# ELECTRIC RISK

# OUTLINE

**The electricity and its risk**

- What is electricity (current, voltage)
- What the pathological effects
- The human body inserted in the electrical circuit

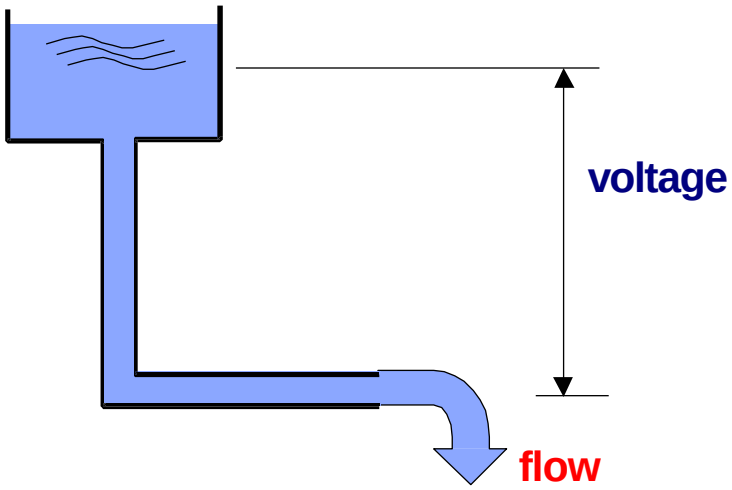
**Technical rules and laws**

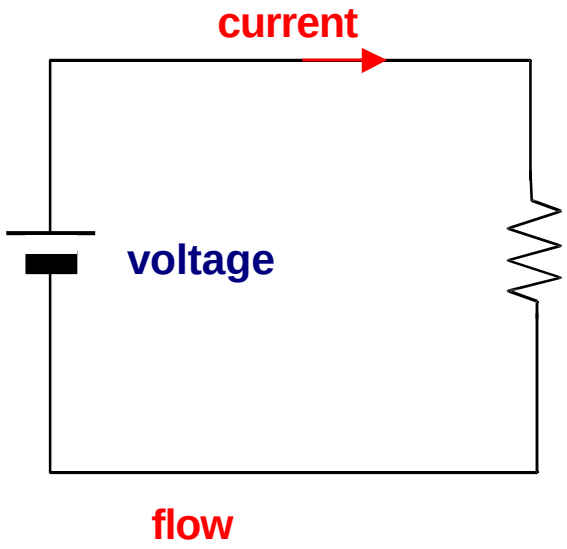
- Comparison between technical rules and laws (the “new approach”)
- Some concepts of technical rules for the worker

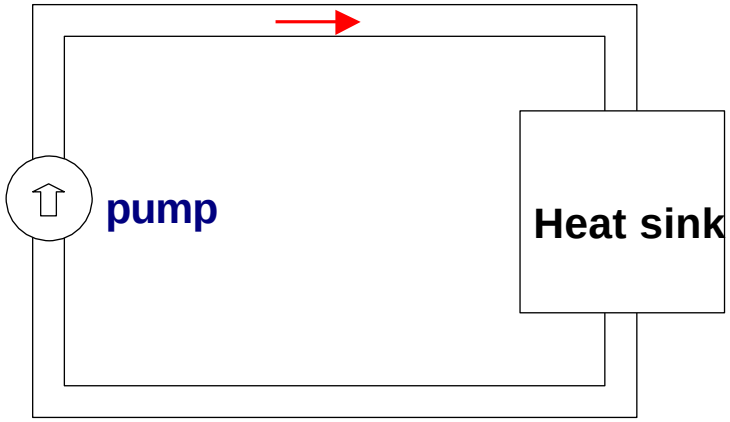
**Hints behavior**

# The electricity and its risk

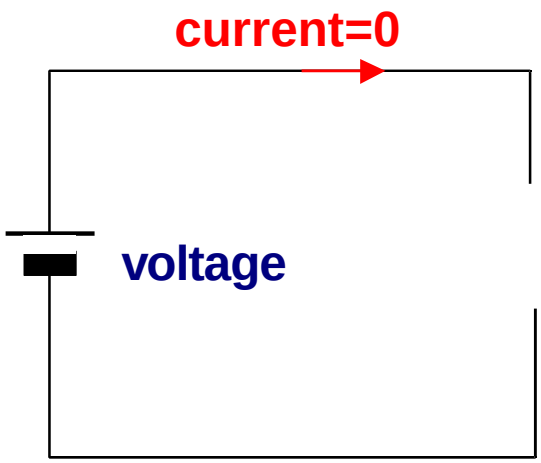
# Current and voltage (hydraulic analogy)

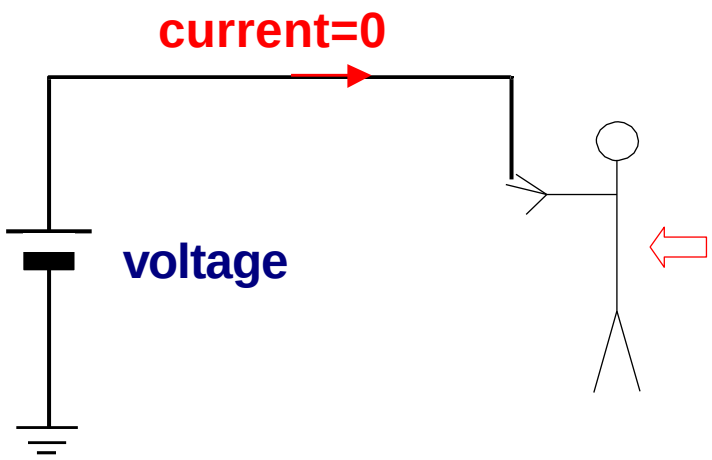


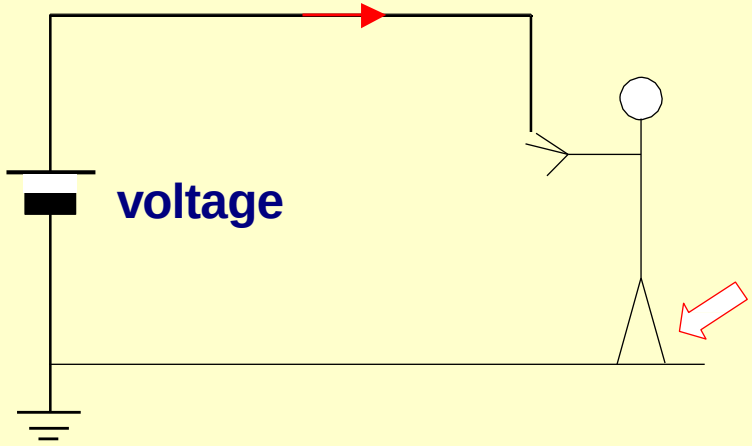
# Current flows ALWAYS in closed circuits, and in which there is a potential difference!



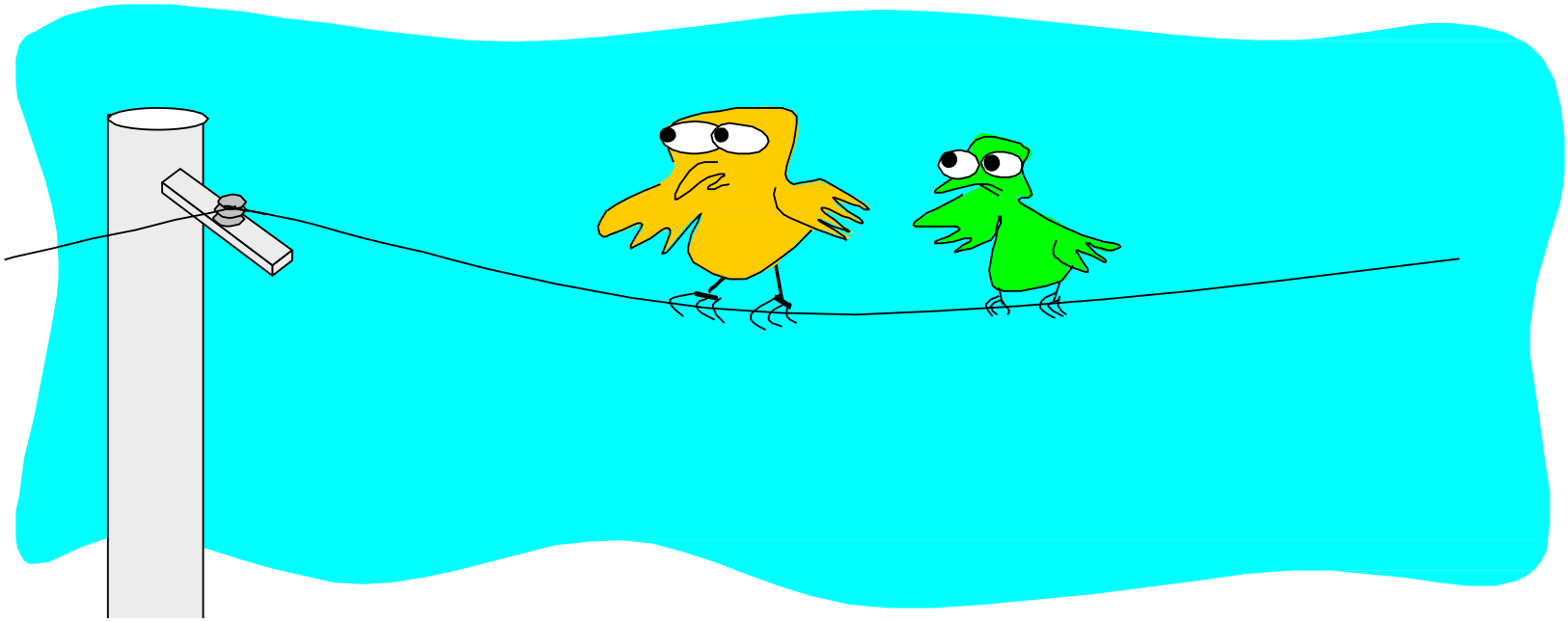

If the contact is only a point (hands), the current can not flow

**The current can flow!**




**Warning !!**
**Almost always our feet are the second point of contact!**

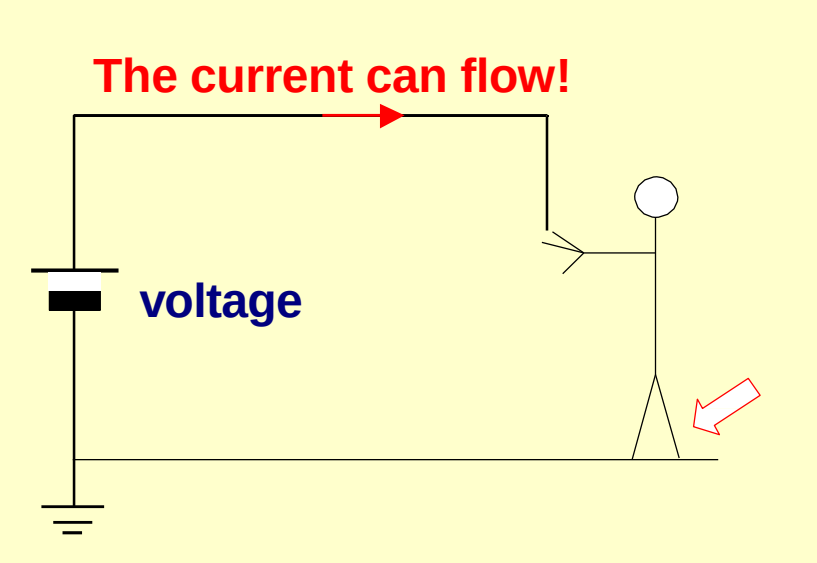
# Experimental test...



Birds on a high voltage cable are not affected by any effect. Indeed, the current can not flow inside their bodies, because they are touching only the cable that is at the same potential in every point. It would be lethal forthem if they touchedthe cable and the pilon support at the same time.

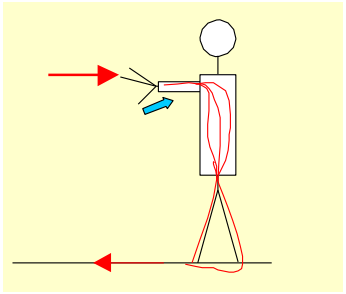
# Dangerousness of electric current: introduction

**The patological effect of electricity are caused by external currents flowing through our body**

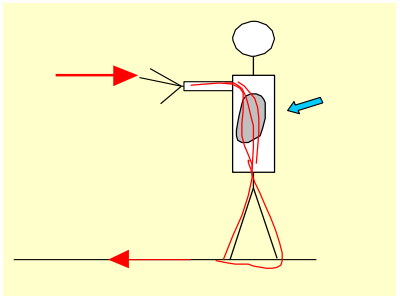



- The body is regulated by biological impulses that govern the voluntary contraction of the muscles
- The intrusion into the body of an exogen current, especially alternating current, superimposed to the biological current and confuses the body. Depending on the intensity, duration and current path, we can have involuntary contractions of various types of muscles.

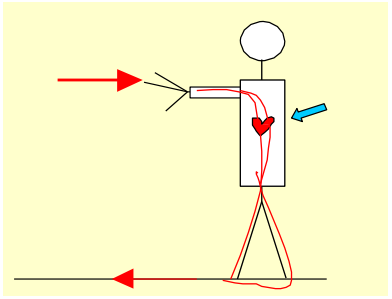
# Pathological effects: qualitative description



- Hand-foot (or hand-hand) contact, and little current: tetanic contraction of the muscles of the limb.

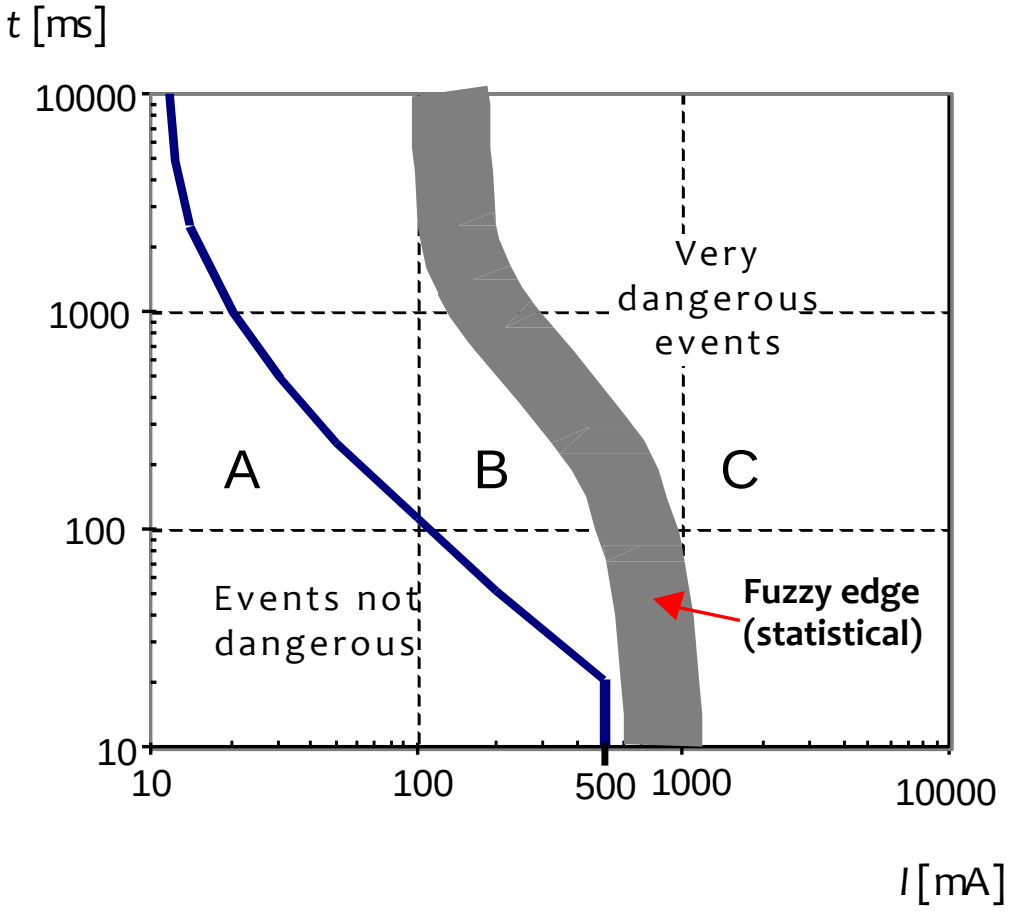


- for heavier current: possible respiratory arrest (involuntary contraction of the muscles of respiration or blocking of the nerve centers that oversee respiration). Normal breathing starts over again when you disconnect: therefore if the duration is not excessive the event does not involve permanent damage.



- for even more intense current: the possibility of ventricular fibrillation. This event does not cease with the cancellation of the current, and almost always leads to death.

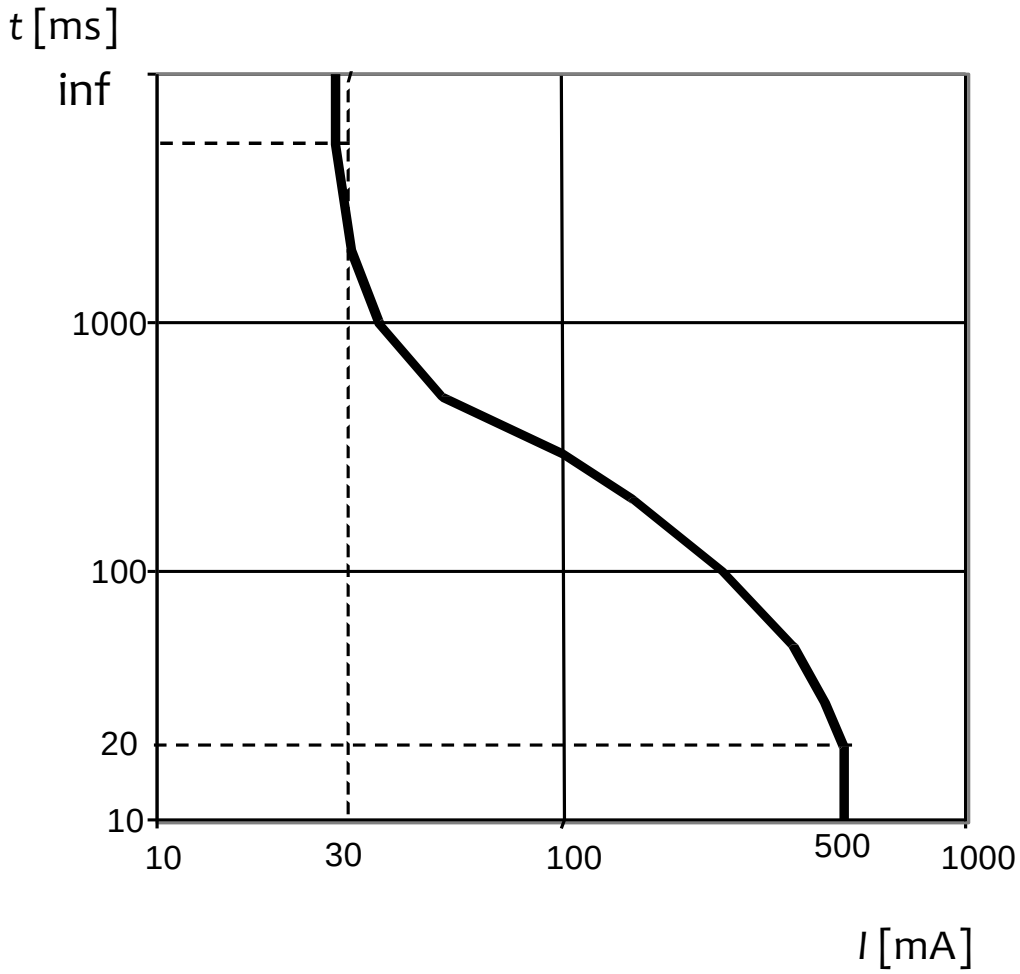
# Pathological effects: quantitative assessment (IEC 479)




**dangerous events**

- Zone A: characterizes events not dangerous
- Zone B: tetanisation muscle; possible respiratory arrest
- Zone C: Likely ventricular fibrillation

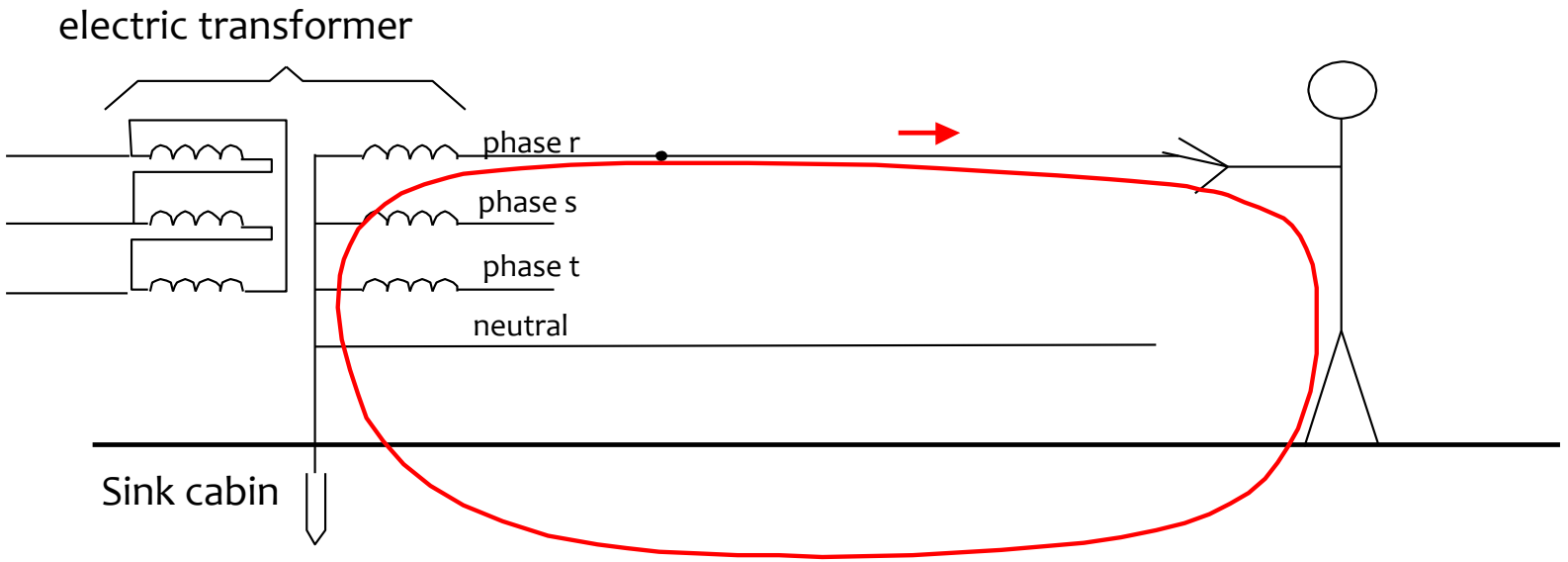
# Pathological effects: conventional safety curve




**notice:**

- Up to 30 mA current is not considered dangerous
- Currents of 0.5 A are very dangerous whatever the exposure time
- Obviously, a current that acts directly on the sensitive parts are dangerous also at much smaller intensities. For cardiac catheterizations, for example, are considered dangerous 30uA !!
- To get an estimate of the current (in A) that passes through us you can divide the voltage (in V) for 1000: 230 V means about 230 mA through the body (really dangerous!!)

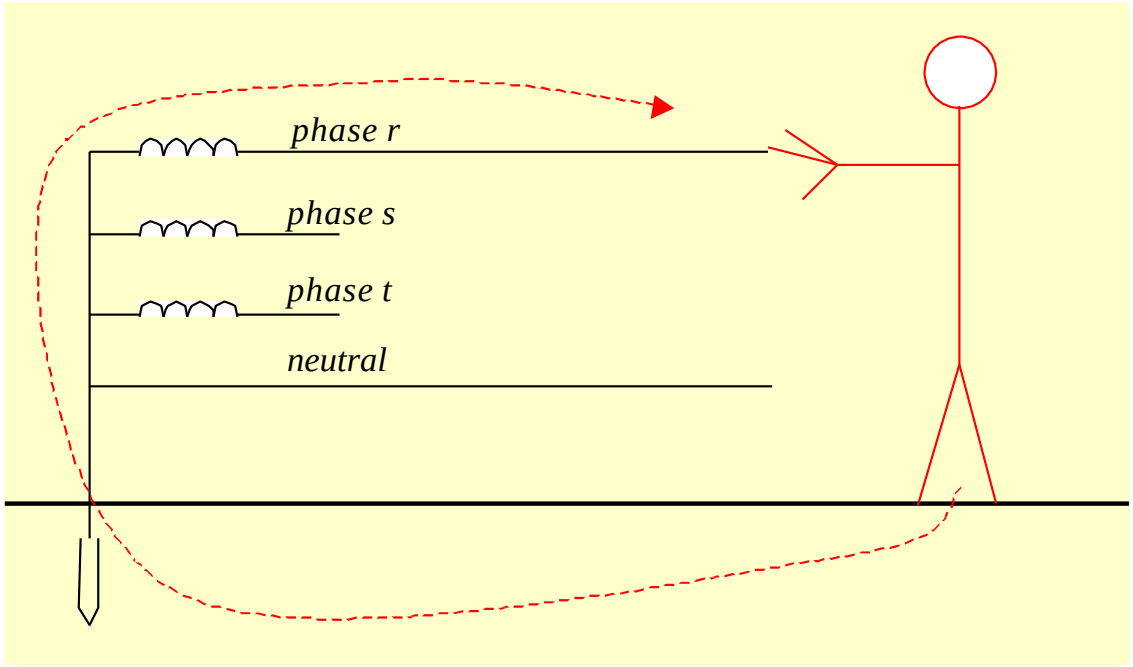
# The human body and the electricity grid: how do you close the circuit?




- In the most frequent case (contact hand-foot) the current flows through the feet, and then through the soil, to close again through the earth sink of the MV/LV transfomer of the distributor, which is always present.

- The condition of the contact of the food are crucial: if you are barefoot and wet, it is much more dangerous than dry feet with shoes; insulated shoes nullify the risk.

# Direct conctats




- Direct contacts are contacts with parts at electric potential
- How do we protect ourselves? Essentially with the conductor insulation: insulating, casings.
- In a plant well made, direct contact occurs only if the user removes the insulation voluntarily, without first powering down the circuit.

# Contatti diretti – Protezione IP

**The degree of protection provided by an enclosure is identified quantitatively from IP code: IPXX or IPXXY**

- The first digit indicates the level of protection against the entry of solid bodies within the casing; this protection also means protection against access to dangerous parts

- The second digit indicates the level of protection against the water ingress inside the case

- The first additional letter is used to specify the level of protection against access to parts that may create specific dangers to humans

Examples
IP40: protected against the ingress of foreign bodies having a diameter of 1 mm or greater; unprotected against ingress of water
IP55: Protected against dust and against water jets
IPXXB: protected against access to dangerous parts of a finger; protection against the ingress of extraneous object and water not specified
IPXXD: protected against access to dangerous parts of a wire; protection against the ingress of extraneous object and water not specified

# Direct contacts – IP Requirements

**IP values prescribed in domestic areas**

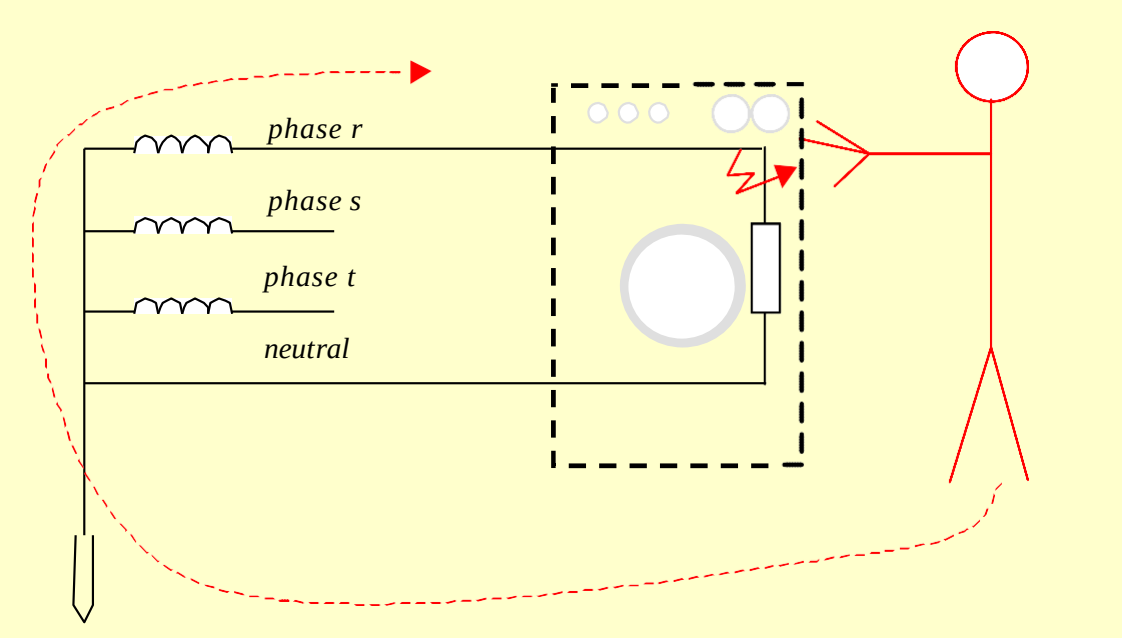
- **protection IPXXB  for all parts of the electric PLANT**

It may be that we have temporarily lower degrees of protection during the replacement of the plant components: typical is the case of changing bulbs.
*An IP20 enclosure is also IP XXB (not vice versa)*

- **protection IPXXD for all horizontal surfaces of casings that are handy**

The Horizontal parts are in fact more dangerous, since in the horizontal holes it is more likely that thread-like conductor objects fall in, causing dangerous situation, it is stipulated that there must be no access to active parts with non-zero potential with a wire of standard features.
*An IP40 enclosure is also IP XXD (not vice versa)*

# Indirect contact




- The indirect contacts are contacts with parts that normally are not at potential, but which are at potential as a result of a insulation failure.
- The indirect contacts are much more unexpected than the direct contacts, since the user is endangered by contact with a part that can normally be touched, and of which trusts.

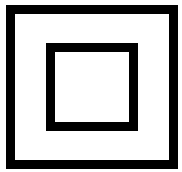
**How do we protect ourselves?**
The most popular way is the use of leakage circuit breakers in combination with a good earthing system: if it happens a breakdown of insulation, the circuit breaker interrupts promptly the supply.

# Indirect contacts - Three modes of protection

It is good that you have a basic level of awareness of the three types of protection from indirect contact:

1. Automatic interruption of the circuit
A switch break off the power if a insulation failure occurred. For correct operation the switch (a leakage circuit breaker) must be associated to a good earthing system.

2. Double insulation or reinforced insulation
In there systems the possibility that the user could touch a part connected at potential is negligible. Therefore it is not necessary to provide the automatic interruption of the circuit.
Devices with this type of insulation are called of class II, marked with appropriate symbol (here shown). So we can avoid the use of the central terminal in the thorns, no longer necessary.



3.Very low safety voltage
The protection against indirect contact is assured in the circuits in wich are adopted particularly low voltages: typically 60 V for alternating current (AC) and 120 V for systems for direct current (DC)

# GOOD PRACTICE

# Some simple rules ...

- **The electrical system can only be changed by expert hands.**

An electrical system well-designed and executed is extremely safe. Untrained hands can easily turn an apparatus into a lethal weapon. It is enought, for example, exchange the yellow-green with a phase conductor in a socket !

- **Be afraid of electricity: the presence of the residual circuit breaker does not guarantee the surviving from the electric accidents!**

The residual circuit breaker (life saving) is only additional protection to direct contacts. Therefore touch a bare wire is anyway with highly risk, even if "we have the life-saving". First of all it is not said that the "life saving" installed is the type with "high sensivity". Further it is an element that has to intervene in this case actively to save, and you do not have sufficient guarantees that it will happen, and will happen quickly enough.

- **A case in which you can have access to parts with electrical potential without tampering is the replacement of a light bulb.**

In this case, pay the maximum attention to the electric risk: replace it with concentration, taking great care to maintain the distance from internal parts connected to the potential.

# Some simple rules ...

- **The use of electrical appliances in the shower stall or bathtub is very dangerous**

The Standardization (CEI 64-8) requires the designer to not install outlets in these areas, so as to discourage the user. The user should not override this implicit block with extensions to bring electrical equipment when not allowed!

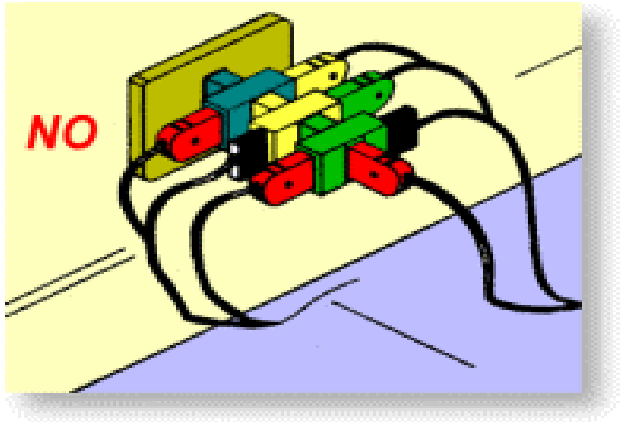
- **Verify the functionality of RCDs periodically**

We recommend performing this  about once a month.
This is a qualitative check and not quantitative, but it is able to discern the most severe and the most frequent failure: the blocking of differential relay.

# Some simple rules...

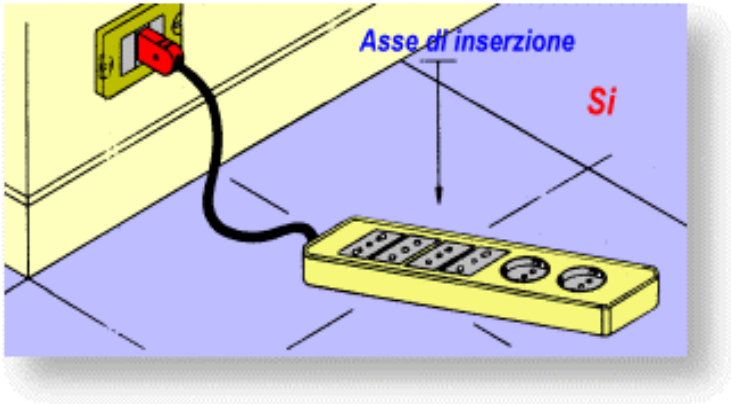
- **Avoid tangles of wires and multiple plugs**

The reason is that the accumulated weight and distance from the wall tends to flex the assembly and remove the thorns closer to the wall.

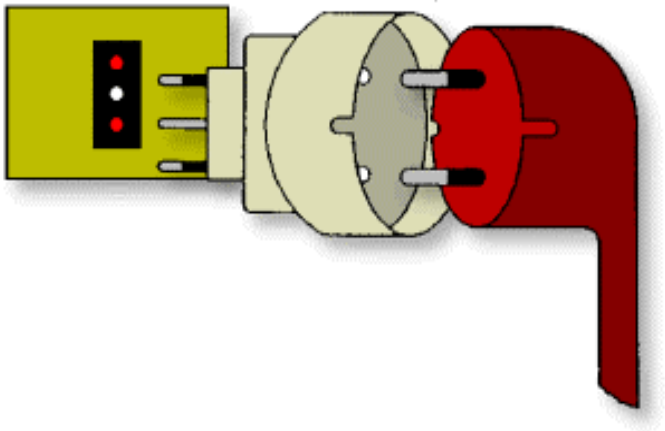



- **Do not exceed the stated maximum total power for power strips (typically 1500 W).**

**NOTE The use of slippers is safe.**
If the system is well designed it cannot give rise to dangerous overloads.
However it is wise to use power strips for small loads entity (few hundred W, leaving the loads larger (eg. electric heaters) connected to wall outlets.



# Some simple rules...



- **Using schuko plug only via adapter**

There is a certain level of mechanical compatibility between schuko plugs in the italian socket plug. In this case the earth is not connected. Therefore if you do not use the adapter you have the correct functionality (with illusion that all is ok), but not safety!

# Finally: a few precautions

An electrical system designed and built to perfection is extremely safe.
It can become unsafe only if used improperly or tampered by inexperienced staff

Examples of misuse are:

- Failure to replace cables "peeled" or insulating parts damaged
- use of incompatible pairs (e.g.: schuko plug in italian sockets)
- use of electrical appliances in areas of the  bathroom is not permitted (and where there are no sockets)
- overconfidence to electricity ("in every case there is the life-saving ...")