



# ARC RADIATION

IO2 – EDUCATIONAL MATERIALS

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- The welding process involves heating materials to high temperatures and materials emit radiation as a function of temperature.
- Light is emitted by the welding processes in the infrared, visible and ultraviolet wavelengths and is of relevance to safety.

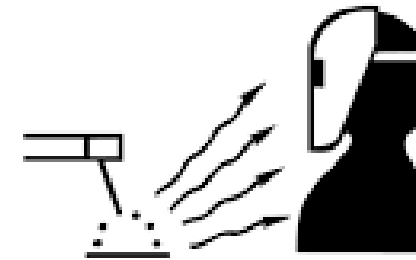


Figure 1 - Arc radiation. Source:  
<https://www.lincolnelectric.com/en-us/education-center/welding-safety/Pages/welding-safety.aspx>

# Electromagnetic Spectrum

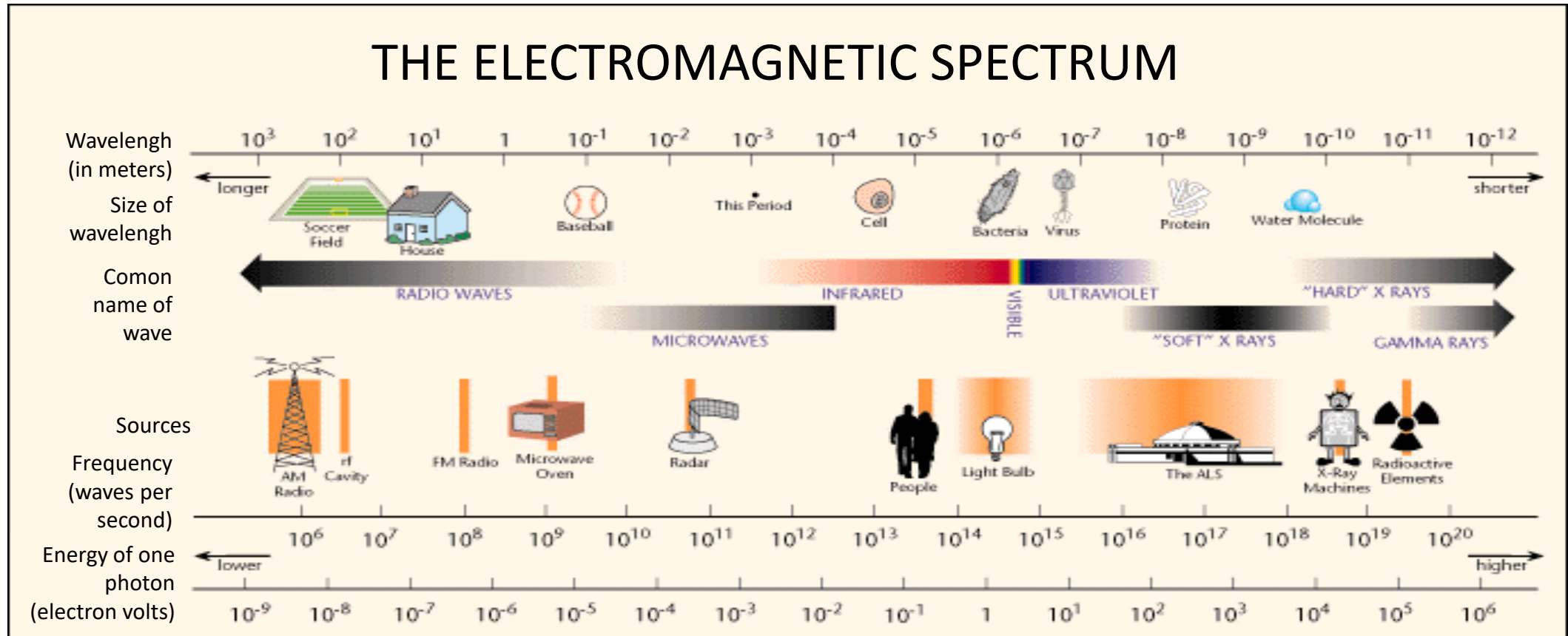


Table 1- Electromagnetic spectrum. Source: [https://marine.rutgers.edu/cool/education/class/josh/em\\_spec.html](https://marine.rutgers.edu/cool/education/class/josh/em_spec.html)

# Radiation

Types	Sources	Health Effects
Ionizing	X-rays Gamma rays	Cancer, congenital defects, death
Non-ionizing	Ultraviolet Infrared Laser	skin problem (redness, premature ageing and cancer ) eye problem (corneal and conjunctival burns, retinal injury, cataract)

# Ionizing Radiation

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- Produced by the electron beam welding process.
- Controlled within acceptable limits by using suitable shielding around the electron beam welding area.
- Produced during grinding (pointing) of thoriated tungsten electrodes for TIG process (grinding dust is radioactive).

# Non-Ionizing Radiation

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- Intensity and wavelength depend on process, welding parameters, electrode and base metal composition, fluxes, and any coatings or plating on the base material.
- Visible brightness (luminance) of the arc increases at a much lower rate.
- Processes using argon produce larger amounts of ultraviolet radiation than those using most other shielding gases.

Arc welding: electrical energy is converted into heat and light.

Both of them can have serious health consequences on the operator.

Arc welding light radiation can be classified as:

<b>Radiation type</b>	<b>Wavelength [nm]</b>
Infra red (heat)	>700
Visible	400-700
Ultra violet	<400

# Ultra violet radiation (UV)

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**All arc welding processes generate UV.**

UV-radiation may be divided in following ranges:

- UV-A also known as black light (315 to 400 nm);
- UV-B (280 to 315 nm);
- UV-C (100 to 280 nm);

UV-C and almost all UV-B are absorbed in the cornea of the eye.

UV-A passes through cornea and is absorbed in the lens of the eye.

The main risk for welders and Inspectors is related to inflammation of the cornea and conjunctiva (arc eye or flash).



# Ultra violet radiation (UV)

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Arc eye (caused by UV radiation) damages the protective layer of cells in the cornea.

The damaged cells die and gradually fall off the cornea.

This causes an intense pain, (sand in the eye).

It develops hours after exposure.

Pain lasts for 12-24 hours (longer in severe cases).

Treatment in case of arc eye: rest in a dark room.

Anaesthetic eye drops can be administered, only by qualified persons.

Wearing safety glasses with side shields considerably reduces such risks.

# Ultra violet radiation (UV)

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- The UV from arc welding processes results in reddening and irritation caused by changes in the minute surface blood vessels.
- In extreme cases, the skin may be severely burned and, on its surface, blisters may form.
- The reddened skin may die and flake off in few days.
- If intense prolonged or frequent exposure, skin cancer can develop.
- Long-term exposure to UV light can produce cataracts for some persons.

# Ultra violet radiation (UV)

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- Ultraviolet rays at welding can react with chlorinated hydrocarbon solvents
- (trichloroethylene etc.) to form phosgene gas.
- Even a very small amount of phosgene may be deadly, although early symptoms of exposure dizziness, chills, and cough.
- Usually it takes 5 or 6 hours to appear.
- Arc welding should never be performed within 50 m of degreasing equipment or solvents.

# Visible Light

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- At welding, very bright visible light can overwhelm the ability of the iris of the eye to close sufficiently and rapidly enough to limit the brightness of the light reaching the retina.
- Light temporarily blinds and/or fatigues the eye.
- Intense visible light can damage the optically nerves on the retina.
- Effects depends on duration/intensity of exposure and the persons reaction.
- Normally this dazzling does not produce a long-term effect.

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- Light, visible to the human eye, has wavelength from 400 to 760nm.
  - Intensities of 400 to 500nm cause photochemical lesions on the retina.
  - „Blue light hazard" is the temporary or permanent scarring of the retina, at around 440 nm wavelength. Blindness may result.

Note: The arc can reflect off surrounding materials and burn co-workers who work nearby. About half of welder's flash injuries are at not welding co-workers.

# Infra Red Radiation

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- Infrared radiation: longer wavelength than the visible light frequencies (perceptible as heat).
- Hazard to eyes: prolonged exposure (years) causes a gradual and irreversible opacity of the lens.
- The arc welding infrared radiation causes damage only within a short distance from the arc.
- A burning sensation in the skin surrounding the eyes should they be exposed to arc heat.
- EN 169 specifies a range of permanent filter shades.

# Overexposure to Arc Radiation

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## Potential Symptoms:

### **Ultraviolet**

Itchy, Tearing

“Sand in the Eyes”

### **Visible**

Spot Blindness

Headache

### **Infrared**

Dry, Tearing, Itchy, Headache

## Potential Damage:

### **Ultraviolet**

Can happen in milliseconds

Usually to cornea (often temporary)

### **Visible**

Takes time to happen (seconds to hours)

Damage is immediate or accumulative

### **Infrared**

In years (cumulative)

Affects the lens of the eye (cataract)

# Arc Welding Filters EN169

MMA

EW 9 to 14

MIG/MAG/FCAW

EW 10 to 14

TIG

EW 9 to 14

➤ Surround welding area with protective curtains.

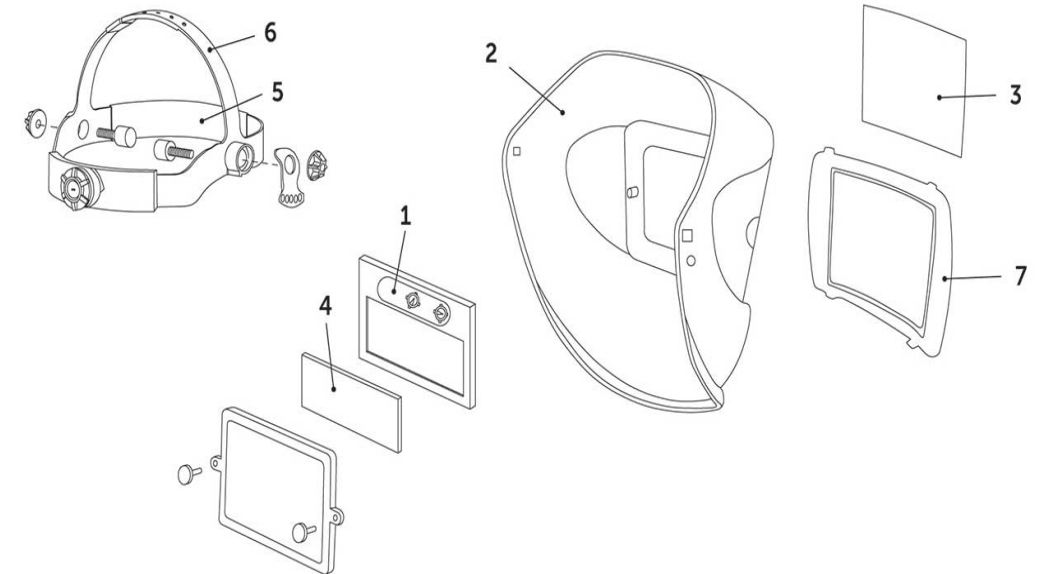


Figure 2 – Element of the welding filter. Source: <http://www.jackson-safety.com/wh40-30-element.html>



# Protection Against Ionizing Radiation

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- Radiation varies with time of exposure, distance from source and shielding used.
- Follow recommended procedures/regulations.
- When pointing thoriated tungsten electrodes, use local exhaust and/or respiratory protection to prevent dust inhalation.
- External radiation from thoriated tungsten electrodes during storage, welding, or disposal of residues is negligible.

# How to Protect Against Non-Ionizing Radiation

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- Use welding helmet, with correct shade of filter plate. (Note: Transparent welding curtains are intended only to protect passersby from incidental exposure.)
- Protect exposed skin with adequate gloves and clothing.
- Be aware of reflections from welding arcs and protect all persons from intense reflections.

# Measures to be taken for skin protection from arc radiation

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- Wear tightly woven clothes to keep UV radiation from reaching your skin.
- Button up your shirt to protect the skin on the throat and neck.
- Wear long sleeves and pant legs.
- Protect the back of your head by using a hood.
- Protect your face and head from UV radiation.

# European, National Regulations and Recommendations

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- EN 169: Personal eye-protection. Filters for welding and related techniques. Transmittance requirements and recommended use
- EN 170: Personal eye-protection. Ultraviolet filters. Transmittance requirements and recommended use
- EN 171: Personal eye-protection. Infrared filters. Transmittance requirements and recommended use
- EN 175: Personal protection. Equipment for eye and face protection during welding and allied processes
- EN 379: Personal eye-protection. Automatic welding filters
- EN 1598: Health and safety in welding and allied processes. Transparent welding curtains, strips and screens for arc welding processes.