



HSE  
Occupational Health & Safety  
and Environmental Protection unit



# Electrical Safety

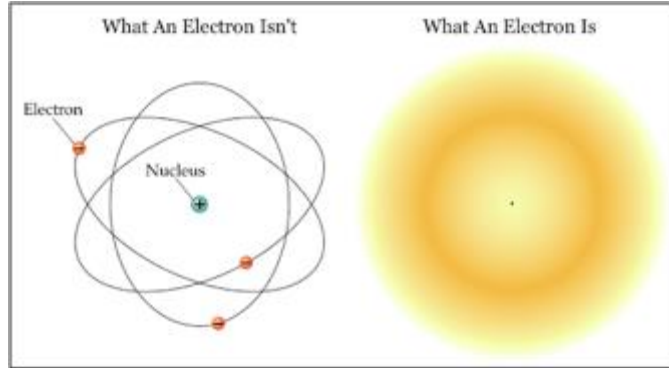
Igor Neuhold

15<sup>th</sup> September 2023

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*

$$U = R \times I$$

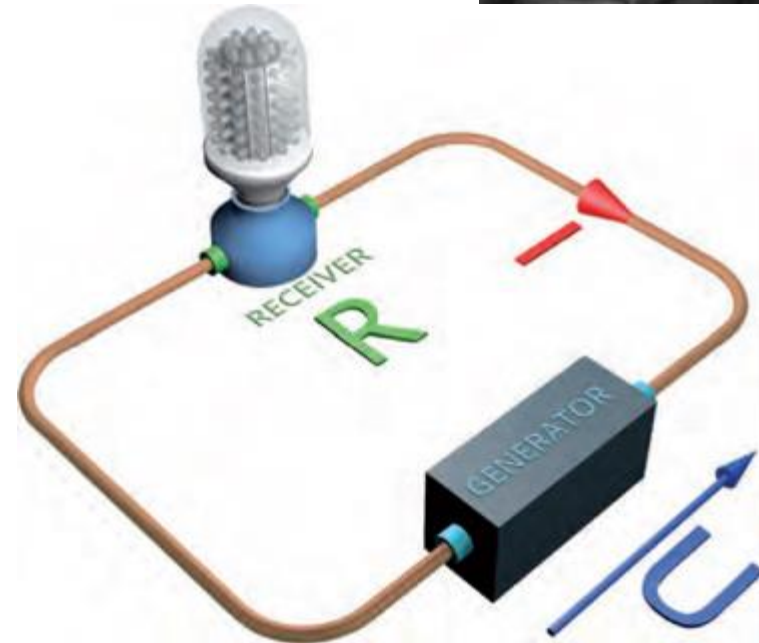
*Ohm's law*

U = Voltage [V]

I = Current [A]

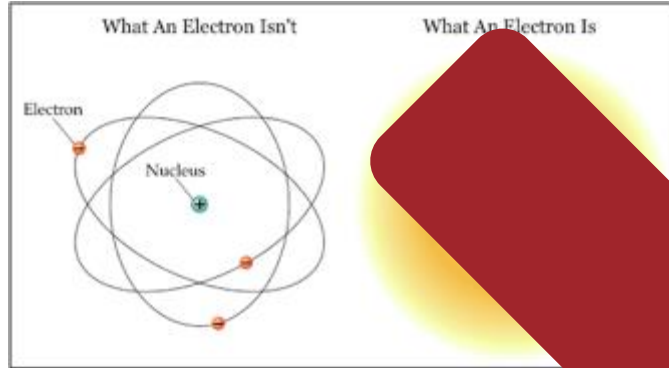
R = Resistance [ $\Omega$ ]

Georg Ohm  
1789 -1854



# Electricity

It starts with the electron...



Georg Ohm  
1789-1854



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Schrödinger Equation for the hydrogen atom

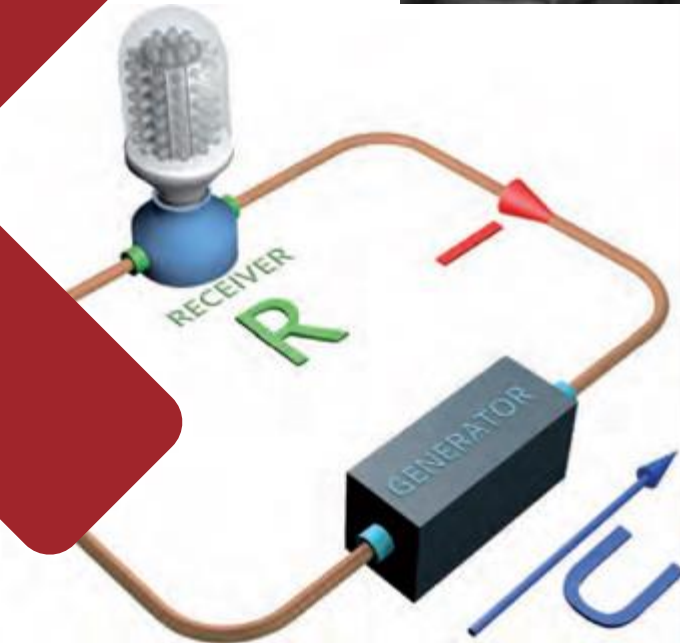
$$U = RI$$

Ohm's Law

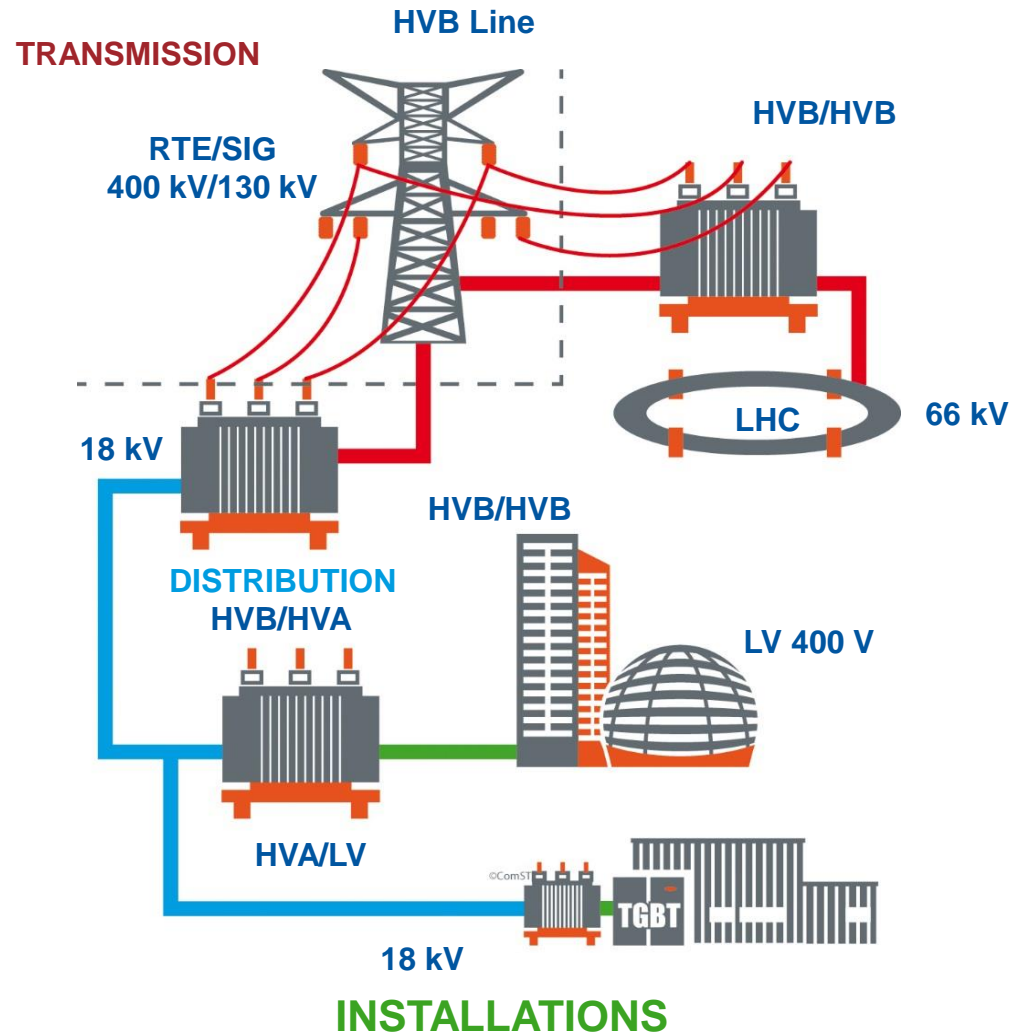
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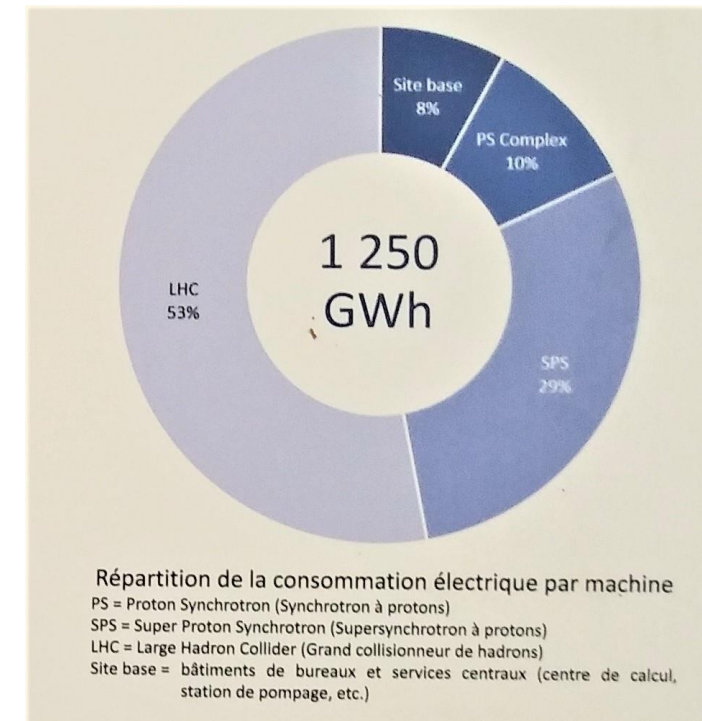
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# Electricity

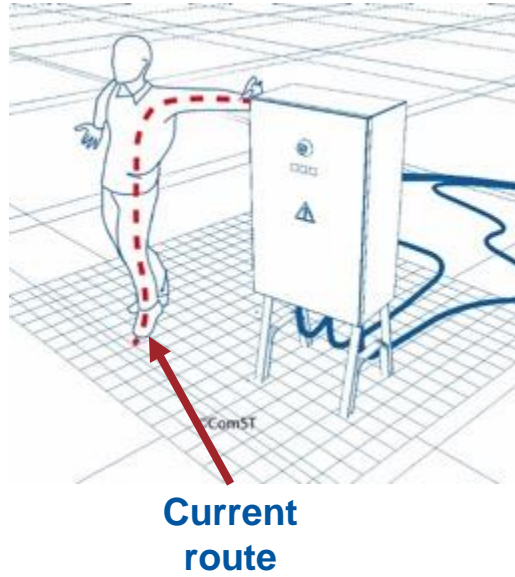
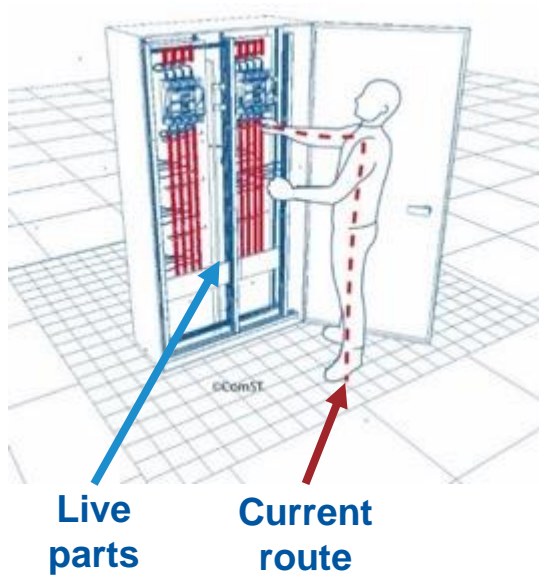


CERN uses 1.3 TWh of electricity annually.  
That represents approximately a third of the  
consumption of the Canton of Geneva.





# Types of risk



Electric contact  
Direct / Indirect



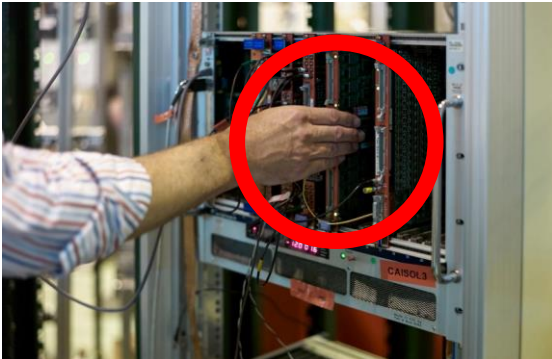
Electrical Arc

Electrical Fire

# Types of risk- Electric shock: Direct and Indirect contact

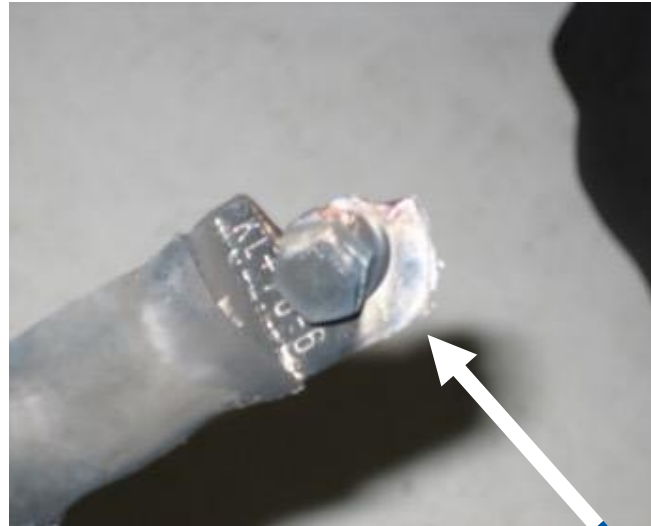
Direct contact

Indirect contact



# Electrical arc

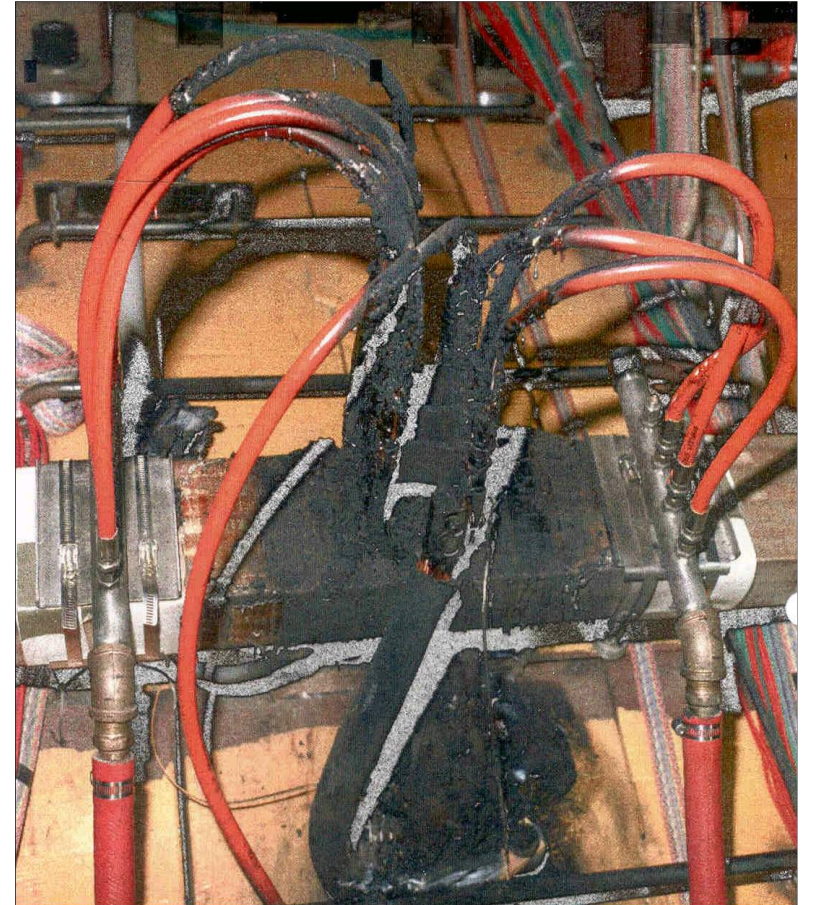
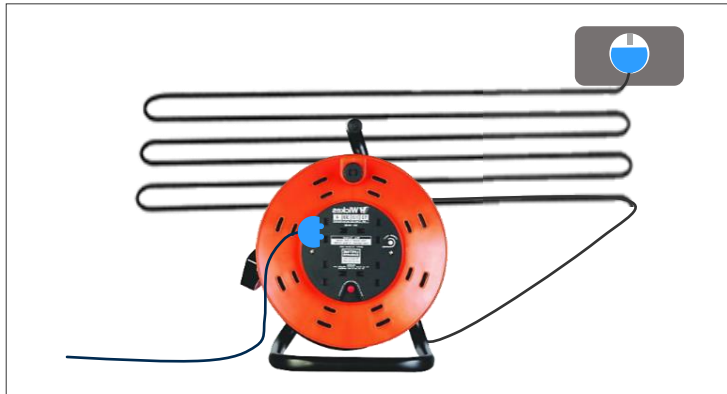
By touching a cable to the battery, a short circuit was produced.  
It created an electric arc which burned the victim's right hand.



*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.

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

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 !!



Do you know who to contact?

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



**74444**  
**+41 22 767 4444**





Always check your equipment  
before performing any work.

Always check your working  
environment before performing  
any work.















# 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.



*Test Fingers*

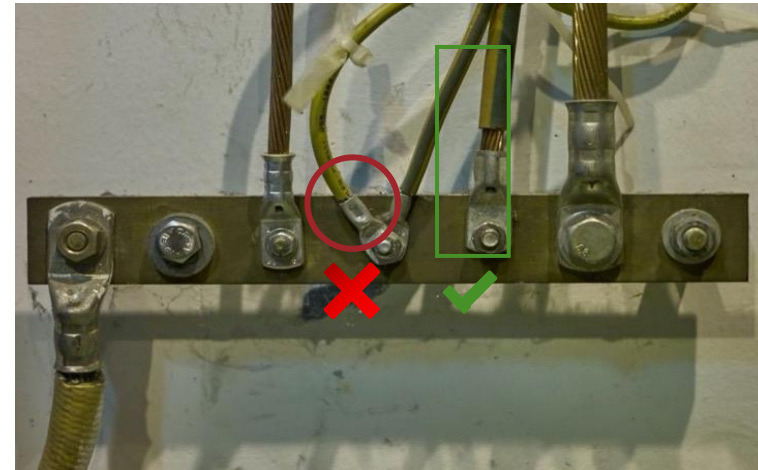
IP (Ingress Protection) Ratings Guide	
SOLIDS	WATER
1  Protected against a solid object greater than 50 mm such as a hand.	1  Protected against vertically falling drops of water. Limited ingress permitted.
2  Protected against a solid object greater than 12.5 mm such as a finger.	2  Protected against 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: <b>IP65</b> 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.

# Grounding – Indirect contact

Earthing = Grounding



*earthing mm<sup>2</sup> = phase conductor mm<sup>2</sup>*

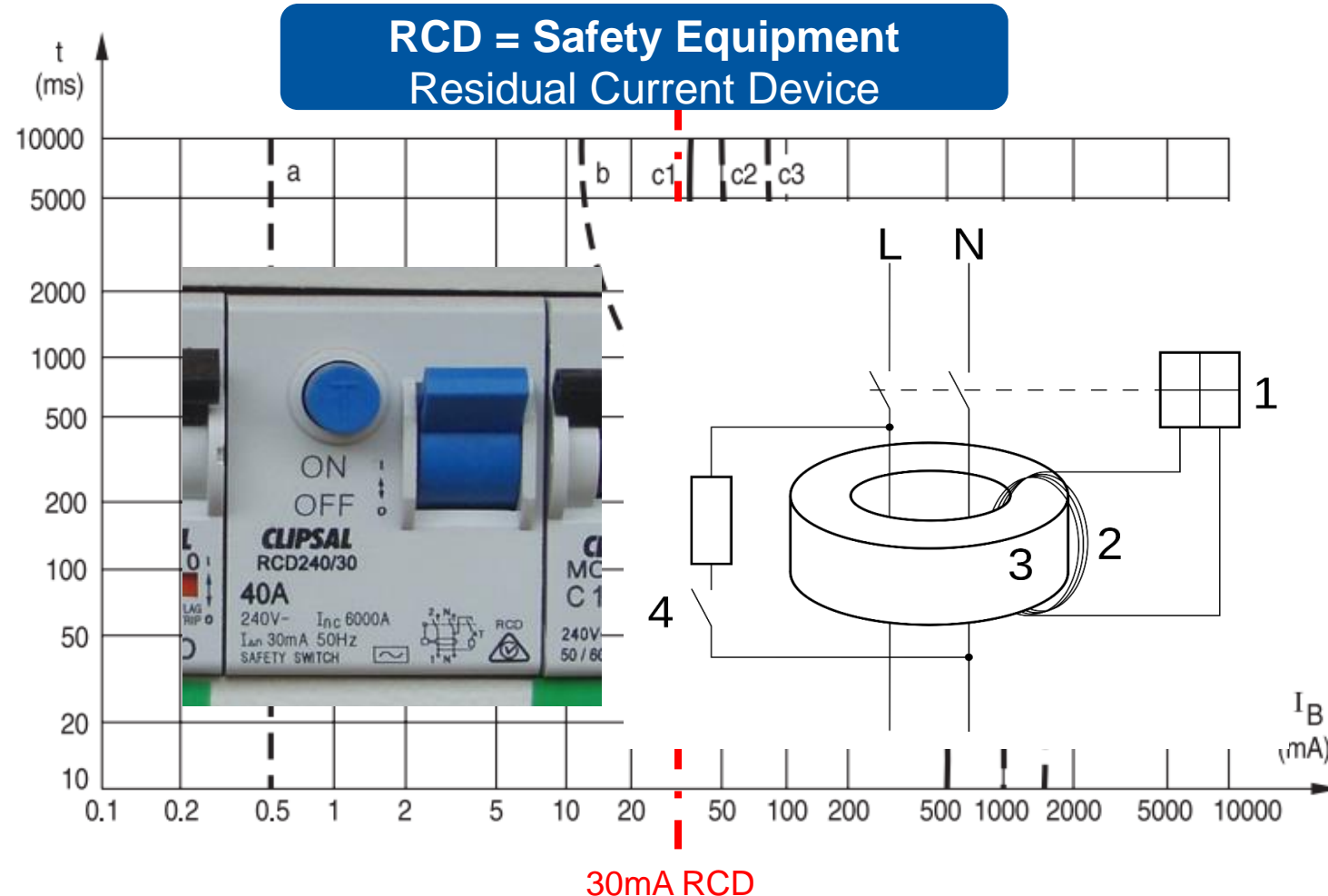


*1 cable = 1 connection point*

- ✓ 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



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.



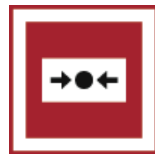
## AUE - Equipment Emergency Stop

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



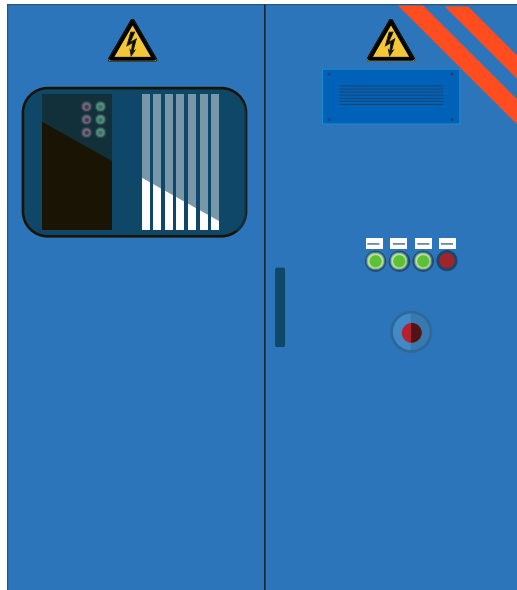
## Evacuation alarm

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).



# PPE and tools



## Personal Protective Equipment (PPE)



Electrical  
Protection Gloves  
SCEM 50.43.20.EA



Protective  
Helmet  
Electrical  
SCEM 50.43.30.D



NOMEX Jacket  
SCEM 50.45.10.A

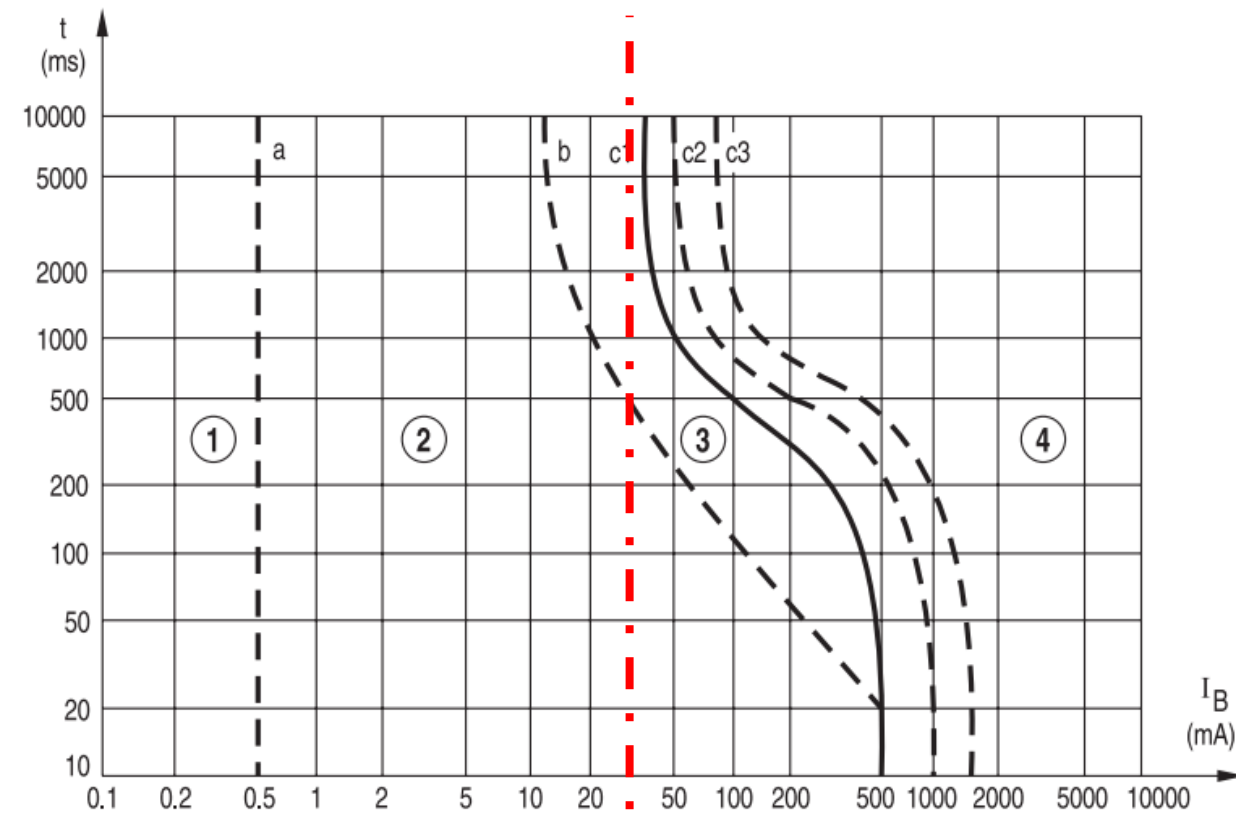


Safety shoes  
SCEM 50.43.10.A



Catalogue - CERN  
Stores

# Consequences- Electrical Shock



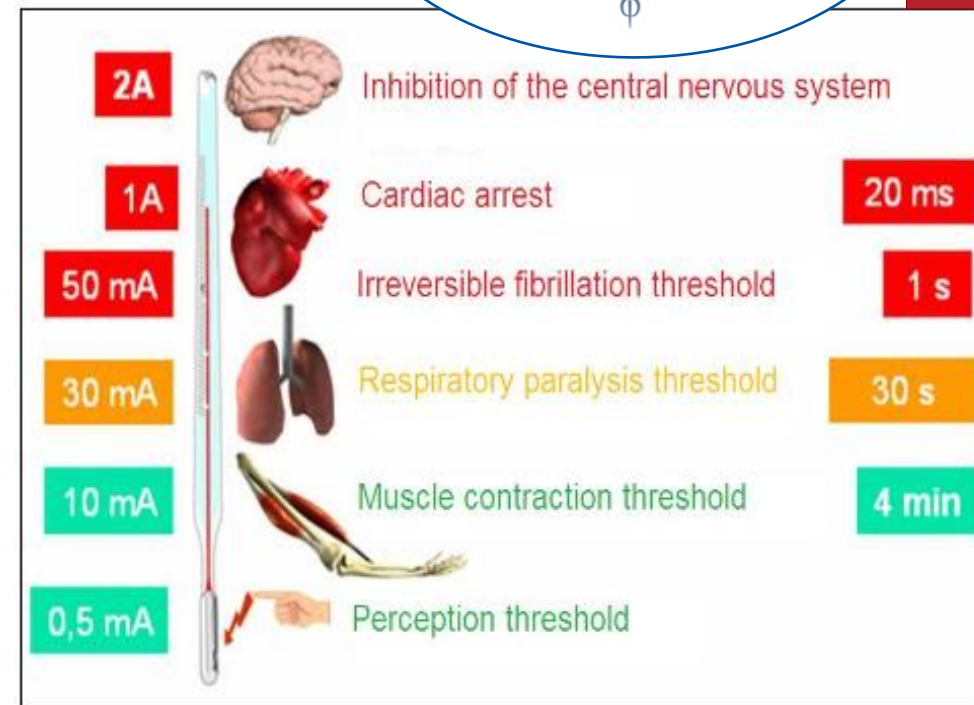
30mA RCD

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

Check-up!

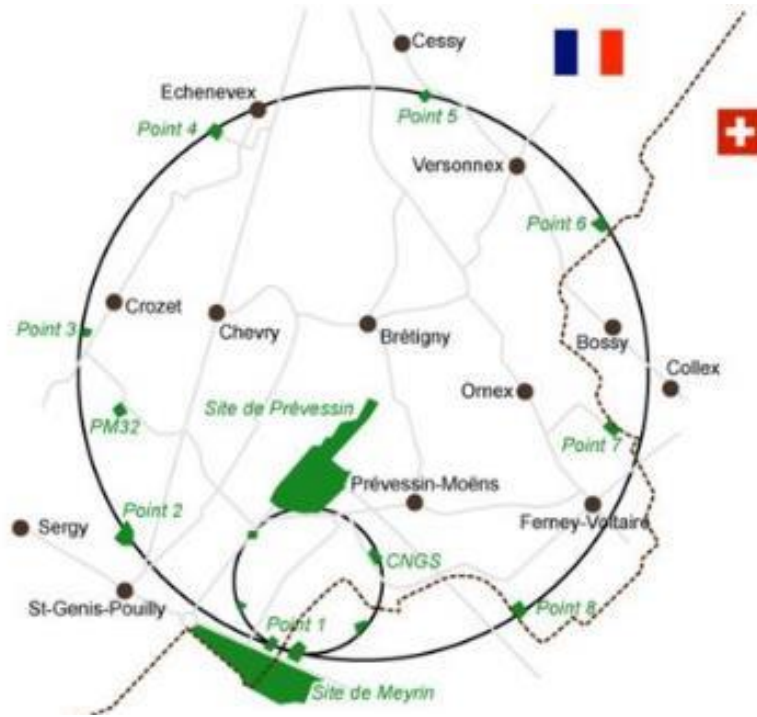


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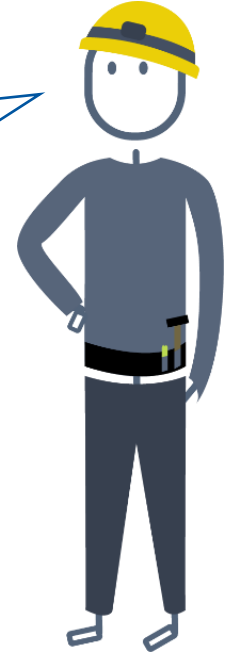


Source: IEC 60479-1

# Rules



Does CERN need to apply Electrical safety standards and if yes, which ones?



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](http://www.cern.ch)