



HSE
Occupational Health & Safety
and Environmental Protection unit

Electrical Safety

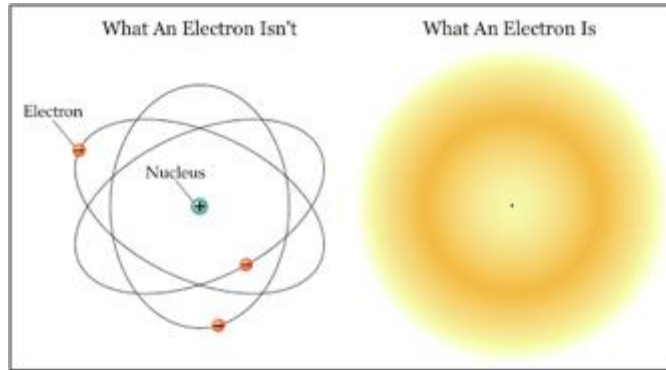
Simon Marsh

23rd September 2022

EDMS reference

Electricity

It starts with the electron...



$$\hat{H}(r, \theta, \varphi)\psi(r, \theta, \varphi) = E\psi(r, \theta, \varphi)$$

Schrödinger Equation for the hydrogen atom

$$U = R \times I$$

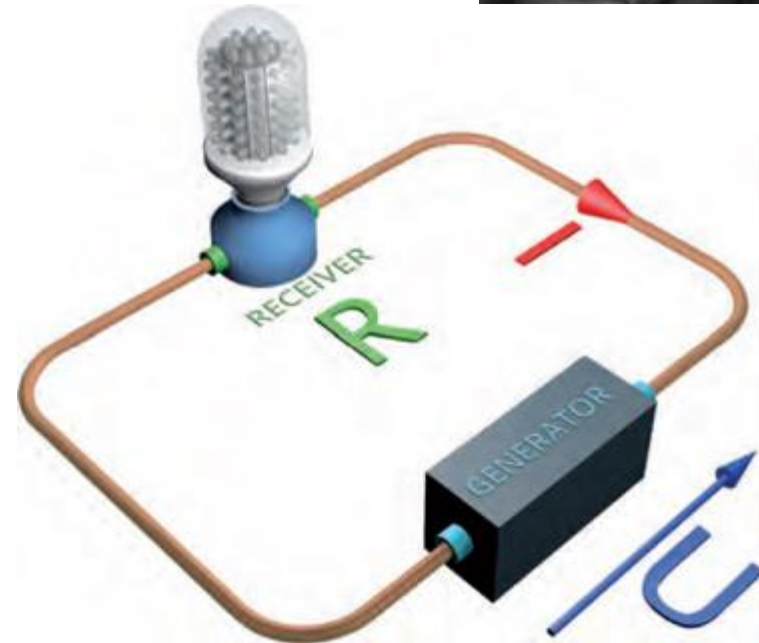
- *Ohm's law*

U = Voltage [V]

I = Current [A]

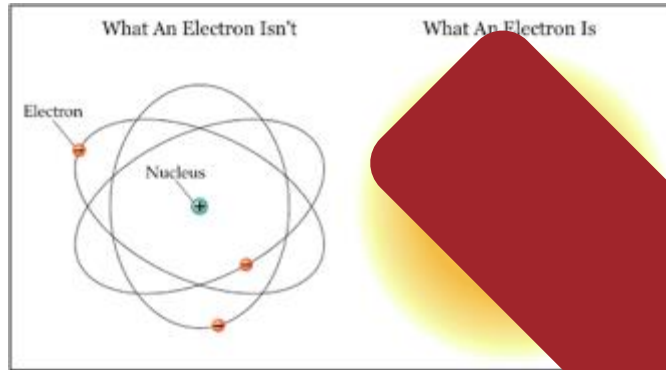
R = Resistance [Ω]

Georg Ohm
1789-1854



Electricity

It starts with the electron...



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$$\hat{H}(r, \theta, \varphi)\psi(r, \theta, \varphi) = E\psi(r, \theta, \varphi)$$

Schrödinger Equation for the hydrogen atom

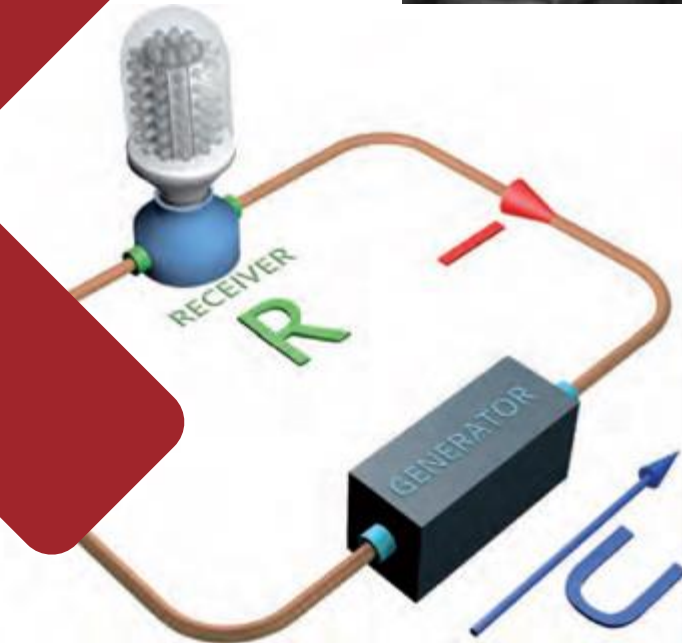
$$U = R \cdot I$$

• Ohm's Law

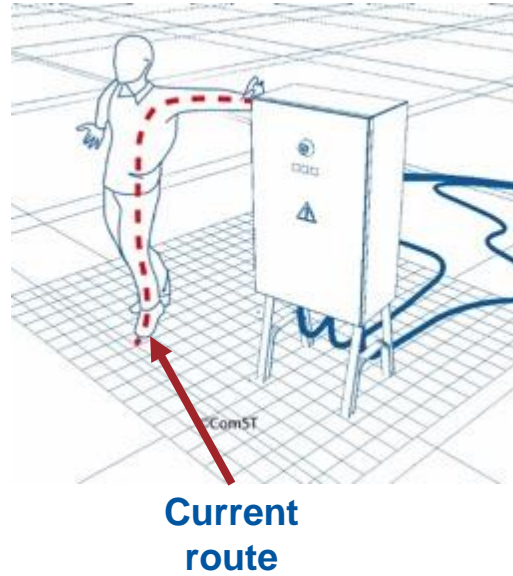
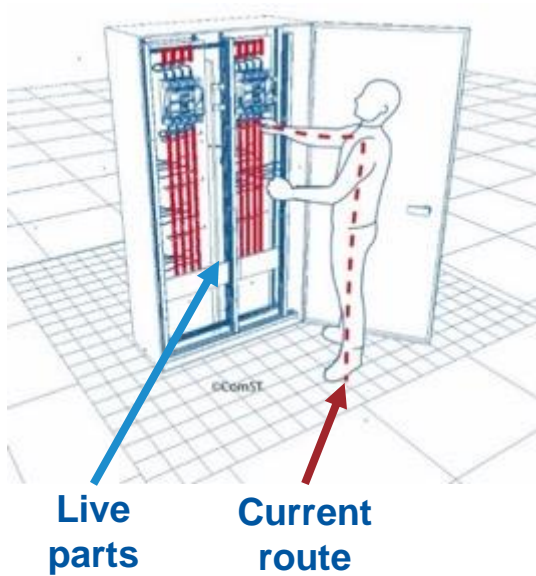
U = Voltage [V]

I = Current [A]

R = Resistance [Ω]



Types of risk



Electric contact
Direct / Indirect

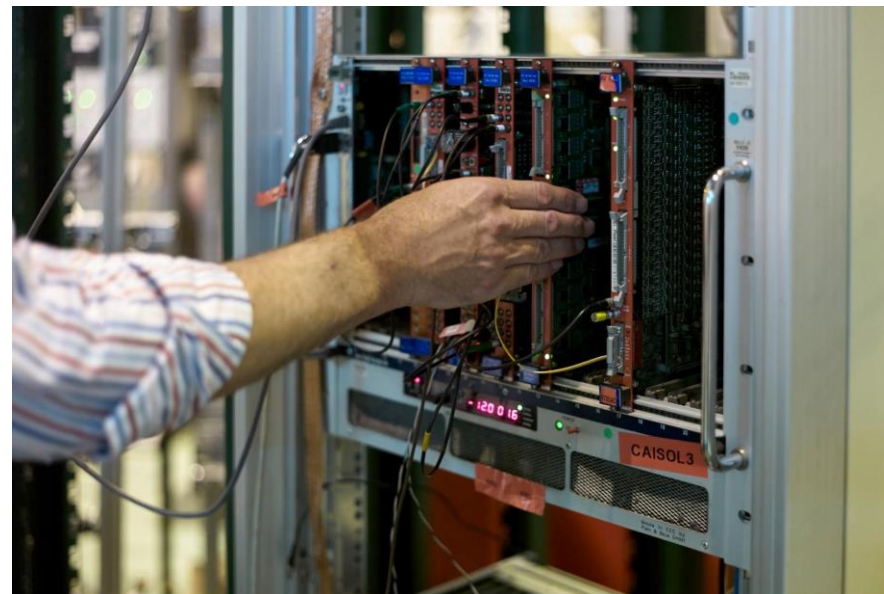


Electric Arc

Direct contact

Incident at CERN:

- IP2X cover removed from device.
- A person accidentally put their hand inside the device.
- They received an electrical shock.



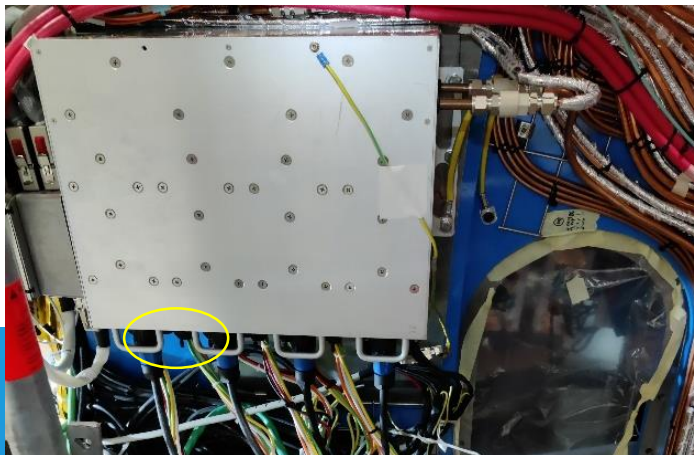
Always check your equipment before performing any work.

If you find an unsafe condition – report it immediately !!

Direct contact

Incident at CERN:

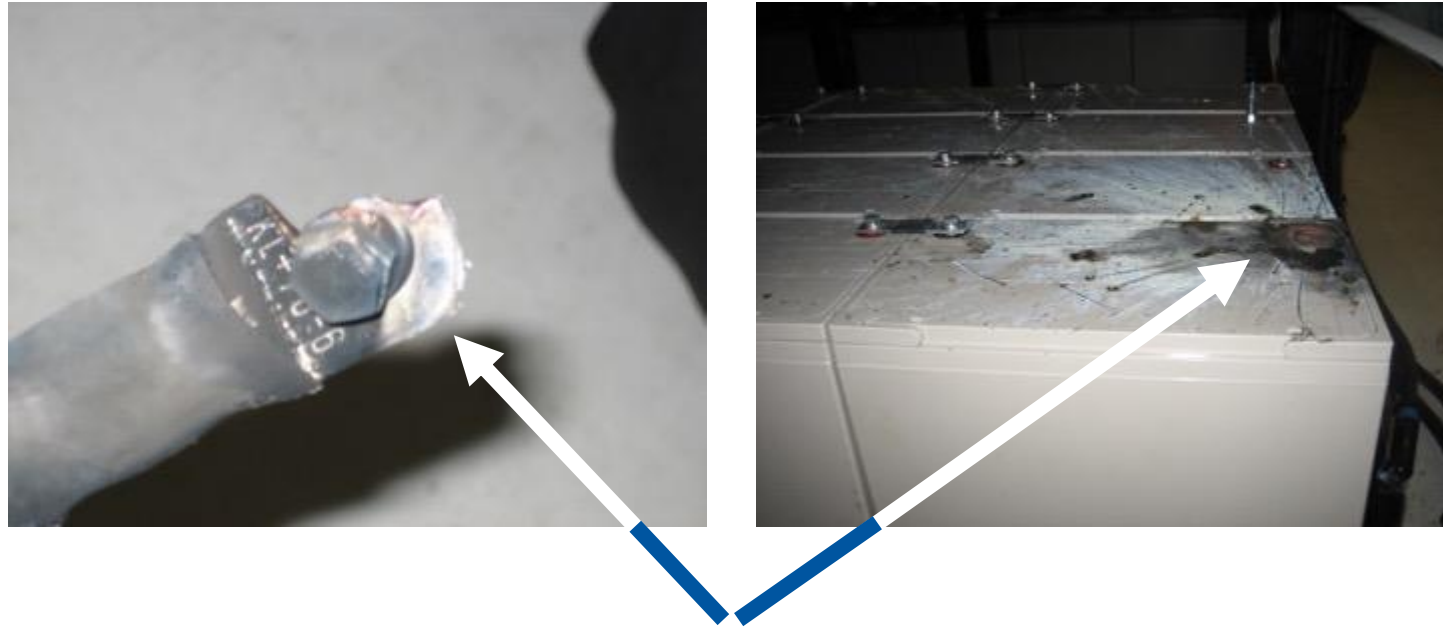
- 300 V DC cable connected via plug to distribution box.
- Worker had mis-understood that it was powered off.
- Removed plug and started to disassemble the connector.
- Worker received electrical shock from direct contact, with current flowing between touching an exposed conductor and the metal scaffolding they were standing on.
- Followed up by medical service after shock.



Electrical arc

Incident at CERN:

- By touching a cable to the battery, a short circuit was produced.
- It created an electric arc which burned the victim's right hand.



*Cable and battery in
short circuit*

Non-electrical work

Non-electrical work can also lead to electrical accidents!

Incident at CERN: Drilling through a live cable.



When working near electricity, there is always a risk, which depends on the:

- type of activity;
- proximity.

If the electrical risk cannot be eliminated a “Habilitation Electrique” title is required.

Consequences



Injury (death)

Explosion

Fire

Projection of molten metal

Damaged installations

Electrical power cut in the area

Physics shutdown

Hazards



Hazards

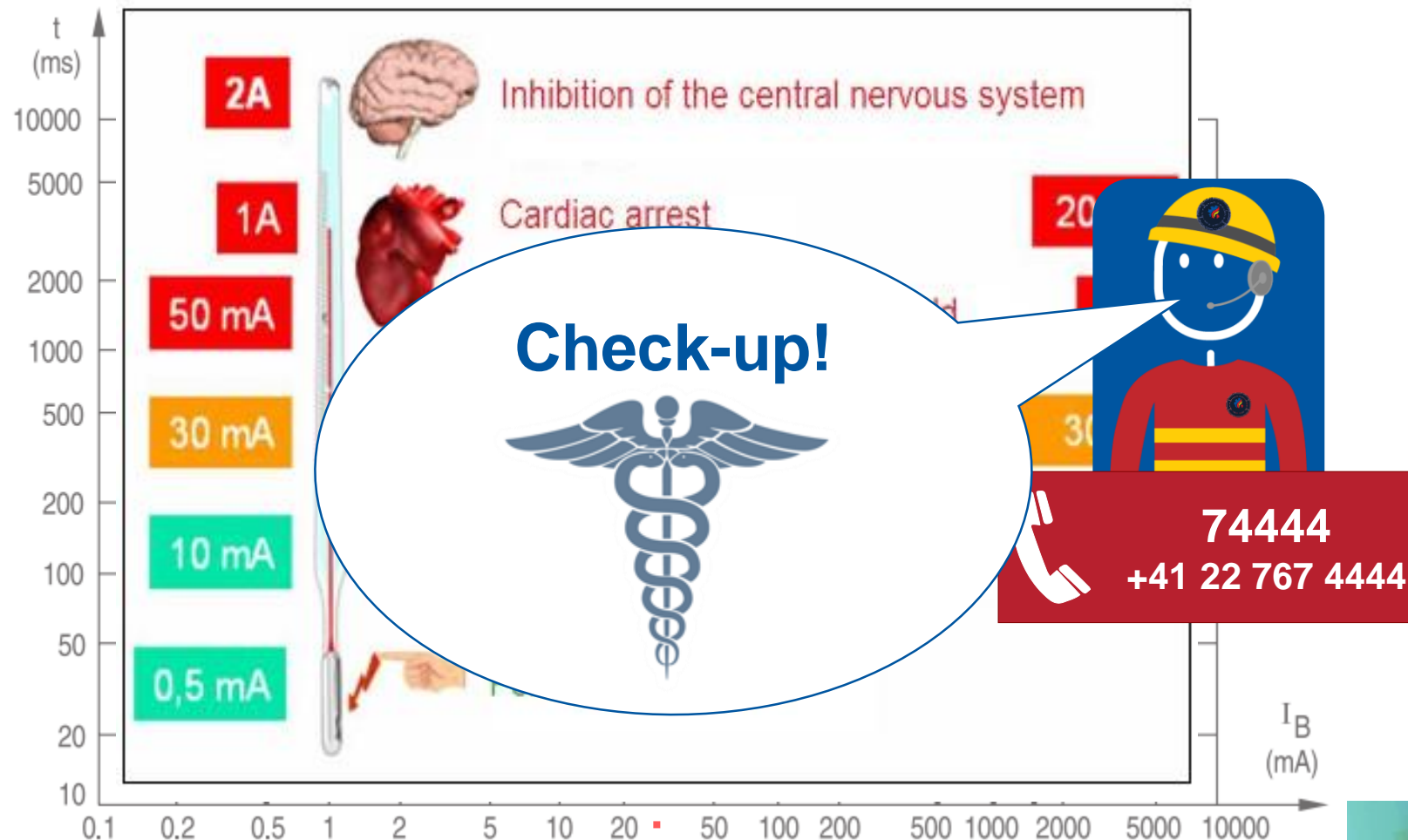


Hazards



Consequences

Time / current zones of effect of AC current (15 Hz to 100 Hz) on human body



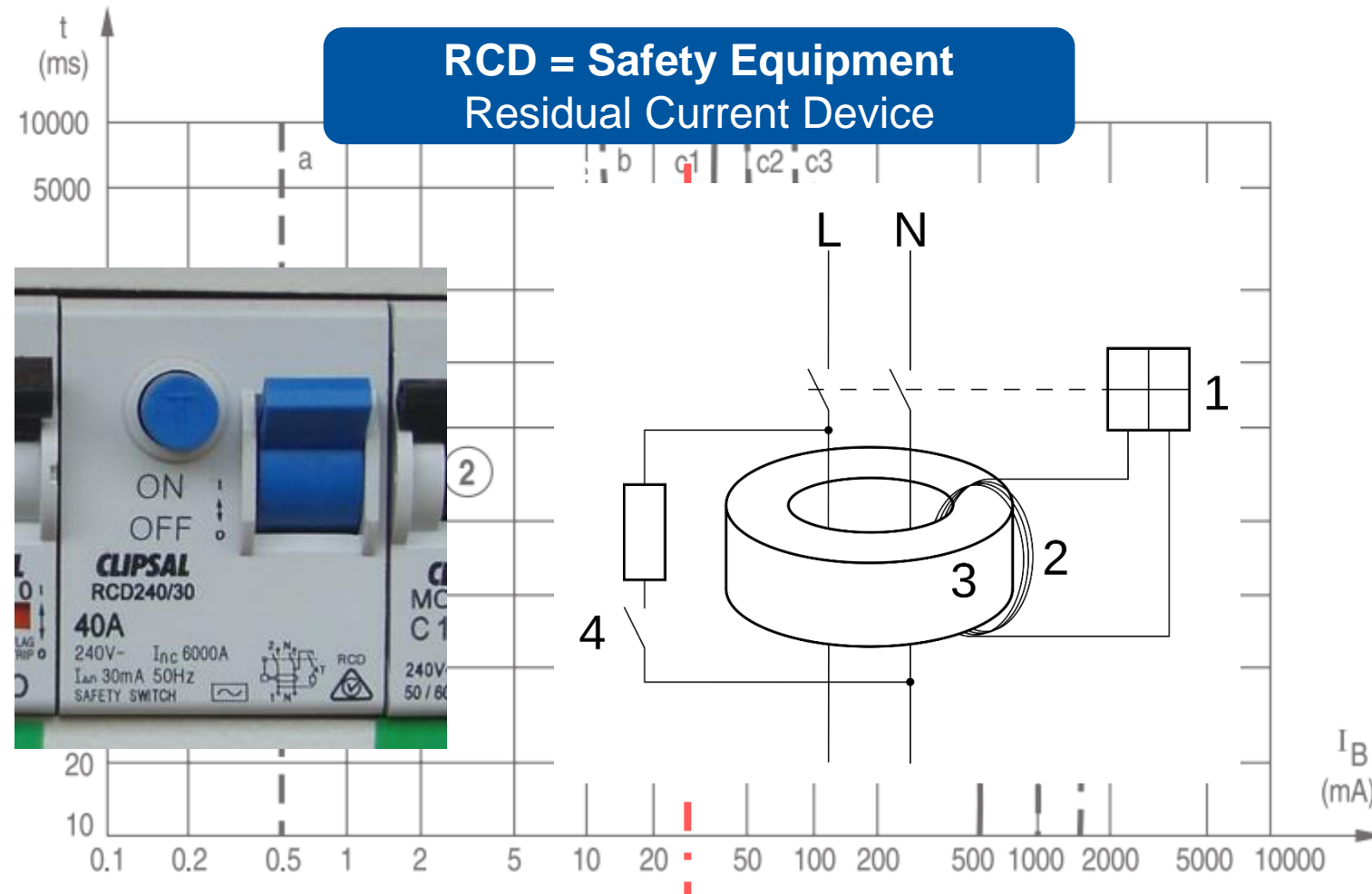
30mA RCD

Note: This is a log-log graph

Source: IEC 60479-1

Residual Current Devices

Time / current zones of effect of AC current (15 Hz to 100 Hz) on human body



30mA RCD

Note: This is a log-log graph

Source: IEC 60479-1

Ingress protection

Preventing direct contact:

- For low voltage equipment, IP2X is required. This means you cannot touch a live part with your finger.
- For high voltage equipment, IP3X is required. This means you cannot touch a live part with a finger or a tool.
- The X means that any water rating is ok, since we do not normally expect water in our experiments.



Test Fingers

IP (Ingress Protection) Ratings Guide

SOLIDS		WATER	
1	Protected against a solid object greater than 50 mm such as a hand.	1	Protected against vertically falling drops of water. Limited ingress permitted.
2	Protected against a solid object greater than 12.5 mm such as a finger.	2	Protected against vertically falling drops of water with enclosure tilted up to 15 degrees from the vertical. Limited ingress permitted.
3	Protected against a solid object greater than 2.5 mm such as a screwdriver.	3	Protected against sprays of water up to 60 degrees from the vertical. Limited ingress permitted for three minutes.
4	Protected against a solid object greater than 1 mm such as a wire.	4	Protected against water splashed from all directions. Limited ingress permitted.
5	Dust Protected. Limited ingress of dust permitted. Will not interfere with operation of the equipment. Two to eight hours.	5	Protected against jets of water. Limited ingress permitted.
6	Dust tight. No ingress of dust. Two to eight hours.	6	Water from heavy seas or water projected in powerful jets shall not enter the enclosure in harmful quantities.
Rating Example: IP65 INGRESS PROTECTION		7	Protection against the effects of immersion in water between 15 cm and 1 m for 30 minutes.
		8	Protection against the effects of immersion in water under pressure for long periods.

Rules



As an intergovernmental organisation, CERN establishes its own safety rules as necessary for its functioning taking into account relevant Host States, as well as European and International regulations and standards.



Electrical Safety Code C1



www.cern.ch