HSE
Occupational Health & Safety
and Environmental Protection unit

# Electrical Safety

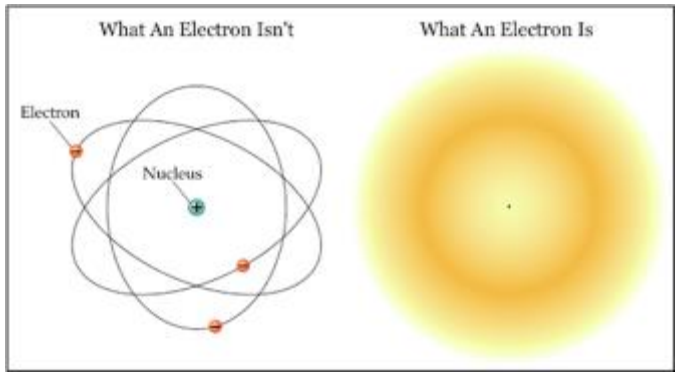
Igor Neuhold

15th September 2023

EDMS reference

# Electricity

It starts with the electron...




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

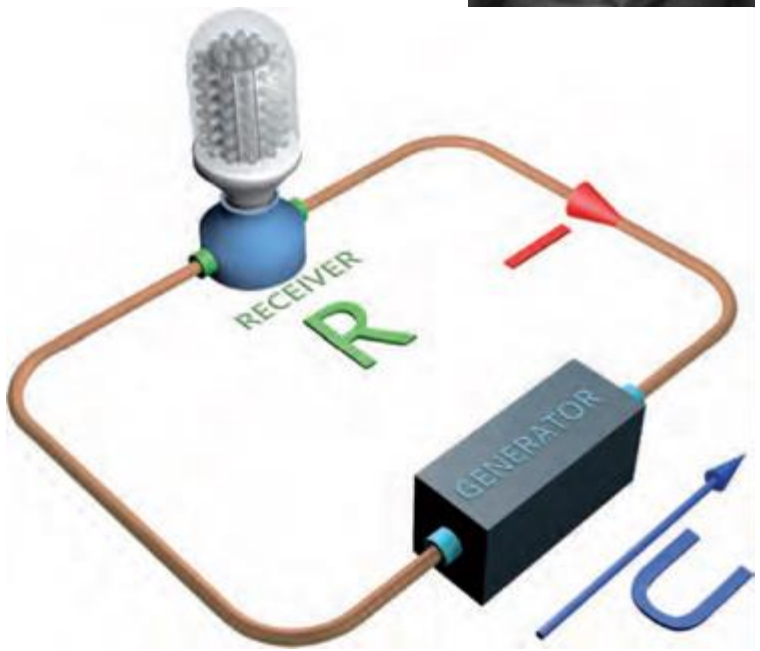
*Schrödinger Equation for the hydrogen atom*

**$U = R \times I$**

*Ohm's law*

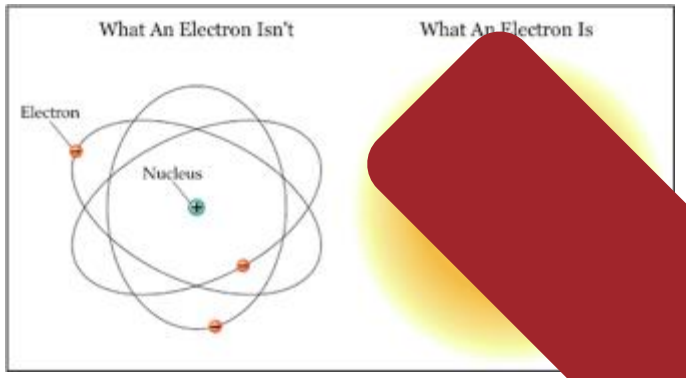
U = Voltage [V]
I = Current [A]
R = Resistance [Ω]

Georg Ohm
1789 -1854



# Electricity

It starts with the electron...




Georg Ohm
-1854

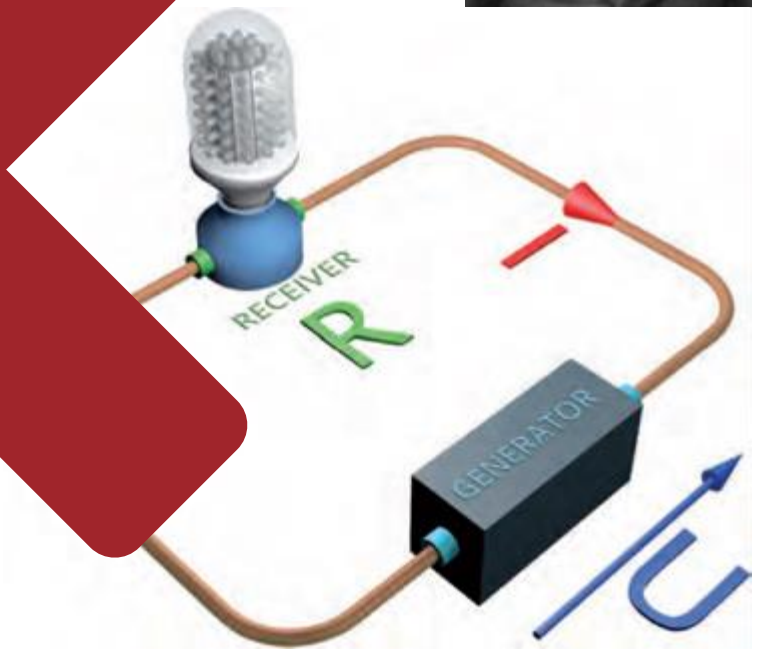
$$\hat{H}(r,\theta,\varphi)\psi(r,\theta,\varphi) = E\psi$$

*Schrödinger Equation for the h*

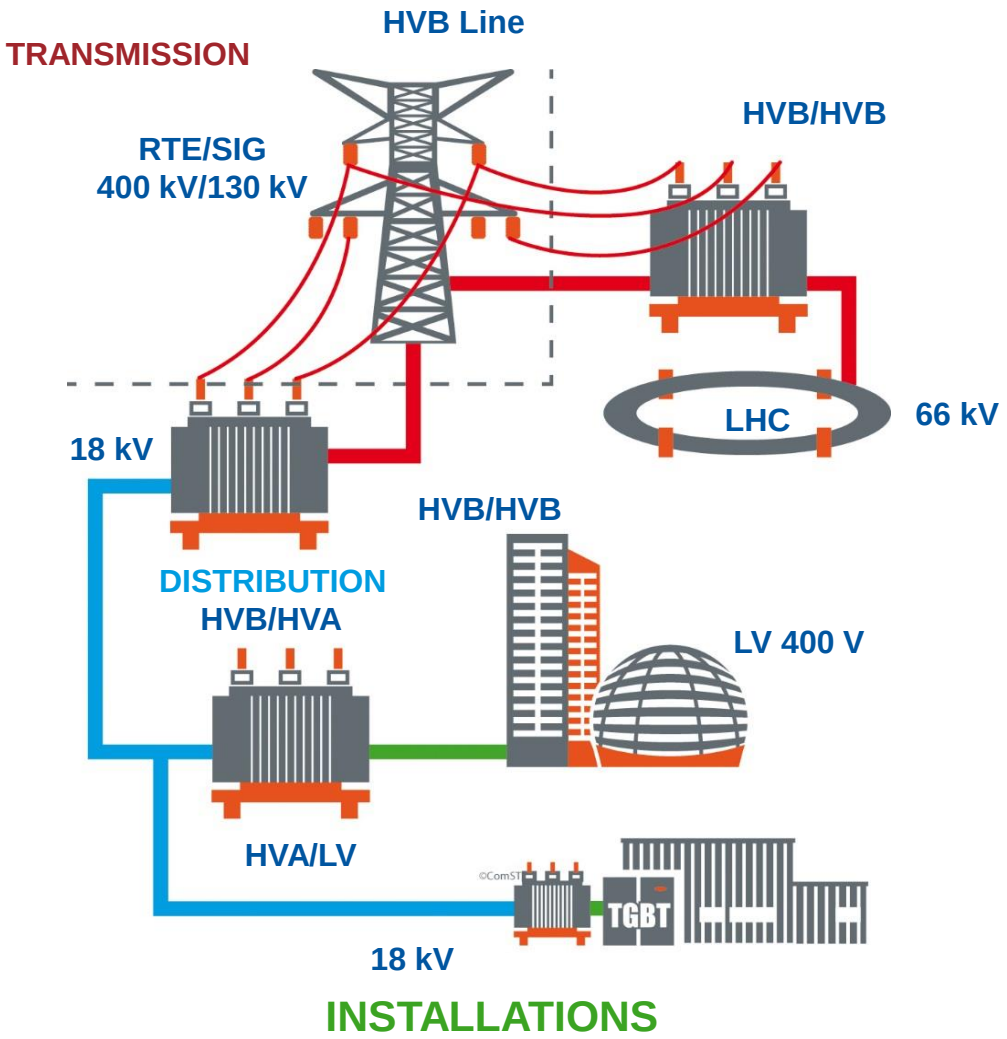
**$U = R$**

*Ohm's*

U = Voltage [V]
I = Current [A]
R = Resistance [Ω]

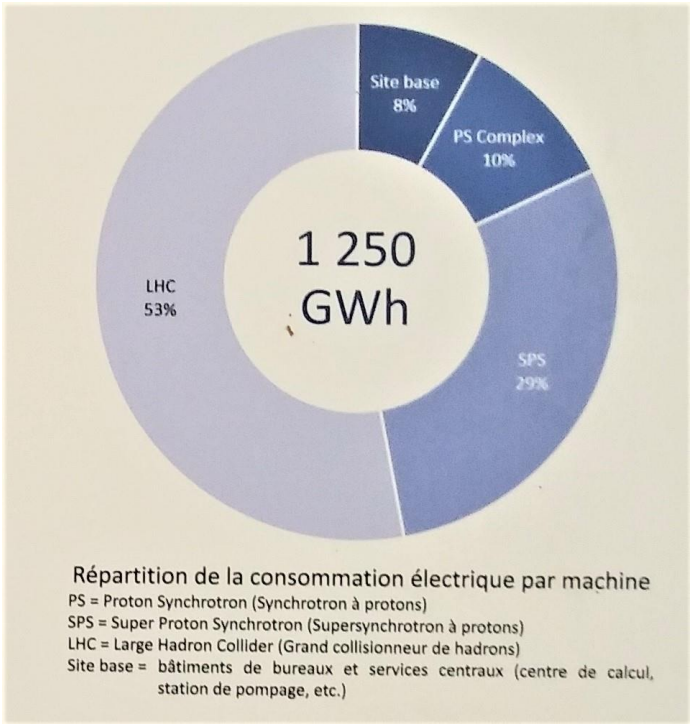


# Electricity

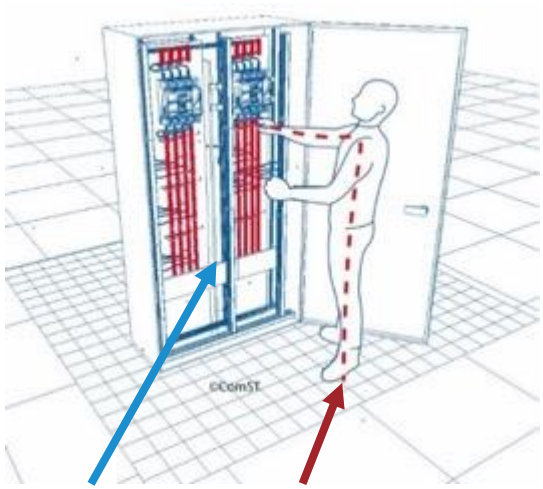


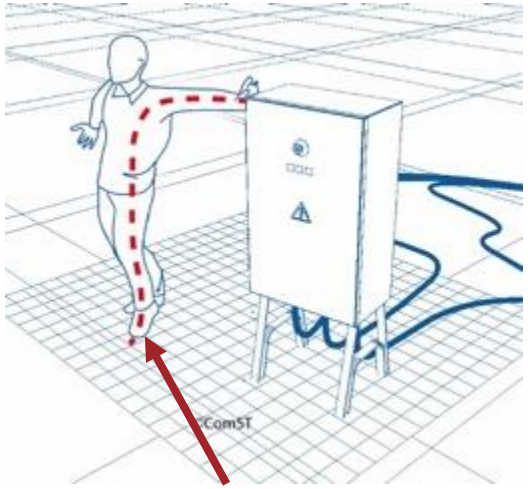

CERN uses 1.3 TWh of electricity annually.

That represents approximately a third of the consumption of the Canton of Geneva.



# Types of risk




**Electric contact**

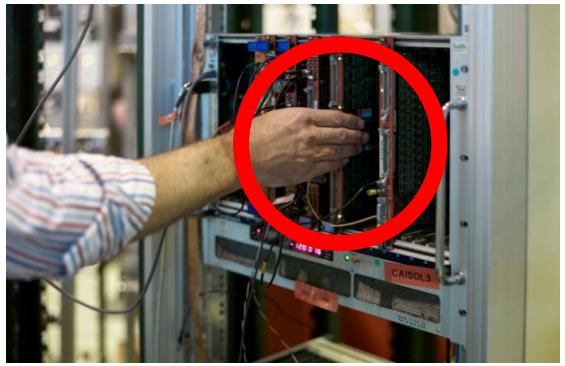
Direct / Indirect

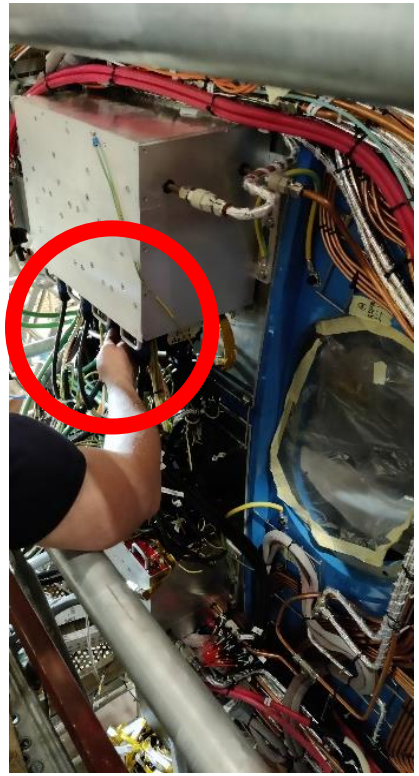
**Electrical Arc**

**Electrical Fire**

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

Direct contact

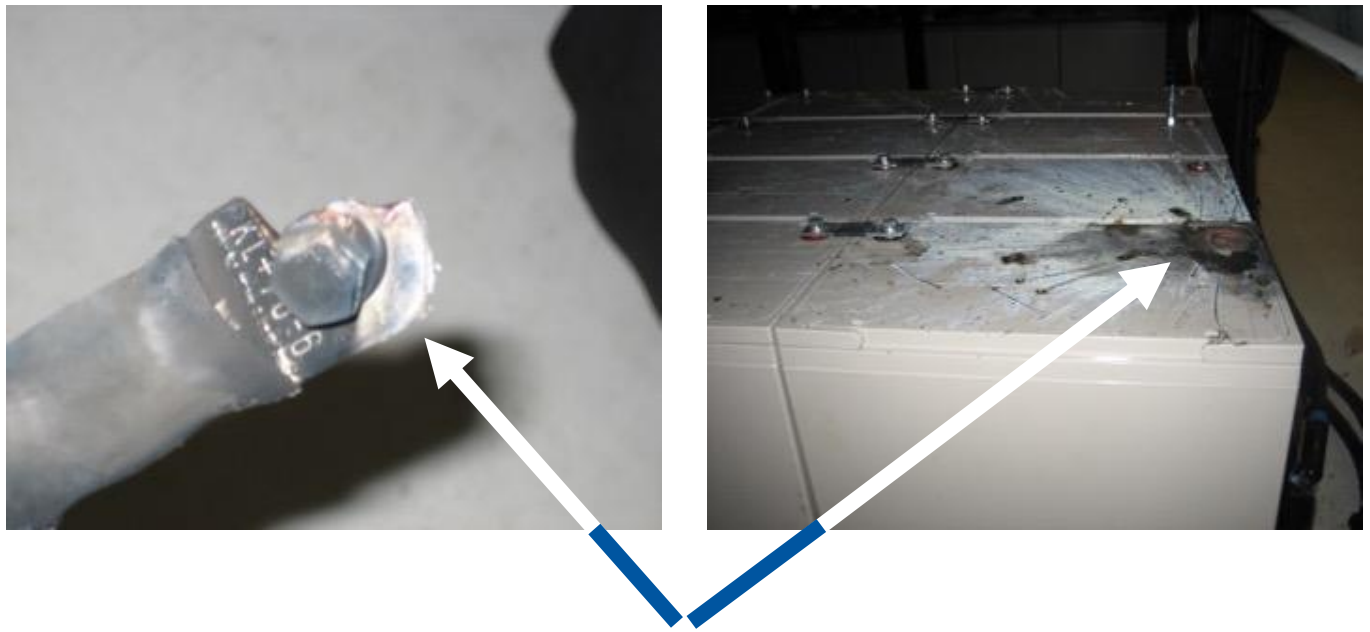




Indirect contact

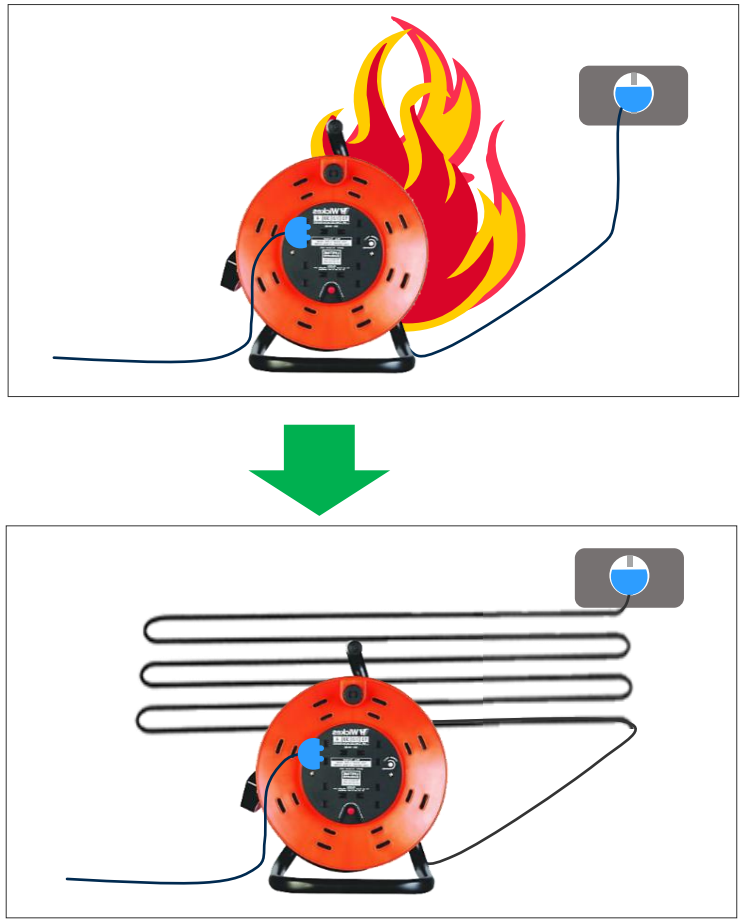
# Electrical arc

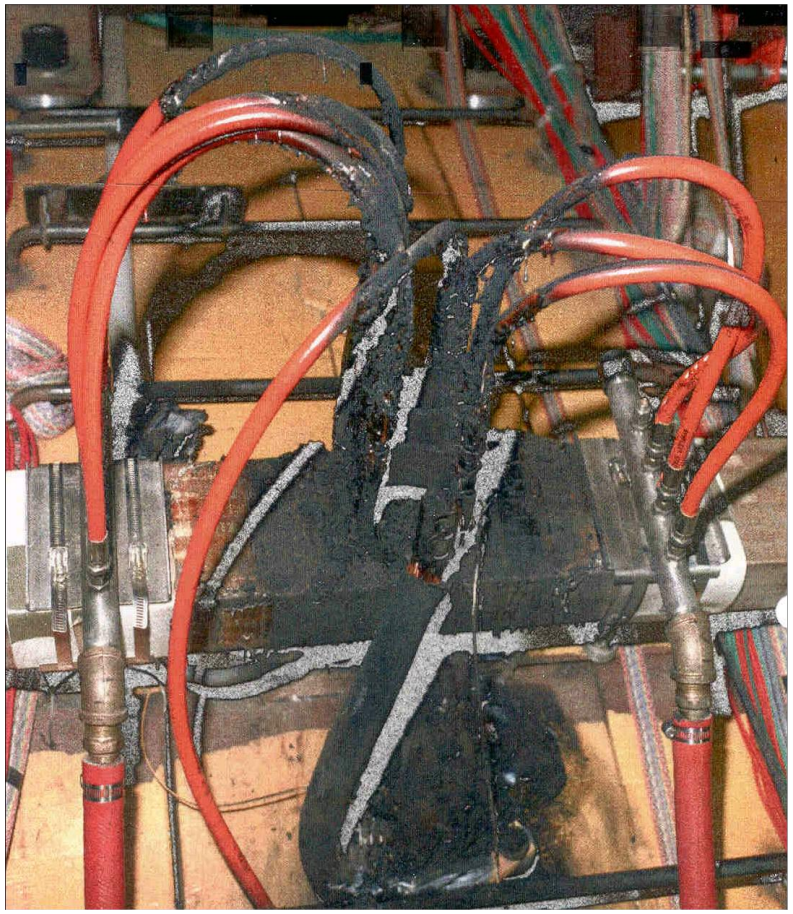
By touching a cable to the battery, a short circuit was produced.
It created an electric arc which burned the victim's right hand.



*Cable and battery in short circuit*

# Electrical Fire





# Non-electrical work

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

**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.

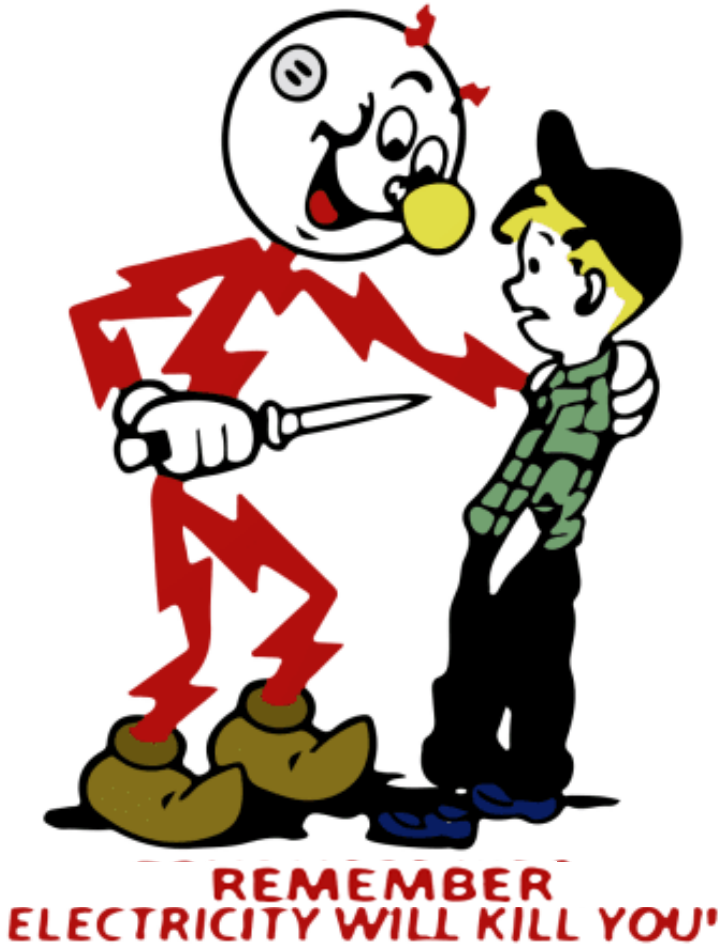
Drilling near live cables has significant risk.

# Electrical Hazards (at CERN)

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

**Do you know <u>who</u> to contact?**

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




**Always check** your equipment before performing any work.

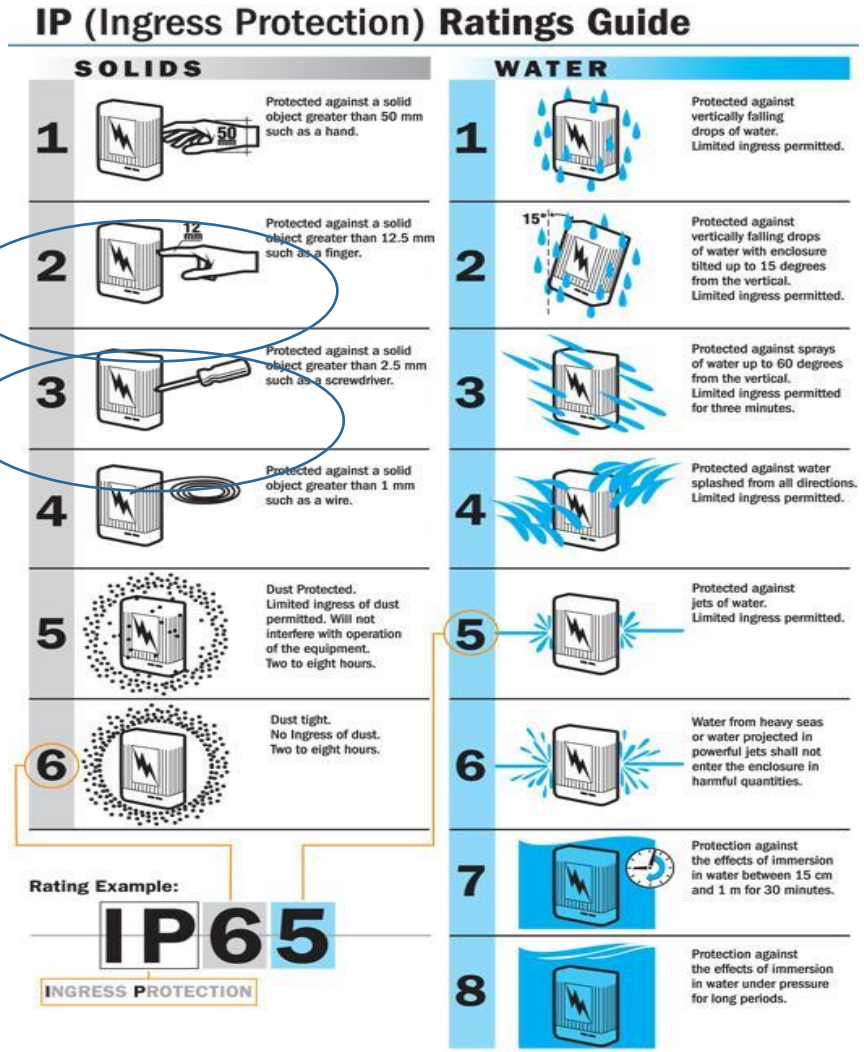
**Always check** your working environment before performing any work.

# 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.

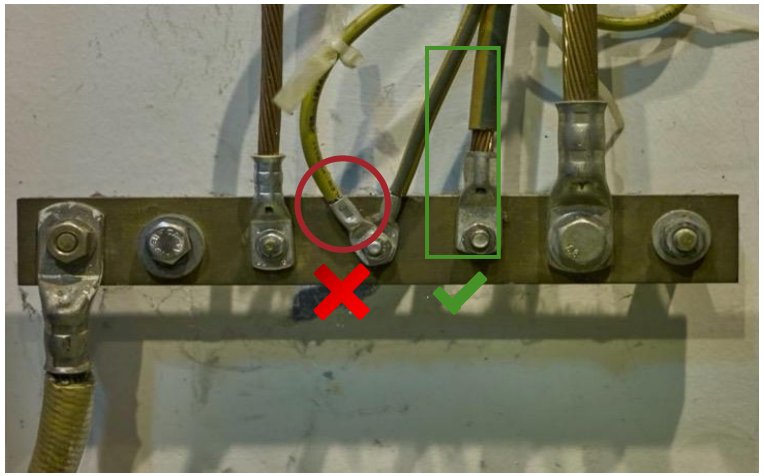
*Test Fingers*



# Grounding – Indirect contact

## Earthing = Grounding

*earthing mm² = phase conductor mm²*

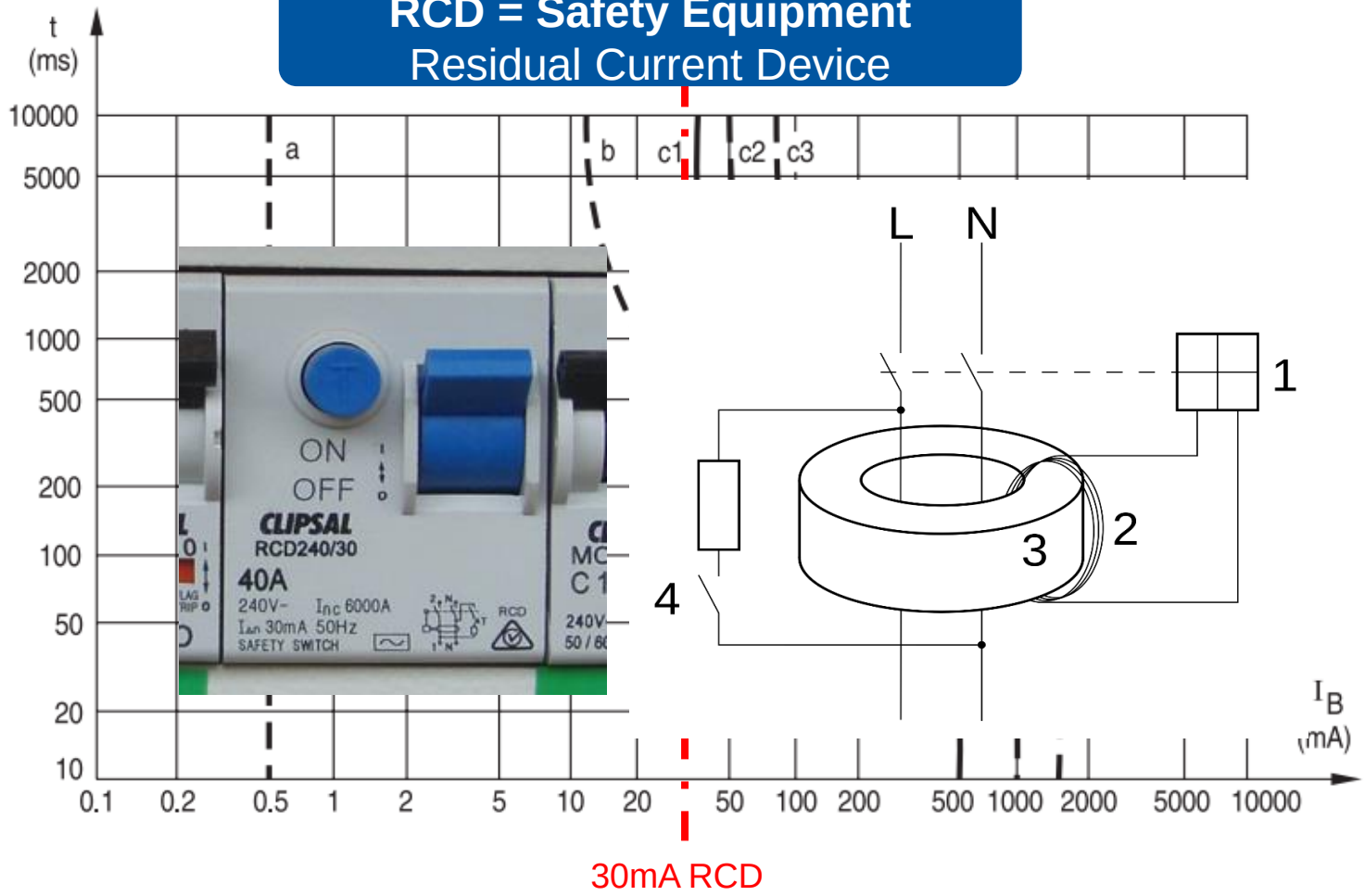


*1 cable = 1 connection point*

- 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




*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

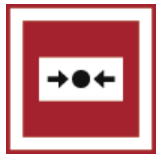
Cuts power only locally (room/zone). Does not call the fire brigade.


## **AUE** - Equipment Emergency Stop

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

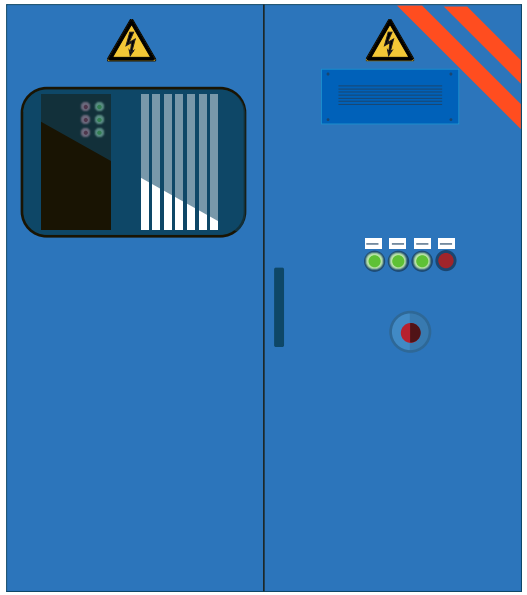

## Evacuation alarm

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).

# PPE and tools

## Personal Protective Equipment (PPE)

Electrical Protection Gloves
SCEM 50.43.20.EA

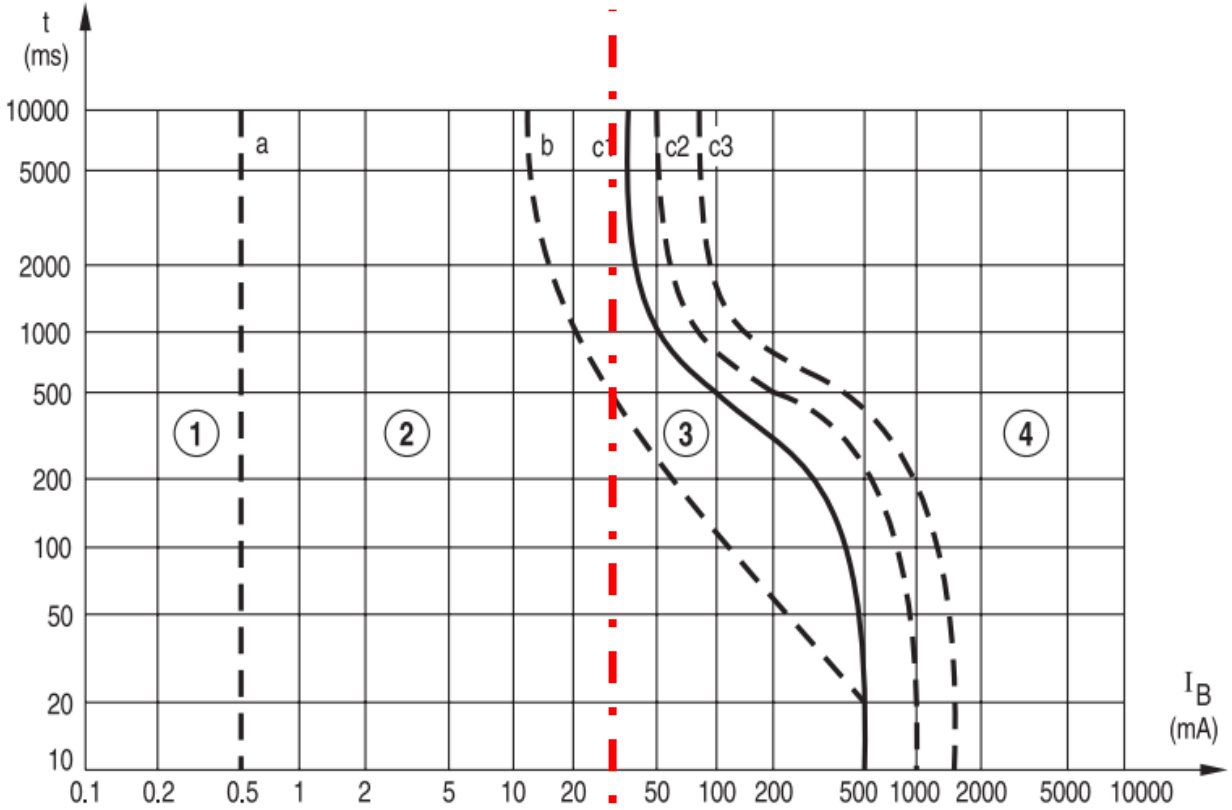
Protective Helmet Electrical
SCEM 50.43.30.D

NOMEX Jacket
SCEM 50.45.10.A

Safety shoes
SCEM 50.43.10.A

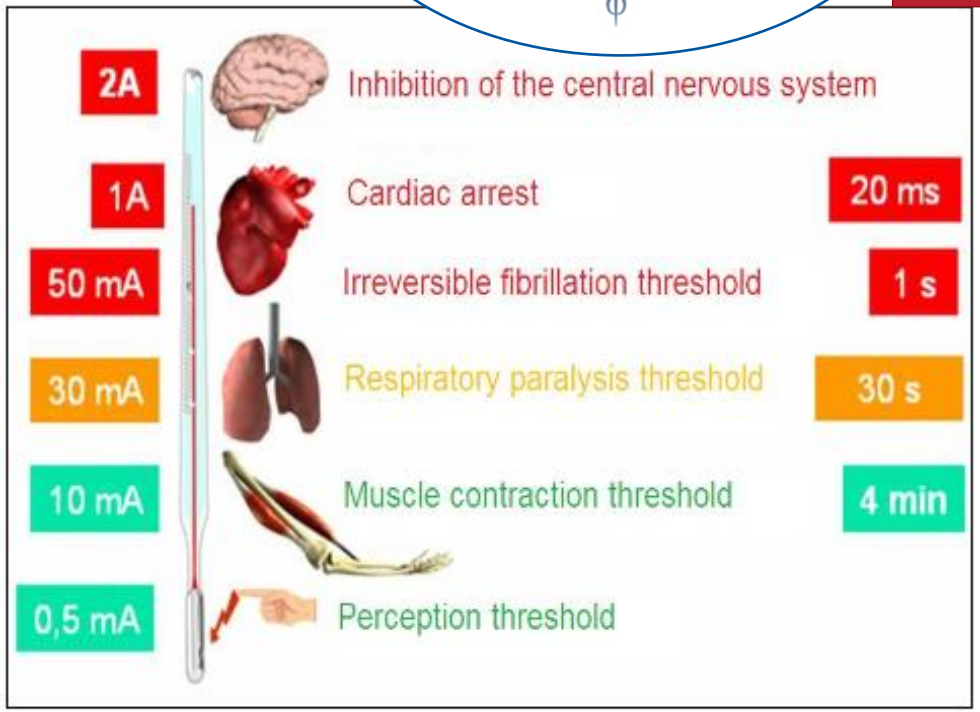
Catalogue - CERN Stores

# Consequences- Electrical Shock




30mA RCD

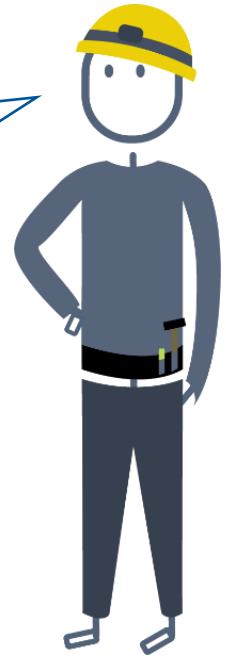
Time / current zones of effect of AC current (15 Hz to 100 Hz) on human body


*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