



HSE
Occupational Health & Safety
and Environmental Protection unit



Electrical Safety

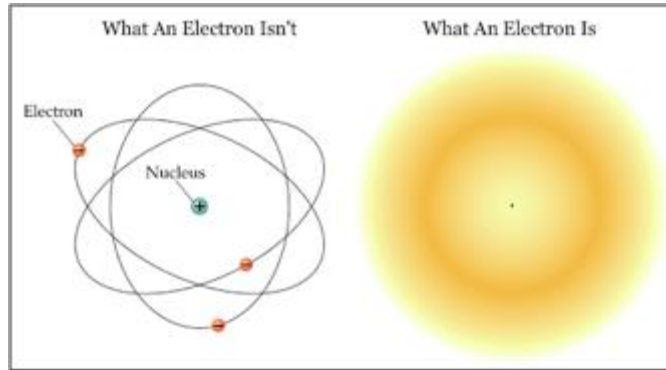
Igor Neuhold

13th September 2024

EDMS reference

Electricity

It starts with the electron...



Georg Ohm
1789 - 1854



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

Schrödinger Equation for the hydrogen atom

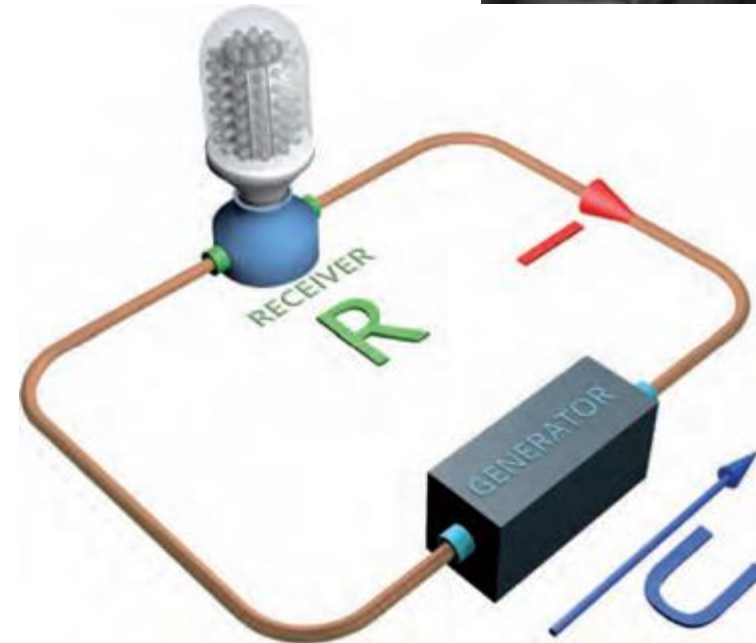
$$U = R \times I$$

Ohm's law

U = Voltage [V]

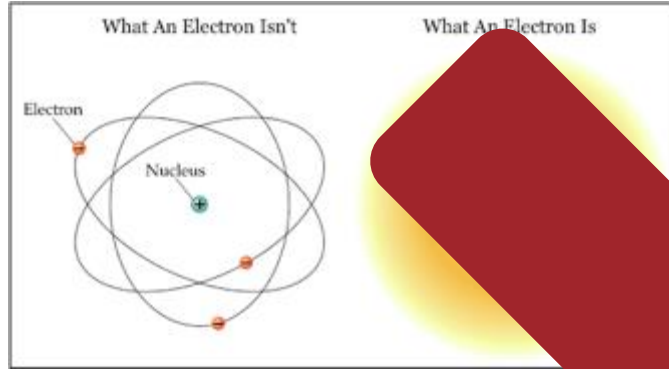
I = Current [A]

R = Resistance [Ω]



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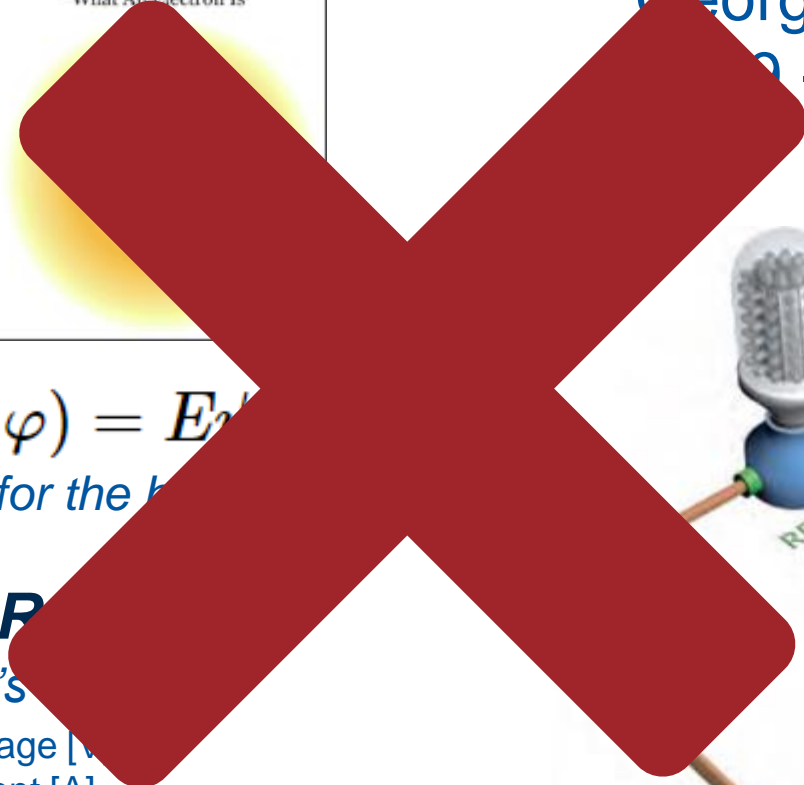
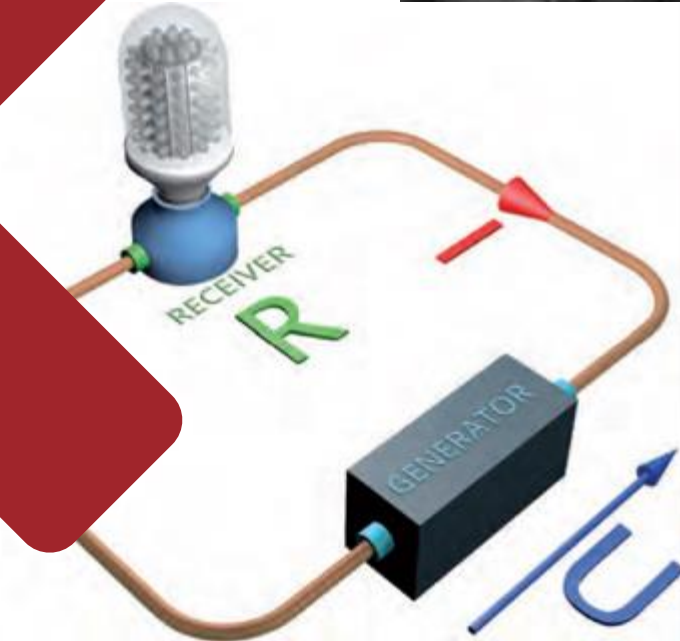
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Schrödinger Equation for the hydrogen atom

$$U = R \cdot I$$

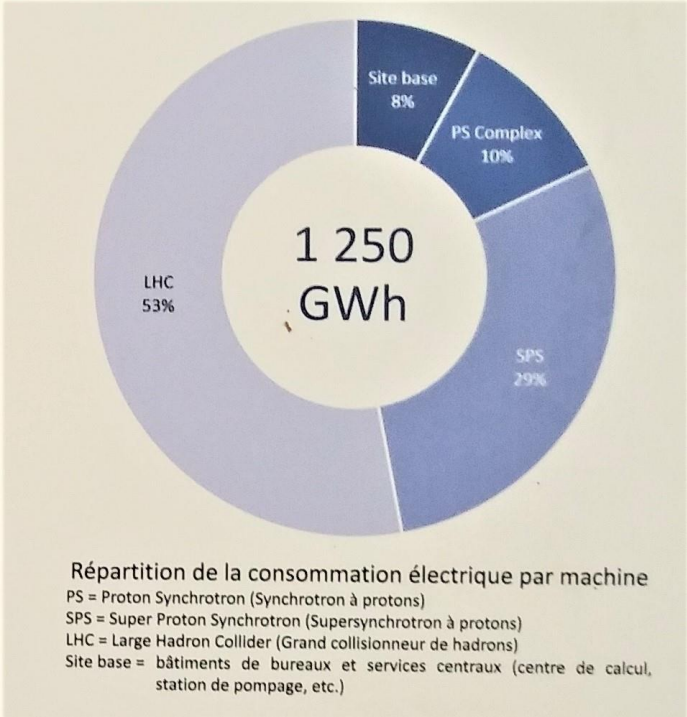
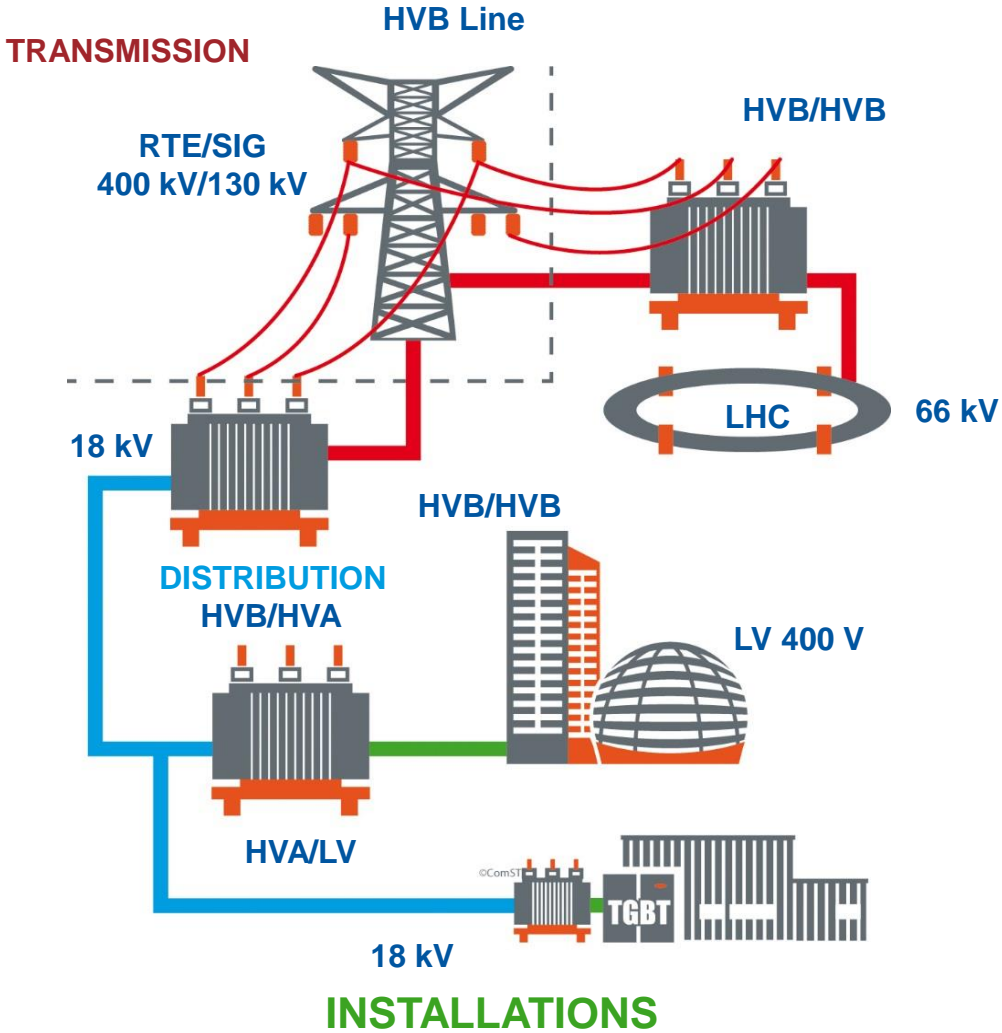
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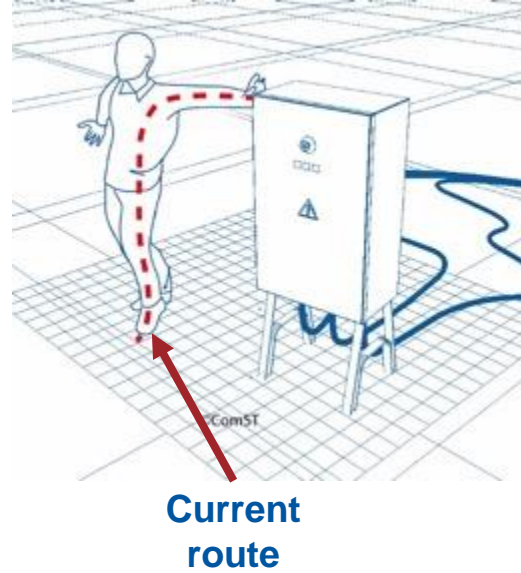
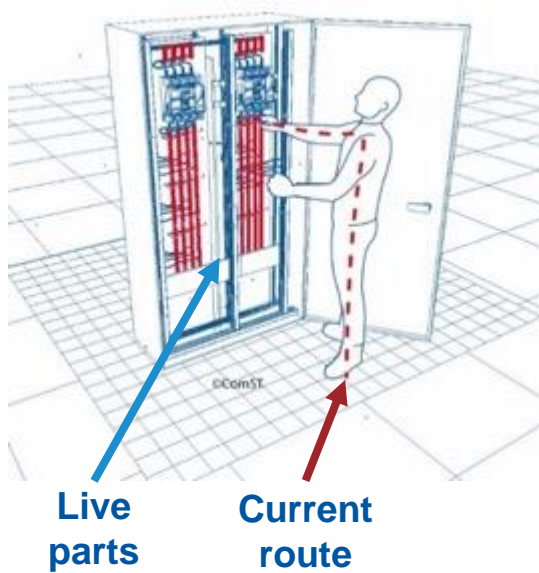


Electrical network at CERN

CERN uses 1.3 TWh of electricity annually. That represents approximately a third of the consumption of the Canton of Geneva.



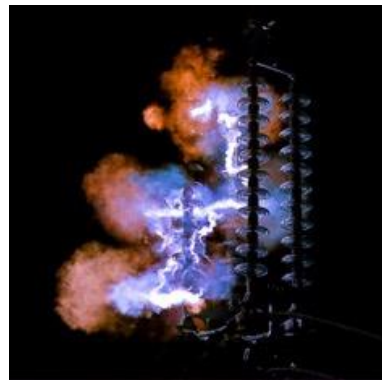
Types of Electrical risks



Electric contact
Direct / Indirect



Electrical Arc

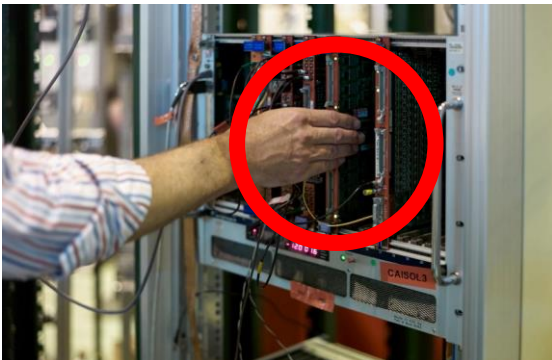


Electrical Fire

Types of risk- Electric shock: Direct and Indirect contact

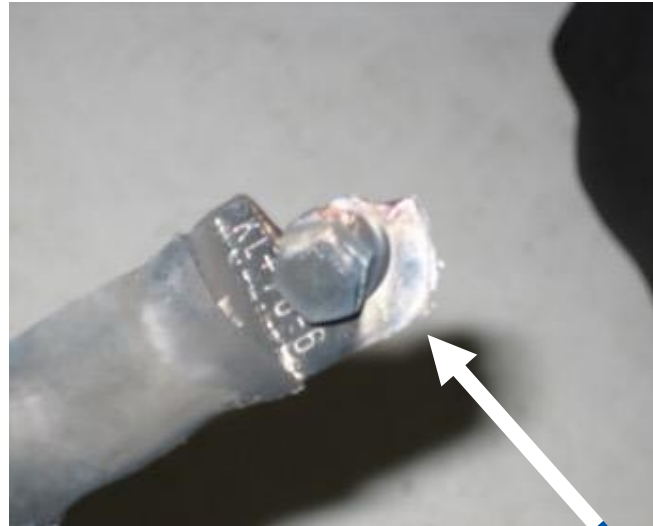
Direct contact

Indirect contact



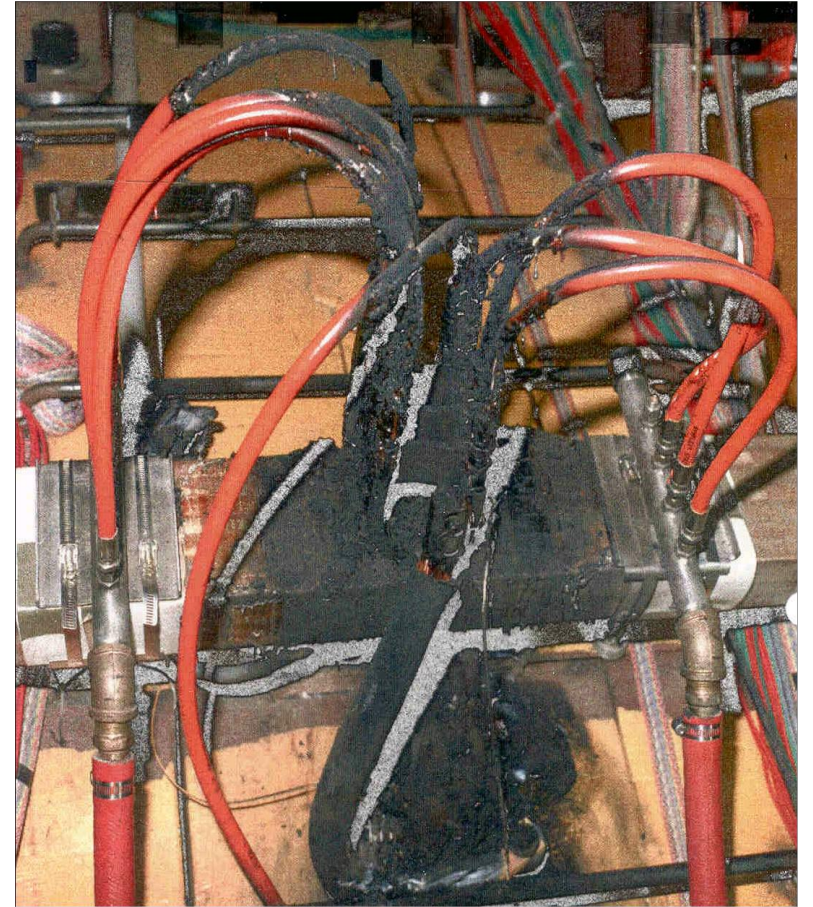
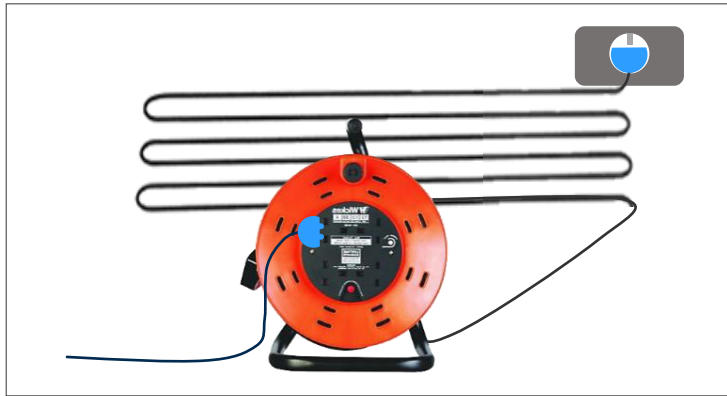
Electrical arc

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

Electrical Fire



Non-electrical work

Non-electrical work can also lead to electrical accidents!!!!



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

- type of activity;
- proximity.

Drilling near live cables has significant risk.



Incident at CERN: Drilling through a live cable

Electrical Hazards (at CERN)



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

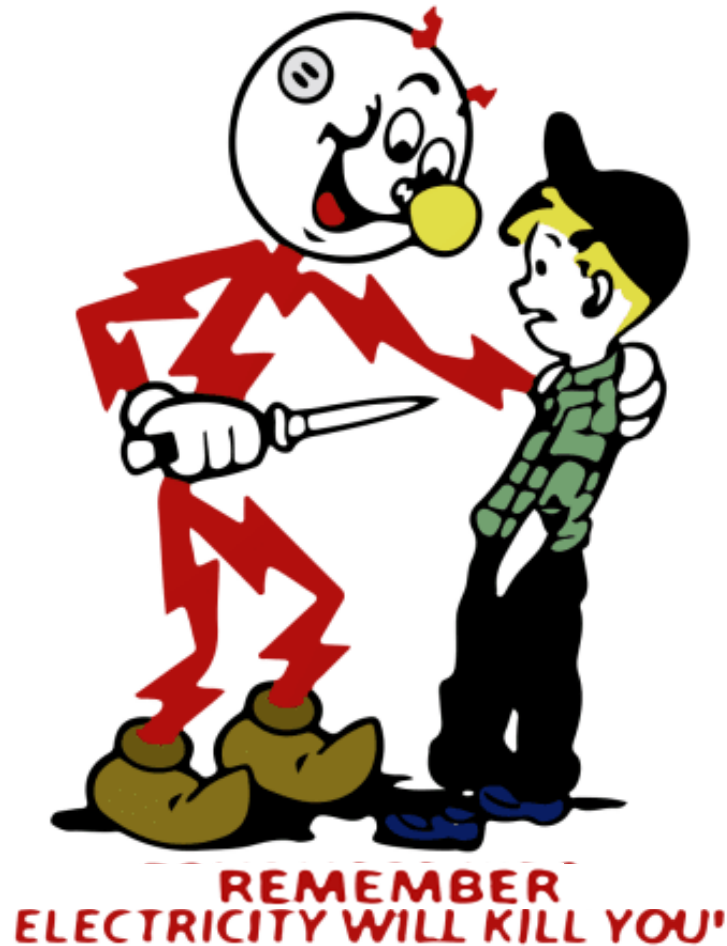


In case of imminent danger, do not hesitate to contact CERN Fire & Rescue Service

Do you know who to contact?



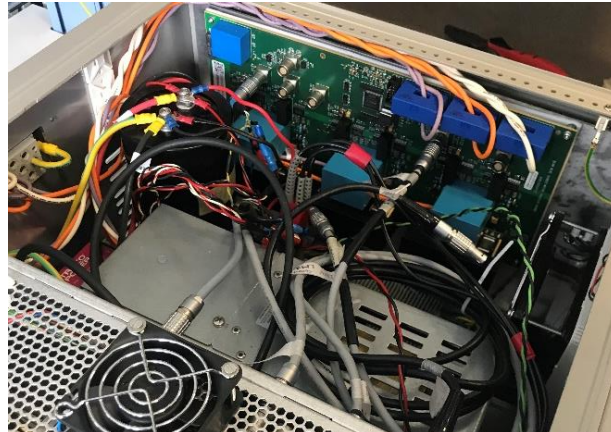
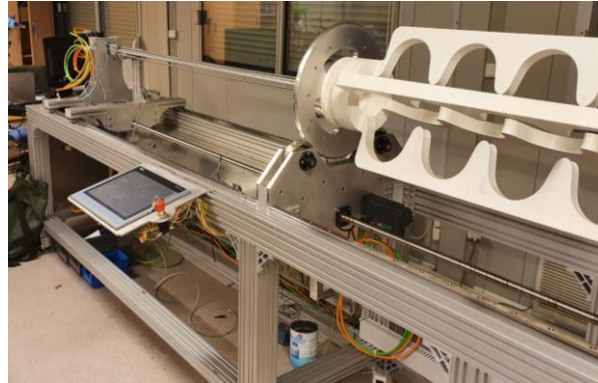
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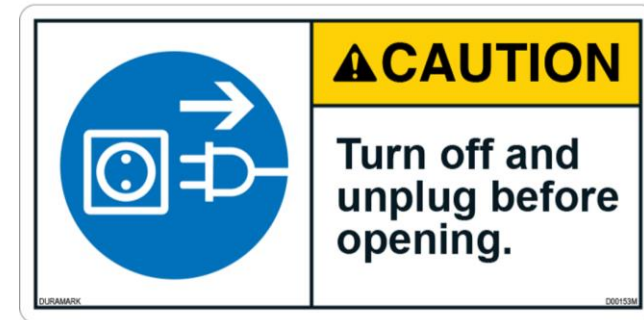
Always check your equipment before performing any work.

Always check your working environment before performing any work.

How to protect?



Always disconnect before servicing.



Ingress protection – Direct contact

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.



IP (Ingress Protection) Ratings Guide

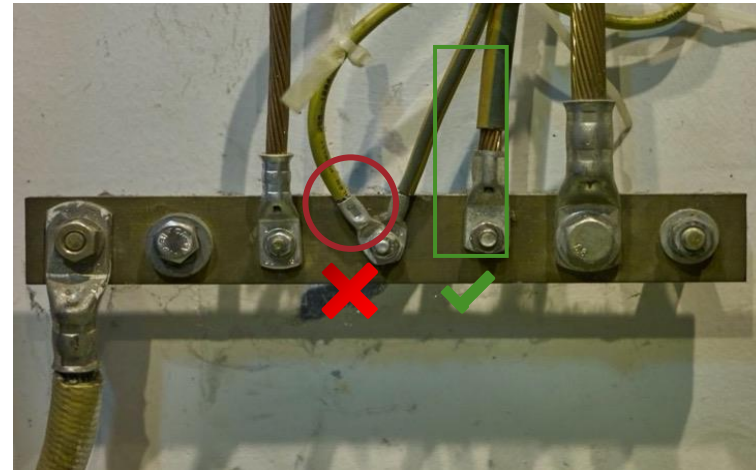
SOLIDS		WATER	
1	<p>Protected against a solid object greater than 50 mm such as a hand.</p>	1	<p>Protected against vertically falling drops of water. Limited ingress permitted.</p>
2	<p>Protected against a solid object greater than 12.5 mm such as a finger.</p>	2	<p>Protected against vertically falling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

Grounding – Indirect contact

Earthing = Grounding



earthing mm² = phase conductor mm²

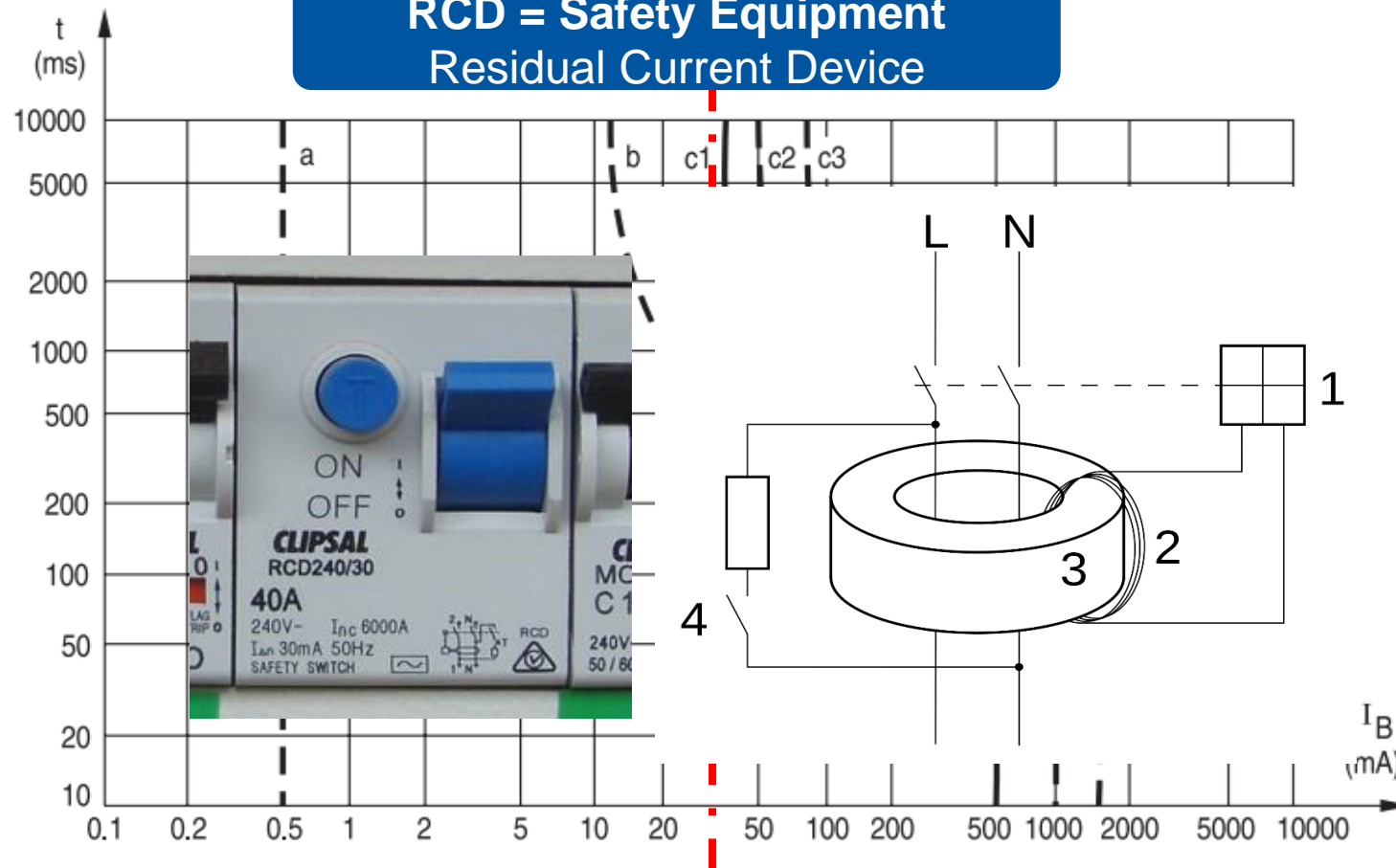


1 cable = 1 connection point

- ✓ Metallic doors to equipment racks shall also be earthed.
- ✓ High frequency equipment: particular attention is required to earthing!
- ✓ Do not remove earth cables unless the equipment is being dismantled.

Residual Current Devices- RCD

RCD = Safety Equipment
Residual Current Device



30mA RCD

Source: IEC 60479-1

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

CERN Specifics- Safety buttons

AUG - General Emergency Stop

Cuts all power in the vicinity and immediately calls fire brigade.



AUL - Local Emergency Stop

Cuts power only locally (room/zone). Does not call the fire brigade.



AUE - Equipment Emergency Stop

Cuts power to a piece of equipment or a single rack.



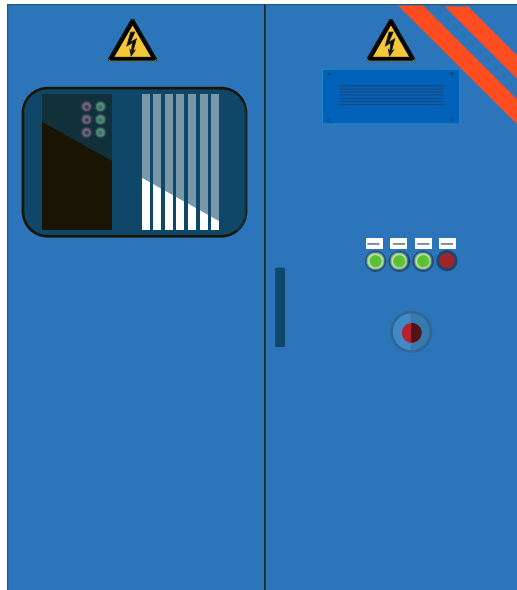
Evacuation alarm

Triggers evacuation sirens, immediately calls fire brigade. Does NOT cut electrical power.



CERN Specifics - Safety equipment identification

Special attention to the **cabinet** with **orange stripes**: they are not cut off by AUG or AUL.



This is reserved for life safety functions and those systems where a power cut causes increased risk (e.g. gas racks, irradiation sources).



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