposure probability P.

1.4 Assessment of risk associated with optical radiation

The main sources of optical radiation (180-3000 nm) are: the sun, arc welding, drying or polymerization source, light sources (metallic halogen lamps/HP sodium vapor lamps/HP mercury vapor lamps, lamps or LEDs in groups 2 and 3 under NF EN 62471, spotlights, surgical lights in operating rooms etc.), etc.

Optical radiation has an impact on the skin or the eyes. Skin damage can manifest itself as erythema (sunstroke) or cancer (melanoma, etc.); eye damage as cornea, conjunctiva or retina injuries or opacification of the crystalline lens (cataract).

1.4.1 Severity rating G

Rating G	Optical radiation: UV-visible-IR-laser **(EU directive 2006/25/EC and EN 12198-1)** *Correlation between irradiance or radiance, and the radiation emission category*			
	Visible and infrared E (700nm – 1mm)	**Visible** E_{eff} (400nm – 700nm) L_{eff} (400nm – 700nm)	**Ultraviolet and visible** E_{eff} (180 – 400nm)	**LASERS**
15	-	-	UV index 8 and higher	Laser source class* 4
7	> 100 $W.m^{-2}$	E_{eff} > 10.10^{-3} $W.m^{-2}$ L_{eff} > 100 $W.m^{-2}.sr^{-1}$	E_{eff} > $1,0.10^{-3}$ $W.m^{-2}$ UV ~ 6-7	Laser source class* 3B (5-500 mW)
3	<100 W.m-2	E_{eff} < 10.10^{-3} $W.m^{-2}$ L_{eff} < 100 $W.m^{-2}.sr^{-1}$	E_{eff} < $1,0.10^{-3}$ $W.m^{-2}$ UV 200-300 J/m² (2-3 SED) UV index 3-5	Laser source class* 3R (1-5 mW)
1	< 33 $W.m^{-2}$	E_{eff} < $1,0.10^{-3}$ $W.m^{-2}$ L_{eff} < 10 $W.m^{-2}.sr^{-1}$	E_{eff} < $0.1.10^{-3}$ $W.m^{-2}$ UV_{ABC} > 30 J/m² (0.3 SED) (skin) UV_A > 10 000 J/m² (100 SED) (eyes)	Laser source class* 1, 1M, 2, 2M (< 1 mW)

Table 7: Matrix - Severity G.

* : The “machine” classes take account of the severity of the “laser source” and its intrinsic protection.

Example: A diffraction particle size analyser incorporates a 3B laser source (severity 7) and its “machine” class is 1 (no risk), because the laser firing system is closed and the laser radiation cannot escape. If the “machine” class is used for the rating, the only means/measures of prevention/protection to be taken into account are organizational and procedural (the rating cannot be reduced twice).

Examples for IR: IR barrier, occasional HC IR detector, high-power infrared LED for CCTV cameras, thermographic cameras, infrared thermography to see and measure distance, heating devices, open fire, etc.

Examples for UV: The shorter the wavelength of the UV radiation, the more harmful it is. But short wavelength UV radiation is less able to penetrate skin.

Industrial sources: Industrial UV radiation is used to dry ink, polymerize glue, detect defects, arc/torch welding, lighting in certain lamps, measuring/laboratory equipment, sterilization, disinfection, etc.

Exposure to welding fumes and UV radiation from welding operations are CMR 1 (CIRC).

The sun: UVC radiation from the sun (100-280 nm) is absorbed by the ozone in the troposphere (the lowest layer of the atmosphere). UVA radiation (315-400 nm) and almost 10% of UVB radiation (280-315) reach the ground and can cause skin damage or cancer.

The intensity of UV varies primarily with the height of the sun in the sky (two hours before and after the midday sun), latitude (UV intensity is higher closer to the equator), altitude (UV intensity increases by almost 10% for every 1000m difference in altitude). UV radiation passes through clouds.

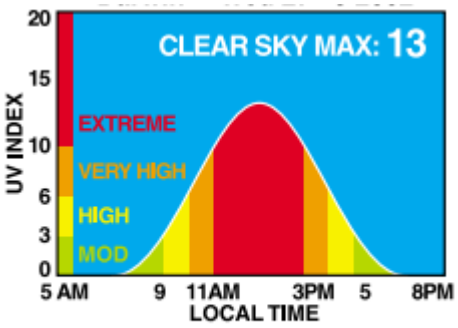


Figure 5: A graphic representing dangerous hours (Bureau of Meteorology, Australia)[2]

E.g. the incidence of skin cancer in Australia is ten times higher than it is in France.

OEL 8 hours (ICNIRP) 30 d/m² or 0.3 SED.

The minimal erythemal dose for a red blotch in a light-skinned person is 200-300 d/m² or 2-3 SED. This equates to an UV index of 3-5.

OMS has developed a prevention tool: The higher the UV index, the higher the risk of skin or eye damage and the quicker this damage occurs.

For countries located at a latitude between 15° north and 15° south, the UV index is higher than or equal to 8 throughout the year. For countries located at a latitude between 45° north and 40° south, see http://www.who.int/uv/intersunprogramme/activities/uv_index/fr/index3.html for the UV index based on the country and the month.

No protection required	**Protection required**	**Protection essential**
It is completely safe to stay outside	Find shade two hours before and two hours after the sun is at its zenith Wear a shirt and a hat, use sun cream	Avoid exposure two hours before and two hours after the sun is at its zenith, work in the shade Wear clothing that provides good cover and a hat, use high-factor sun cream

Examples for lasers: Laboratory measuring equipment (grain size, deformity, pyrolysis, line of sight, spectroscopy…), infrared lasers used for marking, engraving, welding or cutting materials, hand-held cash register laser scanner (barcode reader), printers, audiovisual equipment.

1.4.2 Potential exposure probability rating P

Rating P	Probability of potential exposure to a source of optical radiation (IR, visible, UV, laser)
10	Tasks with direct contact with the source of optical radiation (IR, visible, UV, laser): - Working outside (UV) - Arc welding - Use of a surgical light, etc.
6	Tasks with unpredictable exposure (e.g. worksite surveillance using laser, UV, IR technology, arc welding), etc.
3	Use of laboratory equipment with laser, UV, IR technology, etc.

Table 8: Matrix - Potential exposure probability P.

1.4.3 Residual potential exposure probability rating P'

Reduction of P	Means/measures of prevention/protection against optical radiation (IR, visible, UV, laser)
-1	**At least two procedural or organizational measures from:** See Mp-type matrix (generic table 4 of the method (generic part)) - Laser: Definition of exclusion zone, labelling (pictogram, etc.) Only an authorized person can order the radiation emission The beam is lower than eye level in seated position, removal of reflective objects (smooth, shiny surfaces) and jewelry in the room Wearing of appropriate protective gloves and goggles Laser training, etc. - UV: Long-sleeved shirts, hat, sun cream, access to shade or indoor workplace during the hottest hours of the day, etc. Welding training Marking off of the welding workplace, etc. - IR: Wearing IR protective goggles
-2	- Laser: Special PPE: protective goggles adapted to the wavelength in question; special protective gloves, etc. Optical path length of a covered laser, protective screen, work distance. - UV: Special PPE: welding goggles, special welding coverall and gloves, welding guard, welding tent (to avoid additional exposure to solar rays), etc. - IR: Use of appropriate protective screens, visors and protective clothing, keeping an appropriate distance from the radiation source (marked off exclusion zones), etc.
-3	- Laser: Confinement of the laser beam, locking mechanism, emergency shutdown, etc. - UV: Automatic welding, etc. - IR: Confinement of the beam, view holes for ovens, insulation of equipment, etc.

Table 9: Matrix - Reduction in potential exposure probability P.

1.5 Assessment of risk associated with electrical and magnetic fields (EMC)

Introduction:

The intensity of electrical fields E is measured in V/m and the intensity of magnetic fields H is measured in A/m.

Magnetic induction (magnetic flow density) B is expressed in tesla ($B = 4.\pi.10^{-7}.H$ tesla).

EMC only exist when the electrical equipment is activated.

The field decreases exponentially with distance.

The zone of influence of electromagnetic fields is measured based on the position of the part of the body exposed to the wavelength of the electromagnetic source.

Frequency	Necessity of assessment?	Examples	
~ 0 Hz	yes	Electrolysis tank, flash welding, MRI, etc.	
50 Hz	yes	Distribution of electricity, arc/electric resistance welding, magnetic particle inspection, (de)gausser High-voltage transformers, high-voltage motors, high-voltage cables, magnetic drive pumps, etc.	
2 kHz	yes	Induction heating, melting furnace, etc.	
5 MHz	Yes, if the distance between the source and the exposed person **< 100 m**		
271 MHz	Yes, if the distance between the source and the exposed person **< 2 m**	Radio-frequency welding, etc.	Telecommunications: radios, TVs, mobile phones, Bluetooth, WiFi, interphones, etc.
2.5 GHz	Yes, if the distance between the source and the exposed person **< 20 cm**	Microwave oven, etc.	

Table 10: Zone of influence of EMF sources.

Key:

Short-term sensory effects.	Short-term and long-term thermal effects.

To assess the EMF, the electrical equipment should be listed, the relevant data gathered from the technical data sheets and the equipment added to the table to identify the equipment that could have an impact on health. If there is no technical data sheet, examples can be found in the Non-binding guide to good practice for implementing Directive 2013/35/EU - Electromagnetic Fields - Guide for SMEs.

1.5.1 Severity rating G

Rating G	Electromagnetic fields (EMF) (Directive 2013/35/EC and EN 12198-1)
15	EMF at values considerably higher than the health impact values*.
7	EMF at values higher than the health impact values*.
	EMF at values higher than the values set for exposure of members of the general public at particular risk (people with an implanted device, pregnant person).
	EMF causing sparks.
	EMF generating contact currents.
	EMF causing attraction/repulsion of metallic materials.
3	EMF at values higher than the values that trigger action (AV**).
1	EMF at values lower than the impact values and the values that trigger action (AV**). Values set for the exposure of the general public.

*, **: refer to annex 1.

Table 11: Matrix - Severity G.

1.5.2 Potential exposure probability rating P

Rating P	Probability of potential exposure to an EMF source
10	Tasks with direct contact with the EMF source: - Task working on electrical equipment that is switched on, high-voltage cables, induction heating, telecommunication equipment... - Task in the computer room... - Phone without hands-free mechanism...
6	All other tasks performed at a distance less than 3.2x the distance from the active field (see table 10).

Table 12: Matrix - Potential exposure probability P.

1.5.3 Residual potential exposure probability rating P'

Reduction of P	Means/measures of prevention/protection against the EMF
-1	**At least two procedural or organizational measures from:** - See Mp-type matrix - Special signage for the zones exceeding the AV:  - Reduction in the intensity of the emission - Moving away from the source or manual reduction of the intensity - Reduction of the intensity when the operator is close to the emitting equipment (e.g. when the furnace is being stoked). - Verification of the intensity of the E field after any change to the workplace…
-2	- Moving of the workplace (or equipment) - Device reducing the intensity of the emission when the machine is being adjusted - Placing of non-conductive furniture and work surfaces to avoid the circulation of currents induced in metallic objects...
-3	- Insulation of the emission source by shielding (metallic protection can serve as a Faraday cage, metal rail panels...), etc.

Table 13: Matrix - Reduction in potential exposure probability P.

1.6 Assessment of risk associated with ionizing radiation

It is accepted that the sources of ionizing radiation liable to be encountered in the Group's activities cannot cause major accidents with lethal exposure levels. G = 40 does not exist.

See also the GM-GR-HSE-402 guide.

The equipment used that generates ionizing radiation are:

Mobile sources:

- Gammagraphy: check of welding by gammagraphy (sources of Ir 192 or Co 60)
- X rays: radiographic check of a weld, fluorescence spectrometry.
- Unsealed radioactive sources: laboratories, drilling...

Sealed sources (level measures, metal radiography tests):

- Measurement of liquid level: Am_{241} (activity 1.7 GBq), Cs_{137}-$Ba_{137}m$ (activity 37 MBq)
- Measurement of material thickness: Kr_{85}, Cs_{137}, Am_{241}, Co_{60}, Pm_{147}
- Measurement of density and weight: Am_{241} (activity 2 GBq), Cs_{137}-$Ba_{137}m$ (activity 100 MBq), Co_{60} (30 GBq)

- Measurement of density and humidity of soil or gammadensimetry: double source of Am-Be and Cs_{137}
- Detection and measurement of molecules in GC: Ni_{63}, tritium for products such as pesticides, explosives and drugs; Cd_{109} and Co_{57} for lead in paint
- Measurement tool for the bottom of wells in oil prospection: radioactive sources used for exploring soil properties, for measuring density and detecting the presence of water or hydrocarbons.

Other sources of ionizing radiation encountered are:

- NORMS: Radioelements of natural origin primarily encountered when extracting crude.
- Radon: Radioactive gas present in granite rock.

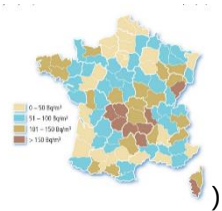
1.6.1 Severity rating G

All radioelements are carcinogenic, **G = 15**.

1.6.2 Potential exposure probability rating P

The potential exposure probability of exposure to **ionizing radiation** when working with an unprotected/poorly protected radioactive source is **10**. Examples:

- Living in a granite region where exposure is more than 100 Bq/m³/life of Radon (check the map of the region, e.g.



).

- Manually cleaning a container that has held NORM (e.g. desalination machine during periodical maintenance).
- Taking the source from the container out of the insulation for use of a collimator or an X-ray inspection.
- Taking the source out of the container while cleaning the container (HF unit)

The potential probability of exposure to a **sealed source** inside a container in perfect condition is **1**, because the source is plated and shielded from the equipment, and the regulatory provisions also impose an obligation to indicate the location of the source with signs and/or markings, to train staff and to have a set operating mode, so the rating is reduced by 3 levels.

The potential probability of exposure to a **mobile source** with a container, a collimator and insulation in perfect condition is **3**, because the source is shielded, the regulatory provisions impose an obligation to indicate the location of the source with signs and/or markings, to train staff and to have a set operating mode, but a potential residual exposure remains when the source is removed from the insulation for the radiographic inspection, so the rating is reduced by 2 levels.

If the sealed or mobile source is no longer airtight, increase the probability level, based on the results of the surface contamination tests.

1.6.3 Residual potential exposure probability rating P'

Reduction of P	Means/measures of prevention/protection against ionizing radiation
-1	**At least two procedural or organizational measures from:** Individual dosimetry for persons performing tasks who are likely to be exposed to ionizing radiation or > 1 mSv. Measurement of an accredited body every year (+ report).Radiometer measurements. Adapted medical surveillance. Surface contamination tests. Radon: regular ventilation, measurements of exposition in the rooms… NORM: indication of the location of the source with signs and/or markings, moving away of the source during the work, training of staff, operating mode available, etc. Mobile sources: work performed at night or when the unit is closed, storage in a special room, insulation of the operator by means of a protective guard (e.g. concrete).
-2	Radon: reinforcement of the natural ventilation or installation of adapted mechanical ventilation if more than 100 Bq/m^3, sealing of cracks and holes in and around pipes with silicone glue or cement, placing of a membrane on a layer of chippings covered with a concrete slab, etc. X-ray sources: anti-radiation coverall, lead apron, etc.
-3	Radon: withdrawal from the inhabited space or the depressurization of the lower parts of the building (any basement or crawl space), or the floor itself. X-ray sources: insulation of the operator by means of a lead-lined control panel in the protection room.

Dose (mSv): Dose factor* x Activity (kilobecquerel)

Table 14: Matrix - Reduction in potential exposure probability P.

* The dose factor depends on the radioelement and the penetration type (inhalation, ingestion). E.g. Plutonium 238 has a dose factor of "1" when ingested and "120" when inhaled; Cesium 237 has a dose factor of "0.014" when ingested and "0.0087" when inhaled.

2 TERMS AND DEFINITIONS

Accident

Any sudden, dated undesirable event that causes injury or illness, damage to property or installations, a production loss, environmental damage or damage to the Group's image.

CMR

Carcinogenic, mutagenic or toxic for reproduction.

CIRC

Centre International de Recherche sur le Cancer.

PPE

Personal protective equipment

Occupational exposure

Being in the vicinity of a (chemical, physical, biological, ergonomic, psychosocial) hazard as part of an occupational activity.

Absence of occupational exposure

Exposure does not exceed the usual level in the general population of the country in which the operating entity is located, deemed an absence of occupational exposure. Measurements are required for evidential purposes.

Frequency and duration of the task entailing potential exposure (F)

The frequency takes account of the number of times the task is conducted and the duration a person is potentially exposed to the hazards identified.

Severity

In Industrial Hygiene, the severity of the hazards is determined on the basis of their known effects on human health; it is the level of potential health consequences of a chemical, biological, physical, ergonomic or psychosocial hazard apart from all prevention and protection measures.

Risk reduction measure or means/measure of prevention/protection (Mp)

Action and/or measure taken as new obstacle to reduce the frequency or negative consequences of the associated risks.

Mp type

Means/measures of prevention/protection type These are defined in paragraph 3.9 "Calculation of residual risk R'" of the GM-GR-HSE-300 guide.

NORM (Naturally Occurring Radioactive Materials)

Material containing naturally occurring radioelements not used for their radioactive properties.

Probability of the occurrence of undesirable exposure

Probability in percentage form that the exposure will occur while the task is being performed, based on the existing protection, type of procedure, how the task is performed, etc.

Chronic risk

Risk resulting from the combination of low repeated exposure over time to a chemical, physical, biological, ergonomic or psychosocial risk with an imperceptible medium- or long-term impact during exposure.

Potential risk

This is the probability that the potential of a hazard is reached in the exposure conditions. These conditions take account of the (fixed and permanent) intrinsic and collective protection. The notion of potential risk is used to identify critical tasks.

Residual risk

Risk that remains after all measures to reduce identified risks have been taken.

Surgical light

Lighting equipment used in operating rooms to eliminate any shadows. By extension, large magnifying glass lit at the edges used in a laboratory.

SED

Standard erythemal dose (100 mJ/m²).

AV (action values)

Lowest exposure value at which risk (e.g. noise, EMF, legionella) reduction actions are taken.

OEL

Occupational exposure limit

3 REFERENCE DOCUMENTS

Reference	Title - Group documents
CR-GR-HSE-405	Industrial hygiene
GM-GR-HSE-401	Preventing risks associated with noise in the workplace
GM-GR-HSE-402	Radiation hygiene

4 BIBLIOGRAPHY

4.1 Regulations

Europe
Directive 2003/10/EC on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise).
Directive 2002/44/EC on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (vibrations).
Directive 2013/35/EC of 26 June 2013 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields).
Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation.
Directive 2006/25/EC of 5 April 2006 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (artificial optical radiation). Table 1.1:

4.2 Standards

Europe
EN 12198-1+A1: Safety of machinery. Assessment and reduction of risks arising from radiation emitted by machinery. Part 1: General principles.

4.3 Guides

Europe
Non-binding guide to good practice for implementing Directive 2013/35/EU Electromagnetic Fields - Guide for SMEs. KE0415142FRN. http://ec.europa.eu/social/main.jsp?catId=738&langId=en&pubId=7850&type=2&furtherPubs=yes
Non-binding guide to good practice for implementing Directive 2013/35/EU Electromagnetic Fields - Case studies. KE0415141FRN. http://ec.europa.eu/social/main.jsp?catId=738&langId=en&pubId=7846&type=2&furtherPubs=yes

France
ED 6113: Sensibilisation à l'exposition aux rayonnements optiques artificiels (ROA) sur les lieux de travail (hormis les lasers et appareils lasers) – INRS.
ED 6161: Analyse de la charge physique de travail – INRS.
TA 57 : Photosensibilisation, cancers cutanés et exposition professionnelle aux UV (épidémiologie, page 113).
VP12: Exposition au rayonnement UV solaire : un sujet brulant.

4.4 Tools

4.4.1 OSEV vibration calculator (INRS)

Arms-hands: http://www.inrs.fr/media.html?refINRS=outil59

Whole body: http://www.inrs.fr/media.html?refINRS=outil39

4.4.2 Noise calculators

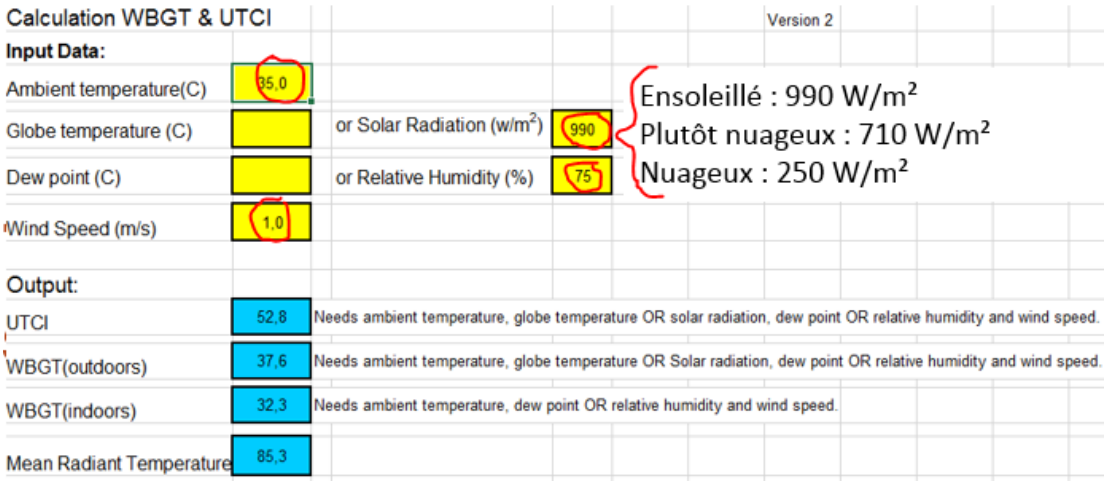
The ISO 9612 calculator is used to calculate the daily noise exposure level $L_{EX,8h}$: http://www.inrs.fr/media.html?refINRS=outil24 (in French, English and German).

UK calculator: http://www.hse.gov.uk/noise/calculator.htm

OSHA calculator (in English) : https://www.noisemeters.com/apps/occ/twa-dose.asp (according to OSHA, NIOSH, EU regulations). The calculator can be customized based on the regulations in the country in question (Custom tab).

4.4.3 Extreme temperatures, relative humidity and wind speed calculators

www.climatechip.org/sites/default/files/content/UTCIWBGT.xls



4.4.4 Optical radiation calculator (INRS)

http://www.inrs.fr/media.html?refINRS=outil03&utm_source=lettre-information-INRS-mars-2019&utm_medium=email&utm_campaign=newsletter-INRS (in French, English, German and Spanish)

4.5 Useful links

Temperature/humidity/wind
OSHA: https://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_4.html
Laser
APINEX : https://www.apinex.com/det/classification_des_lasers.html
UV
OMS: http://apps.who.int/iris/bitstream/handle/10665/42459/9241590076.pdf;jsessionid=1EE6263FD6586FF216D3D07D7F1E3710?sequence=1 HST: http://www.hst.fr/dms/hst/data/articles/HST/TI-DO-19/do19.pdf pages 39 et suivantes.
Ionizing radiation risk

ISRN:
http://www.irsn.fr/FR/connaissances/faq/Pages/Quelle_est_la_dose_de_radioactivite_dangereuse_pour_la_sante.aspx

Radon:

ISRN: http://www.irsn.fr/FR/connaissances/Environnement/expertises-radioactivite-naturelle/radon/Pages/1-Le-risque-radon-dans-les-habitations-en-10-questions.aspx#.WoK9OK7ia70

OMS: http://www.who.int/mediacentre/news/notes/2005/np15/fr/

5 LIST OF APPENDICES AND SUPPLEMENTARY DOCUMENTS

Reference	Title
APPENDIX 1	Electromagnetic field values

APPENDIX 1

Electromagnetic field values

Legend of the three tables below:

Values *in blue* and in italics correspond to a frequency of 50 Hz.

The pink zones correspond to thermal effects and the blue zones to non-thermal effects.

*** EMF limit values for health:** Directive 2013/35/EC.

These values are based on biophysical and biological considerations.

Frequency f	**Sensory effects**	**Short-term effects on health**	
	Localized exposure of the head (limbs)	**Exposure of the whole body**	**Localized exposure of the head and trunk (limbs)**
0-1 Hz	**2**T **(8T)**	**8T**	-
1 - 10 Hz	**0.7/f** V/m	***1.1*** *V/m*	-
10 - 25 Hz	**0.07** V/m		-
25 - 400 Hz	**0.0028f** V/m *For 50 Hz, 0.14 V/m*		-
400 - 3000Hz	-		-
3 - 100 kHz	-	**3.8.10^{-4}f** V/m	-
100 kHz - 10 MHz	-	**3.8.10^{-4}f** V/m (non-thermal) **0.4** W/kg (thermal)	**10** W/kg
10 MHz - 300 MHz	-	**0.4** W/kg	**(20** W/kg**)**
0.3 - 6 GHz	**10** mJ/kg		
6 - 300 GHz	-	**50** W/m²	-

Short-term sensory effects: dizziness, nausea, metallic taste, light flashes, clicking, tingling, muscle contractions, palpitations, etc.

Short-term thermal effects: tingling, burning sensation, red blotches, superficial or deep burns, internal necrosis, explosion or fire;

Long-term thermal effects: leukemia or glioma in due course (ED 6136).

**** Values triggering the action associated with the direct biophysical effects of EMF (AV):** Directive 2013/35/EC.

Frequency f	**Electrical field AV**	**Magnetic field AV**			**Induced currents AV**
	E (V/m)	**B low** (µT)	**B high** (µT)	**limbs localized B**	**I** (mA)
1 - 8 Hz	***20000***	**$2.10^5/f^2$**	**$3.10^5/f$** *For 50 Hz: 6000 µT*	**9.105/f** *For 50 Hz: 18000 µT*	-
8 - 25 Hz		**25000/f**			-
25 - *50* Hz		***1000***			-
50 - 300 Hz	**$10^6/f$**				-
300 - 1640 Hz		**$3.10^5/f$**			-
1.64 - 2.5 kHz	**610**				-
2.5 - 3 kHz					-
3 - 100 kHz		**100**	**300**	**300**	-
100 kHz - 1 MHz	**610** (thermal or non-thermal)	**100** (non-thermal) **$2.10^6/f$** (thermal)			-
1 MHz - 10 MHz	**610** (non-thermal) **610/f** (thermal)				-
10 MHz - 110 MHz	**61**	**0.2**	-	-	**10**
110 MHz - 400 MHz			-	-	-
0.3 - 2 GHz	**$3.10^{-3}f^{1/2}$**	**$10^{-5}f^{1/2}$**	-	-	-
6 - 300 GHz	**140**	**0.45**	-	-	-

**** AV associated with certain indirect effects of EMF:** EU directive 2013/35/EC.

Frequency f	**Interference with implanted devices*****	**Attraction/repulsion for B > 100 mT**	**Discharge of sparks**	**Stable contact current**
	AL (B_0)	**AL (B_0)**	**E** (V/m)	**Ic** (mA)
0-1 Hz	**0.5 mT**	**3 mT**	-	***1***
1 - 25 Hz	-	-	**20000**	
25 - 2500 Hz	-	-	**$5.10^5/f$** *For 50 Hz: 10000 V/m*	
2.5 - 3 kHz	-	-		**0.4f**
3 - 100 kHz	-	-	**170**	
100 kHz - 10 MHz	-	-		**40**
10 MHz - 110 MHz	-	-	-	

*** Active or passive implants: heart stimulators, defibrillators, insulin pumps, metal joints/pins/plates/shrapnel.