Safety at Electrical Engineering

Support presentation for lecture: Safety at Electrical Engineering

Jan Dudek

September 2016

Department of electrical engineering
Faculty of electrical engineering and computer science, VŠB-TU Ostrava

Introduction

- Students of electrical engineering schools may, according to valid rules and laws, operate the electrical equipment and installation in the way which corresponds to their skills and physical condition.
- All work tasks shall be performed only under inspection or under permanent supervision of the person nominated and responsible for laboratory experiments.
- For reasons shown above, the students of bachelors 1st grade or the 1st grade of follow-up master study shall pass the exam of Safety at electrical engineering. The successfully passed exam allows the students to operate electrical apparatus in laboratories of FEECS (FEI)

Legislation - Decree Vyhl. 50/1978 Sb.

Qualification:

Qualification = education + professional experience

Qualification degrees according to Decree No. 50/ 1978 Sb.:

- **§3 ordinary person** (neither skilled, nor instructed)
- **§4 instructed person** (provably instructed, ability of avoiding risks)
- **§5 skilled person** (education, knowledge, experience,ability of avoiding risks and risk assessment)
- **§6-11 skilled person with higher qualification** (prof. experience)

§3,4 is intended for persons wit no education
In the field of electrical engineering

Note:

- **Nominated person on control of an electrical installation**

(nominated for every electrical installation or apparatus)

Introduction – Work safety

Electrical installation of LV = reserved electrical equipment (reserved equipment are also - pressurized-, gas-, lift-)

Person operating electrical installation shall have apropriate qualification according to Decree 50/ 1978 Sb.

Other laws and rules:

Act No.. 262/2006 Sb. – Labour code

Governmental order. 101/2005 Sb. Directive of Czech government – includes detailed requirements for workplaces and working environments

Decree No. 73/2010 Sb. determines the reserved electrical equipment and sets up some close conditions for providing their safety

Decree č. 48/1982 Sb. Directive of Czech Work Safety Institute, this decree specifies the essential requirements to ensure safe working and safe functioning of technological equipment

Etc... (Governmental order 21/2003, Act No 458/2000, Act No 309/2006)

Risks – Dangerous phenomena

Risk = combination of the harm occurrence probability and the severity of that harm

Risks associated with hazards related to electrical devices shall be assessed as the part of complex requirements for risk assessment of work activities

By following the rule, it is possible to assess the adequate risk reduction and necessary measures for risk exposed persons

The aim is to minimize the risks down to „residual risks“ (tolerable risk level) or even the entire removal of these risks.

1.

Risk, hazard, harms, origins

Risk = combination of the probability of occurrence of harm and the severity of that harm

Harm = physical injury, accident, crash

Definition in the scope of this lecture: physical injury or health damage

Hazards

- Machinery, materials, work activities

Definition – potential source of harm

Hazard origins

- Machinery, materials, work activities

Definition –hazard origins activates hazards in concrete (particular) area and time

1.

Risk analysis

It is needed to know input data for risk analysis

- it is necessary to know the situations which did not turned into harm, too

The procedure of risk analysis:

- Hazard identification
- Risk assessment for every source of hazard
- Decision if the hazard level is acceptable

Work Accident reporting

According the local legislation (Act No. 262/2006 Coll., **all work-related accidents shall be reported – no matter how minor**

The responsible person for completing the report is the employee, at university lecturer or other university staff in charge with control of work activity

The record shall contain the following

1. Date time and a place of the accident;
2. Name of the casualty and work-related injury description (part of a body, type of injury);
3. The work activity during which the injury happened;
4. The number of working hours during shift prior to the accident occurrence
5. Source of the injury (electric energy, mechanical energy, etc...)
6. Name of witnesses, name and work position of the person, who recorded the work accident report

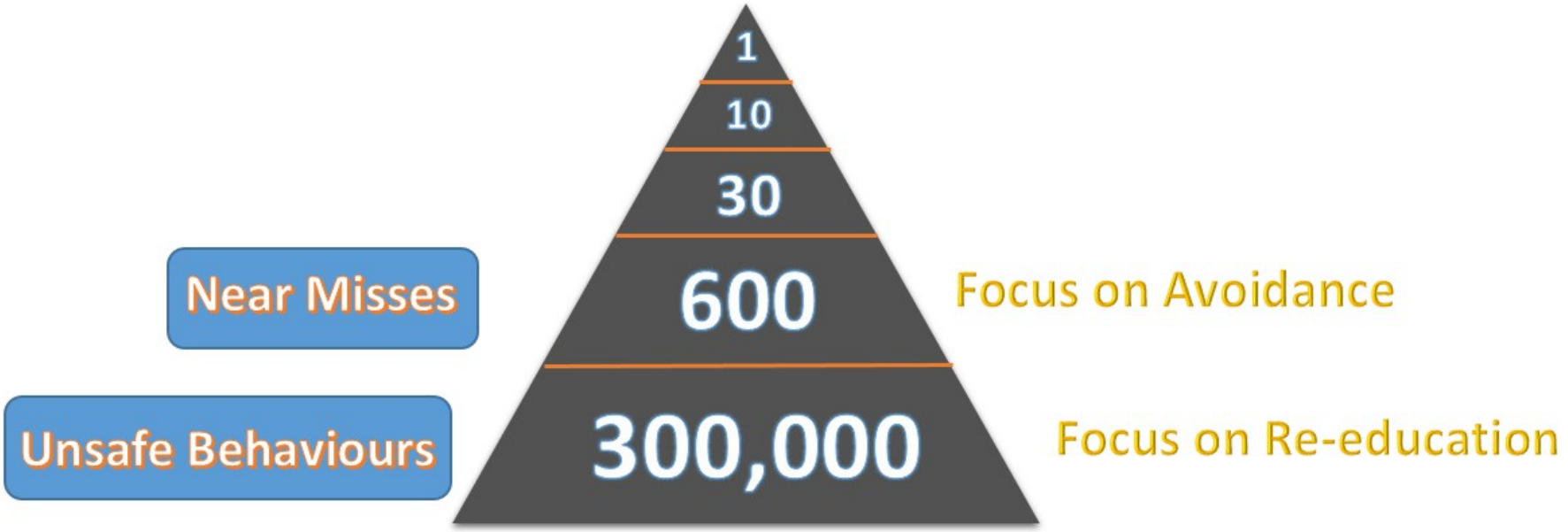
Near miss

A Near Miss is an unplanned event that did not result in injury, illness, or damage – but had the potential to do so. Only a fortunate break in the chain of events prevented an injury, fatality or damage; in other words, a miss that was nonetheless very near.

The Safety Triangle refers to a ratio which has come to define many safety practices and policy developments to date – 1-10-30.

According to Czech legislation – near misses and/or faults at workplace that may jeopardize workers shall be announced to superordinate person (lecturer).


Major Injury
1
Highly Unlikely
Severe Accident
10
Very Unlikely
Property Accident
30
Unlikely


1
10
30
Near Misses
600
Focus on Avoidance
Unsafe Behaviours
300,000
Focus on Re-education

Basic principles of electric shock protection

Definitons

Live part: conductor or conductive part that is used for conducting the current during normal operation (part is energized)

Exposed conductive part: conductive part of electrical apparatus that is not ususally live, but may become live in case of basic insulation fault

Hazardous live part: live part that may, upon certain conditions, cause the electrick shock

Basic insulation: insulation of hazardous live parts, which provides the basic protection

Supplementary insulation: supplemetary (independent) insulation used, besides to the basic insulation, for providing the fault protection

Double insulation: insulation comprising both basic and supplementary insulation

Protective earthing:

Equipotential bonding: electrical interconnection between conductive parts = potential balancing

Protective equipotential bonding: interconnection of exposed conductive parts for safety purpose

Identification of conductors by alphanumeric or colours in LV electrical installation

Insulation conductors colour:

Network system TN-S

Phase (L): BLACK / BROWN/ GREY

Neutral conductor (N): Light blue

Protective condductor PE: Green-yellow

Network system TN-C:

Phase (L): BLACK / BROWN/ GREY

Protective and neutral conductor PEN: Green-yellow (with blue markings -creeling – at both conductor terminals)

Orange colour is prefered for marking conductors in fixed installation not disconected by main switch/circuit breaker

Colours of painted bare conductors, busbars e.g. substation:

Network system TN-S

Phase (L): ORANGE (phase order is marked with black stripes)

Neutral conductor (N): Light blue

Protective conductor PE: Green-yellow

Network system TN-C:

Phase (L): ORANGE (phase order is marked with black stripes)

Protective and neutral conductor PEN: Green-yellow

DC installation –

+ (positive pole) – red

- (negative pole) – dark blue

Identification of conductors by alphanumeric or colours in LV electrical installation - cont´d

Red – machinery control circuits installation – AC power supply

Dark blue - machinery control circuits installation – DC power supply

Important note: Green-yellow colour and light blue colours are so called codified colours, i.e. the conductor shall not be used for other function than for PE and N respectively

Note 1 – Except of codified colours (mandatory) other conductor colours are preferable (i.e. its funciton may be changed in some extraordinary situation)

Note 2 – The old installation may use green conductor as PE and neutral conductor may be of grey colour – still valid for some equipment imported from the USA

2.

Actuator (button) colour

Push-button Start/On: White, black, green, grey

!!! never red !!!!

Push-button is NO type (normally open)

Push-button Stop/Off: Black, white, red, grey

!!! never green !!!!

Push-button is NC type (normally closed)

Push-button total/emergency stop:

Red with yellow reflex background

Push-button is NC with arrestment (remains in open position after pressing)

2. Colour encoding warning labels and tables

Orange, yellow – warning, possible hazard

Green – Informative, marking

Blue – order, explanation

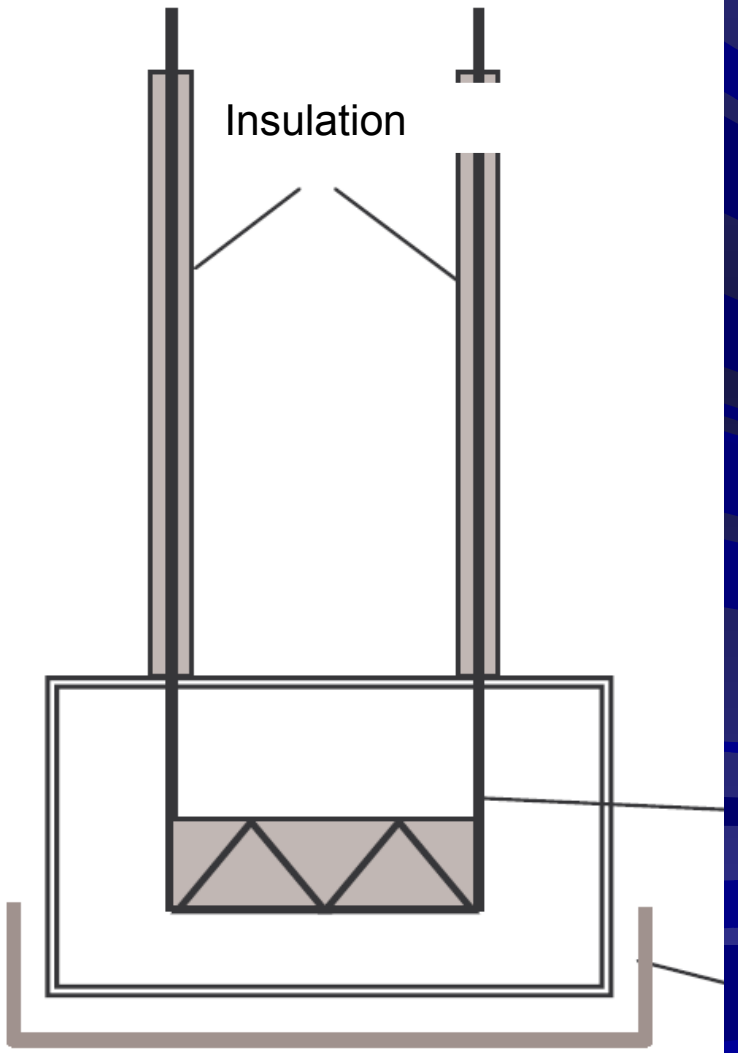
Red – ban, what to avoid

Basic principles of protection against electric shock HD 60364 – 4 – 41 :2007, plus EN 61140

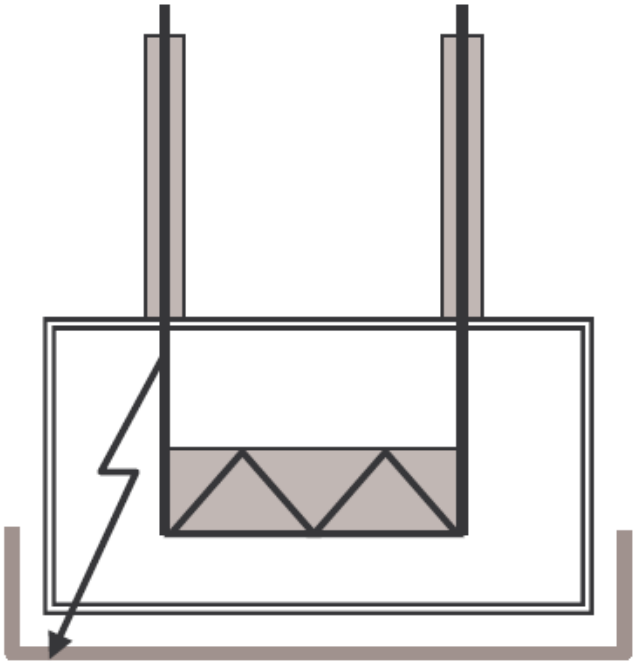
Basic rule of protection against electric shock:

Hazardous live part must not be accessible and accessible exposed conductive parts must not be hazardous live neither in normal service conditions (intended use without fault) nor in case of one fault

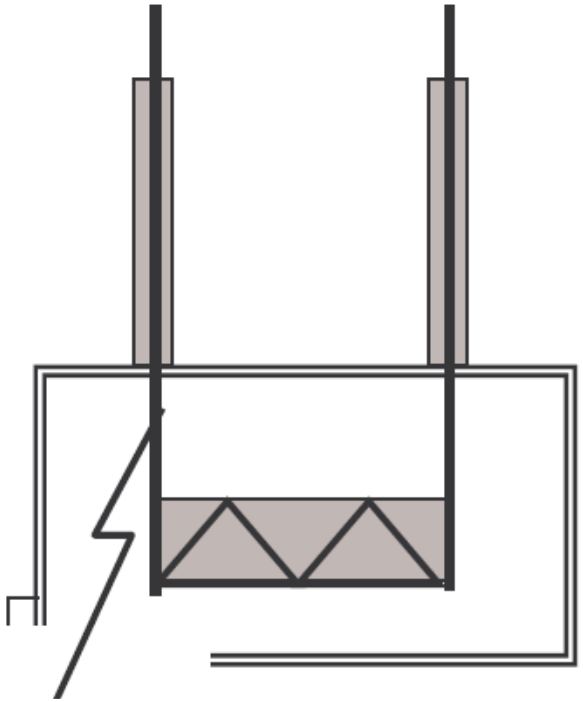
Basic principles of protection against electric shock - explanation



Basic principles of protection against electric shock - explanation



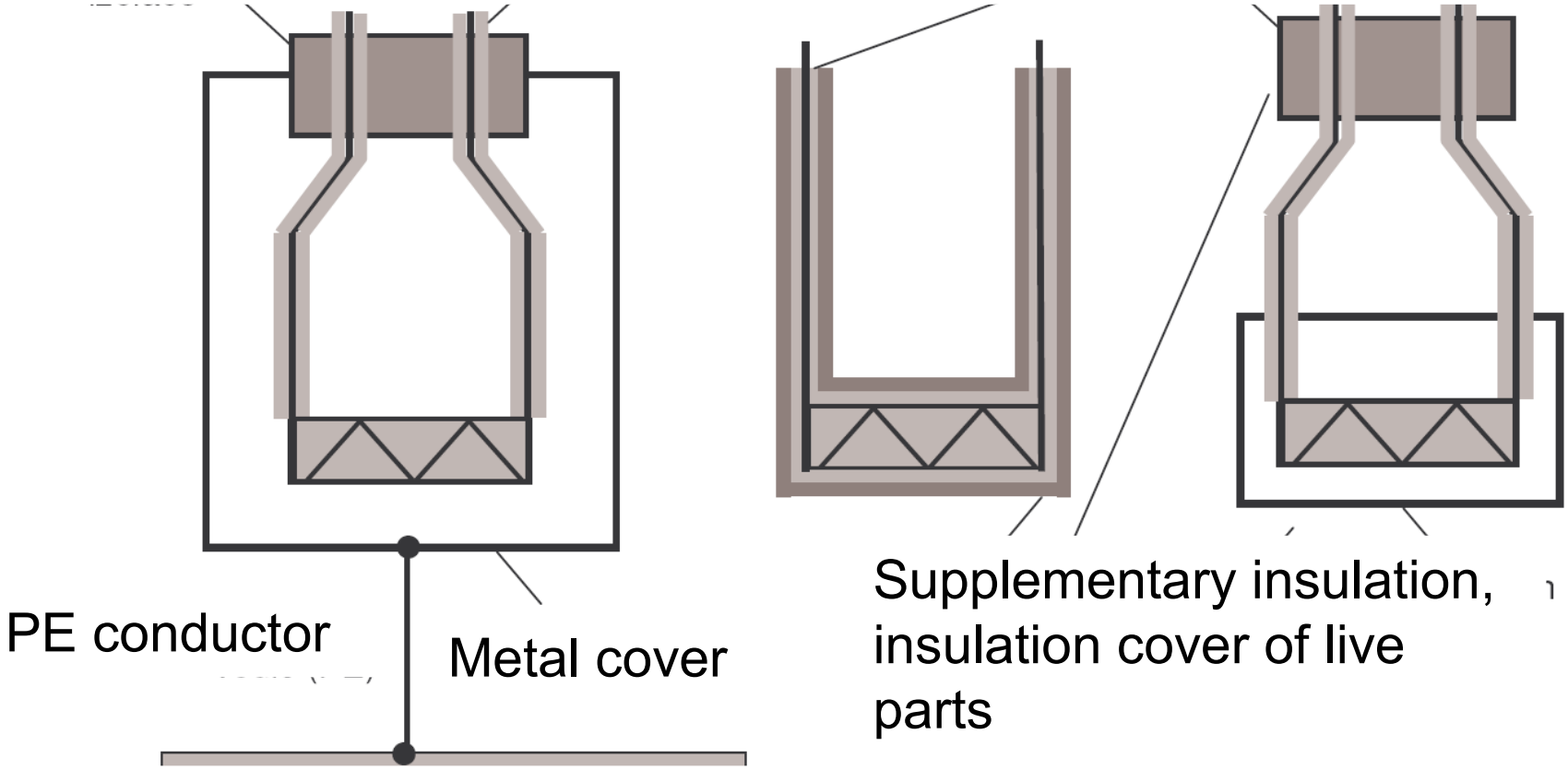
Insulation fault, exposed conductive part became hazardous live part



Hazardous live part became accessible because of cover damage

Basic principles of protection against electric shock - explanation

Supplementary insulation, Basic insulation



Protective equipotential bonding (mostly earth bonding with PE)

Basic principles of protection against electric shock - explanation

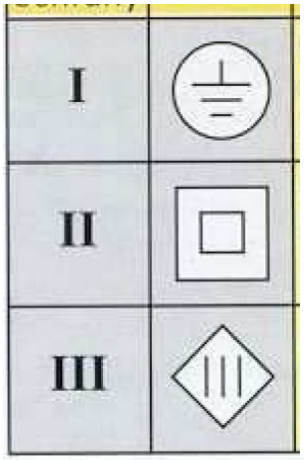
Appliance classes (protecton of electrical apparatus)

Class I: basic insulation + metal cover, protective terminal must be used and connected (asynchronous motor, iron, welding machine)

Class II: basic and supplementary insulation, no additional protection needed

Class III: supplied from ELV source, no additional protection needed

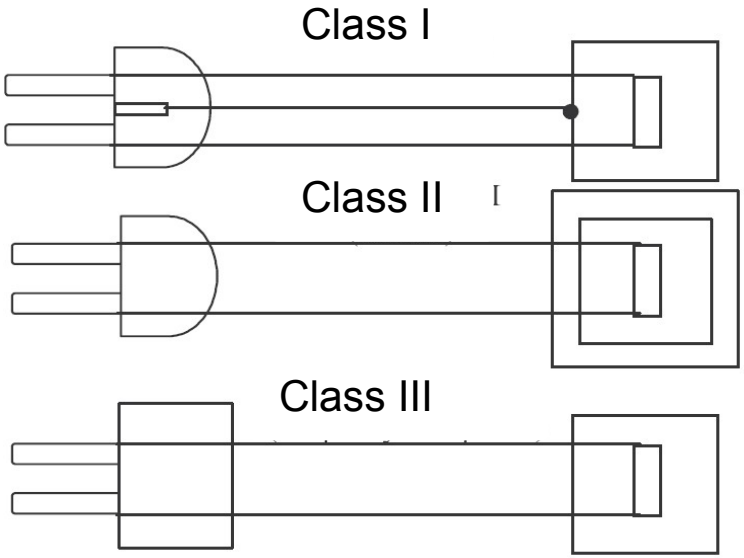
Class Description
Alternative Sign



Connection to PE needed, automatic disc. of supply

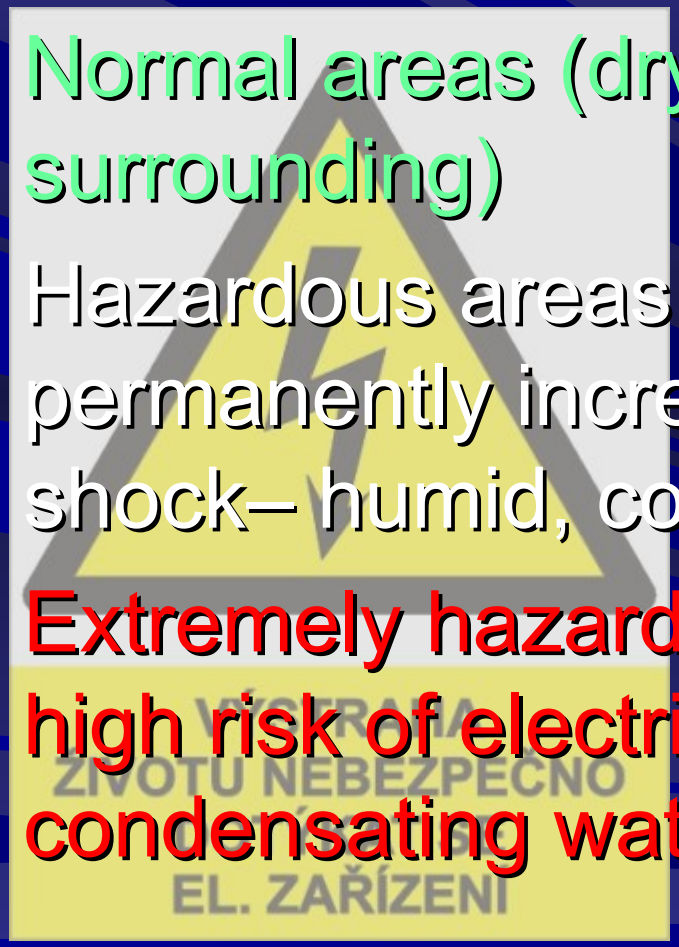
Double insulation, single fault is not dangerous (repair needed)

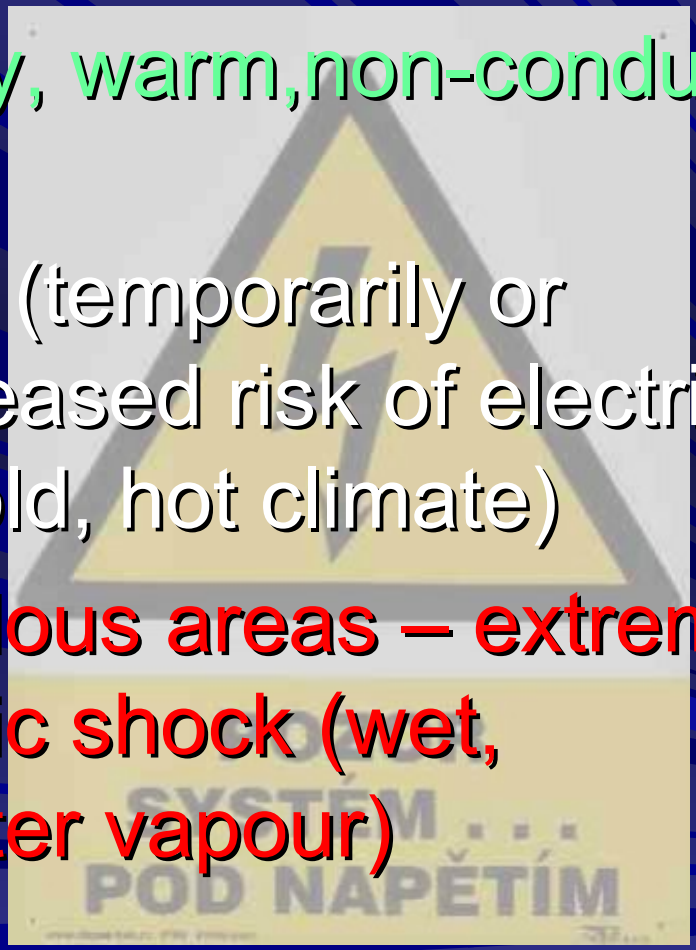
Extra low voltage, fault is not dangerous-no electric shock



Area classification according to electric shock hazard – ČSN 33 2000 – 4-41 Z1:2010

- Normal areas (dry, warm,non-conducting surrounding)
- Hazardous areas (temporarily or permanently increased risk of electric shock– humid, cold, hot climate)
- Extremely hazardous areas – extreme high risk of electric shock (wet, condensating water vapour)





Note – these classifications are valid in Czech republic only

Limits of Extra low voltages

Extra low voltage protection – the most safe protection, apparatus shall not be supplied with higher voltage than limits, the fault current flowing through human body is considferd to be safe in the case of fault/ unintenional touch

The magnitude of extra low voltage limit depends on area classification and acessibility of live parts – for normal dry areas the limit is 50 V AC and 120 V DC.

Areas	Contact with apparatus parts during operation is with those parts	The highest magnitude of ELV (live parts voltage)	
		AC supply	DC supply
Normal and hazardous	Live	25	60
	Exposed conductive	50	120
Extremely hazardous	Live	-	-
	Exposed conductive	12	25(30)

3.

Basic protection

Basic protection (protection agaist direct contact - dangerous touch of live parts)

- Insulation
- Covers, barriers, min. Protection code IP 2X or IP 4X
- Obstacle / position

Fault protection

(Protection against dangerous indirect contact i.e. Protection against dangerous contact in case of basic protection fault)

Always basic protection plus

- Automatic disconnection of supply
- Double or reinforced insulation
- Electrical separtation for supplying one apparatus

In case of supervision by qualified (skilled) person may be used besides items shown above - basic protection plus

- Non-conductive environment protection
- Electrical separation protection for supply more than 1 apparatus
- Protective equipotential bonding (unearthed)

Supply network sytems

Installation standards (IEC 364, ČSN 33 2000, etc.) use three basic supply network systems TN, IT a TT, and define important rules and requirements for achieving safety

Used letter coding principle has these meanings

First letter -relation between network and earth bonding

T – direct connection of one network point to ground (low impedance is possible)-Terra
I – separation of all live parts from earth potential or connection through high impedance - Insulation.

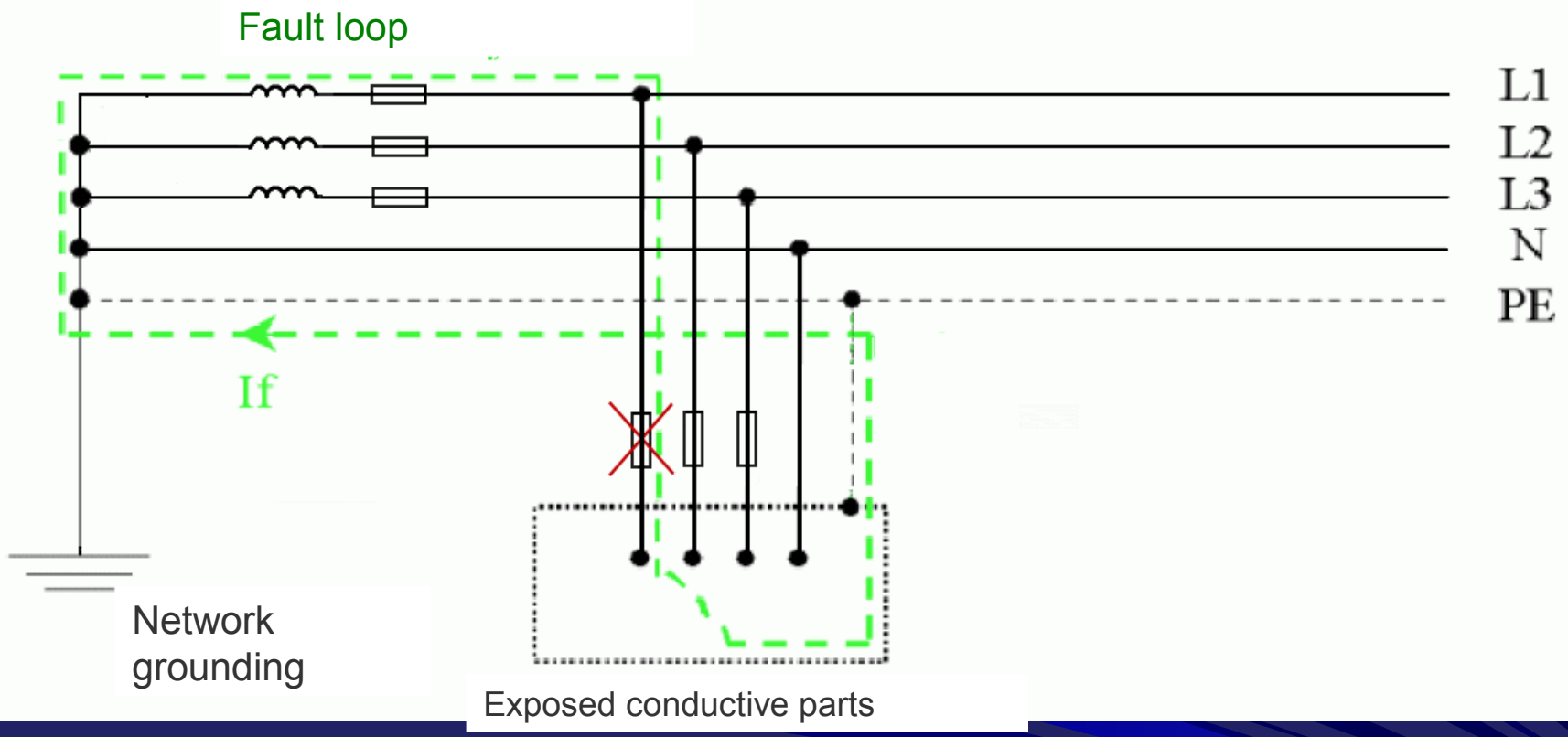
Second letter -relation between exposed conductive parts and earth bonding:

T – direct connection of exposed conductive parts to ground - Terra
N – direct connection of exposed conductive parts to earth bonded network node (in AC networks the commonly grounded part is the neutral conductor, if not present phase conductor) - „Neutra”

Additional letters (if exist) refer to arrangement of neutral and protective conductors:

S – function of protective conductor is provided by the separate conductor (separated from neutral conductor, or from earth bonded pole conductor in case of DC networks) “Separatum”
C – function of neutral (middle) conductor is combined in one conductor (PEN conductor) “Corporali immersa”

TN System – *one node of supply network directly grounded*



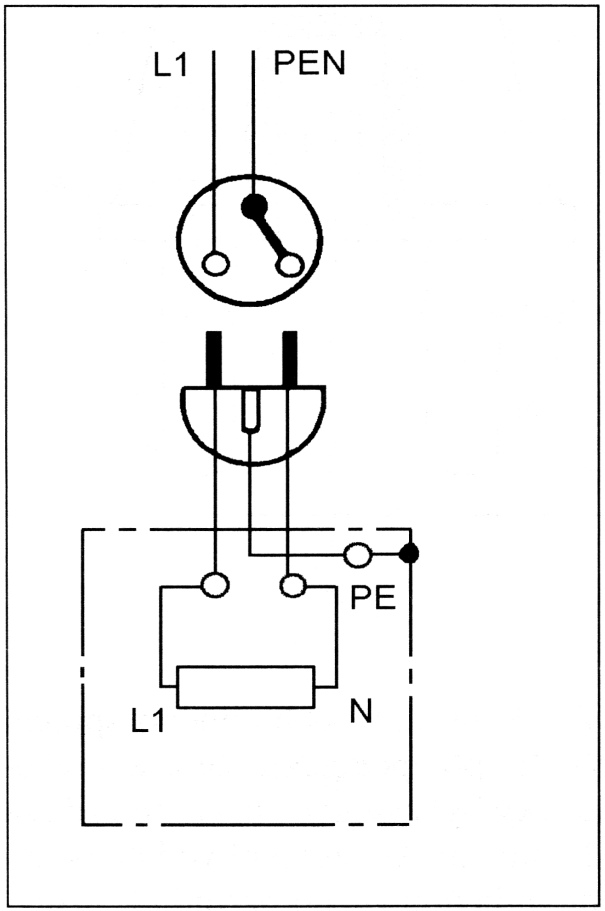
System TN-S: The whole installation utilizes separated neutral (N) and PE conductor
System TN-C-S: function of the neutral and protective conductor is combined in the part of network into one PEN conductor, from separation point network acts as TN-S
System TN-C: function of neutral and protective conductor is combinated into PEN conductor in the whole network

The fault acts as one phase short circuit, magnitude is limited only by low impedance of fault loop, the fuse blows instantaneously – automatic disconnection of supply

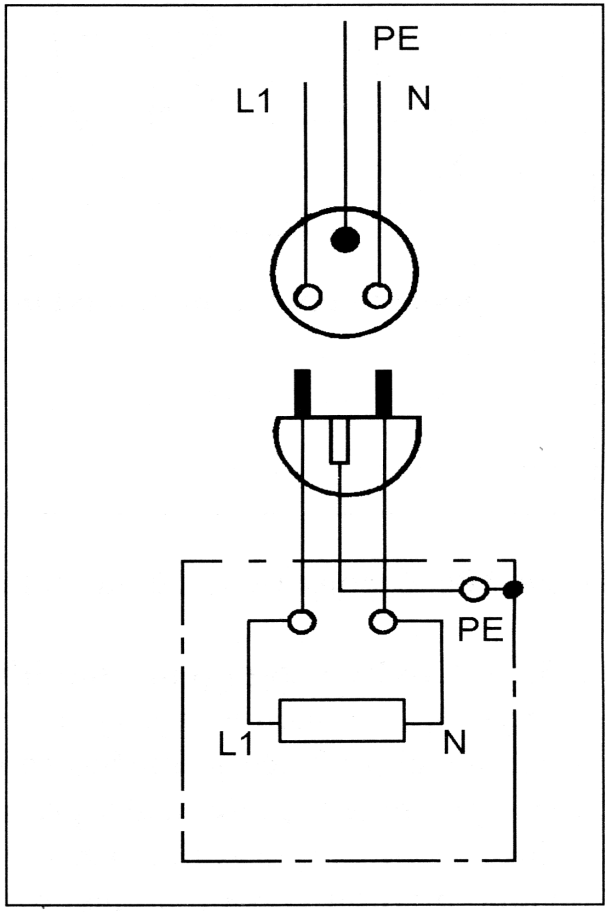
Double or reinforced insulation protection

- Marking of apparatus 
- It means that basic insulation (1250 V withstand proof voltage), is appended with supplementary insulation (2500 V withstand proof voltage)
- No connection between metal exposed conductive part and PE conductor
- Metal parts are marked - 

Correct connection of sockets, flexible cords and cables

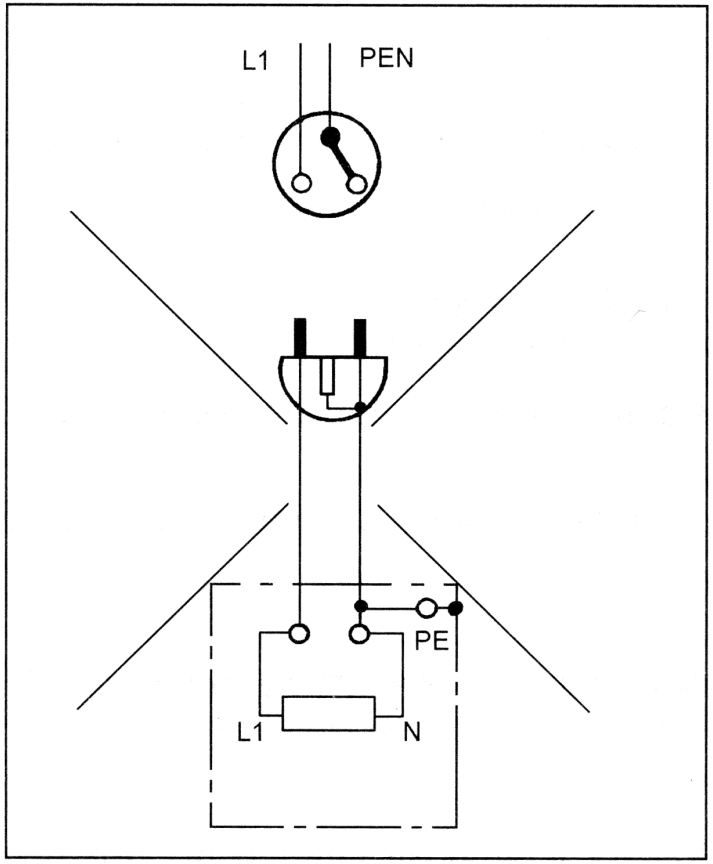


Correct connection of flexible cord and socket in TN-C system (old installations) – valid for Class I, all three wires are separate in flexible cord

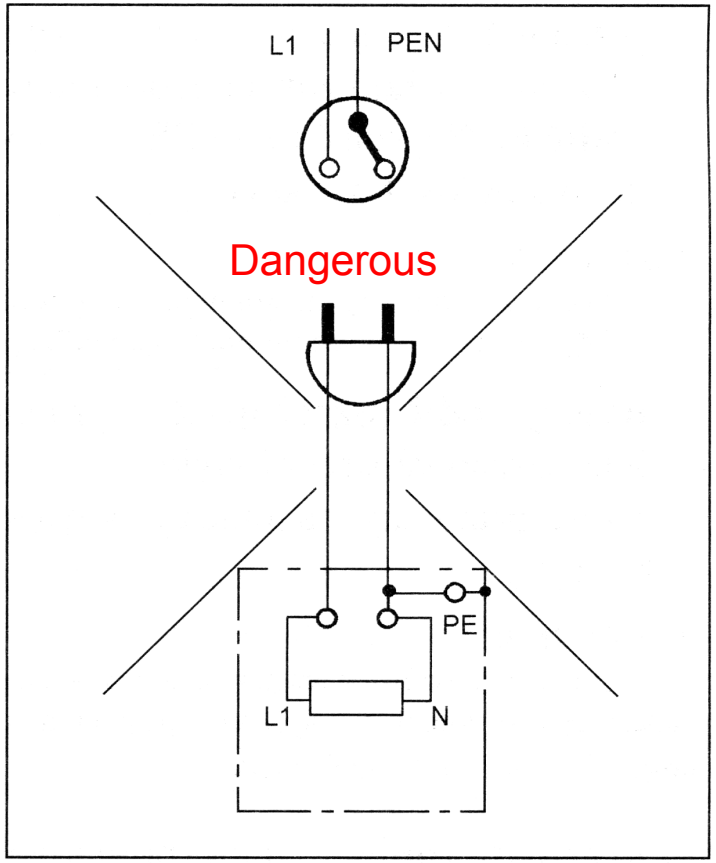


Correct connection of flexible cord and socket in TN-S system (installations since 1999 in Cz) – valid for Class I, all three wires are separate in flexible cord

Incorrect connection of flexible cords and cables

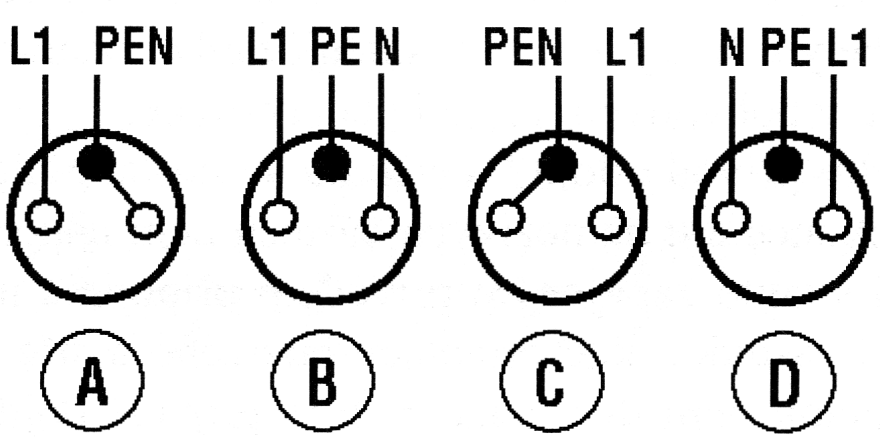


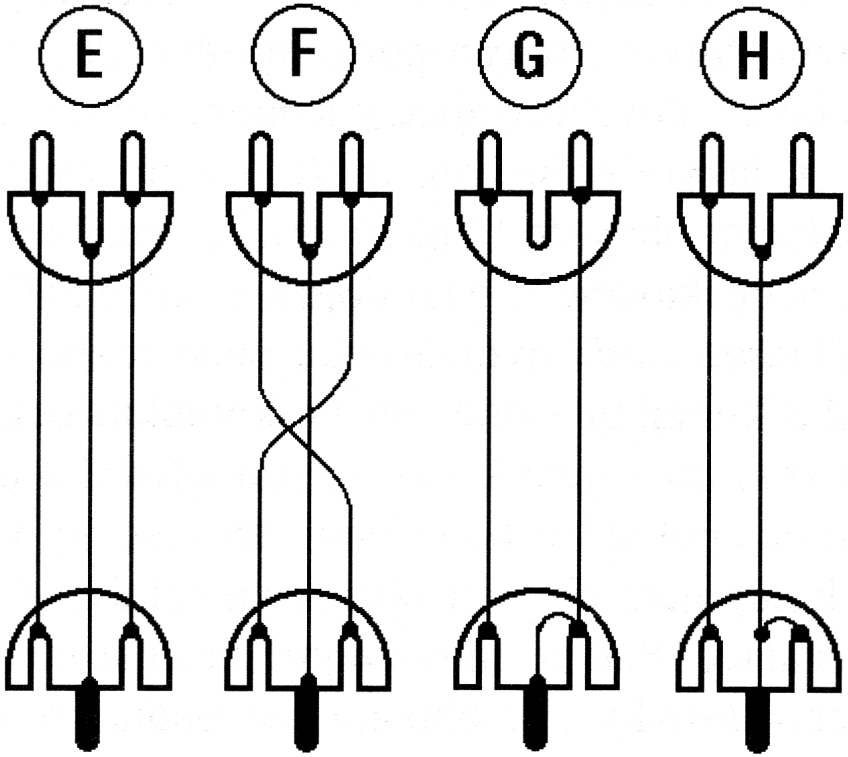
Incorrect connection of flexible cord – may cause circuit breaker trip (or RCD trip in TN-S)



Dangerous connection of flexible cord – may cause electric shock

Comparison and evaluation of various flexible cords connections





- correct – B & E
- allowed for old installations – A
- not dangerous, but **not allowed** in normal op. condition – C, D, F, H
- dangerous during normal operation - G

Operation of electrical installations - ČSN EN 50110 ed.2

- **Operation (servicing, electrical work) the electrical installation –** mounting, revision, service the electrical apparatus.
- Operation (operating) the electrical apparatus – the operations that are related with the operation of electrical apparatus e.g. switching on - off, regulation, reading values of permanently mounted apparatus, the change of screwed and internal apparatus fuses, bulbs, the inspection of apparatus etc.

- **Work with (permanent) supervision –** inspector is responsible for keeping safety rules, supervision = immediate control
- **Work under inspection –** detailed instruction, supervision is performed before work task and occasionally during work task.

Work according to instruction – workers are responsible for their safety

Work activities (possibility of electric hazard occurence)

- **Operation of electrical installation –** (electrical work)
- **Non-electrical work –** work in vicinity of electrical apparatus (cleaning, painting etc..)
- **Live working –** only for skilled persons, special requirements and rules

Work in the vicinity of live parts – any work in vicinity zone

- **Dead working –** skilled persons, instructed person + supervision by skilled p.

Criteria for dead working

1. Disconnect completely (from all power supplies)
2. Secure against re-connection
3. Verify absence of operating voltage
4. Carry out earthing and short circuit for all conductors (keep the step order) – earthing and short-circuiting equipment must be visible from work place
5. Perform additional measures if another live parts are in vicinity zone (provide proetection against adjacent live parts)

(LV installations sometimes do not require step 4 and 5).

The HV (MV) installation is considered to be live immediately after taking off the short-circuit set

Competence coparison for §4 – instructed person and §5 – skilled person

Instructed person (§4) - may:

- Operate (switch on/off handle) electrical installation and apparatus of all voltage levels
- Perform dead work activities (according to instruction) in LV electrical installation
- Perform work activities under inspection of qualified person in the vicinity of live parts in LV installation (>200 mm)
- Perform work activities in the vicinity zone of MV (HV) installation under supervision (immediate control), perform work tasks in vicinity zones of dead MV (HV) with inspection
- Perform measurement with appropriate portable measuring devices

Competence coparison for §4 – instructed person and §5 – skilled person

Instructed person (§4) – must not:

- Perform work acticities at LV, MV live parts

(except of simple approved work tasks with given work step order in ELV and LV installations)

Competence coparison for §4 – instructed person and §5 – skilled person

Skilled person (§5) - may:

- Operate (handle) electrical installation of all voltage levels
- Perform independent electrical live work activities in LV installations
- Based on qualification degree the person may perform work activities in HV (MV) installations (simple work tasks alone, the other with supervision)

Skilled person (§5) – must not:

- Perform banned live work activities in LV, MV, HV
- Skilled persons (§5) must not work alone in the LV parts in wet, outdoor and restricted conductive areas

Protection against electric shock

Protection against electric shock:

The set of technical and organizational measures.

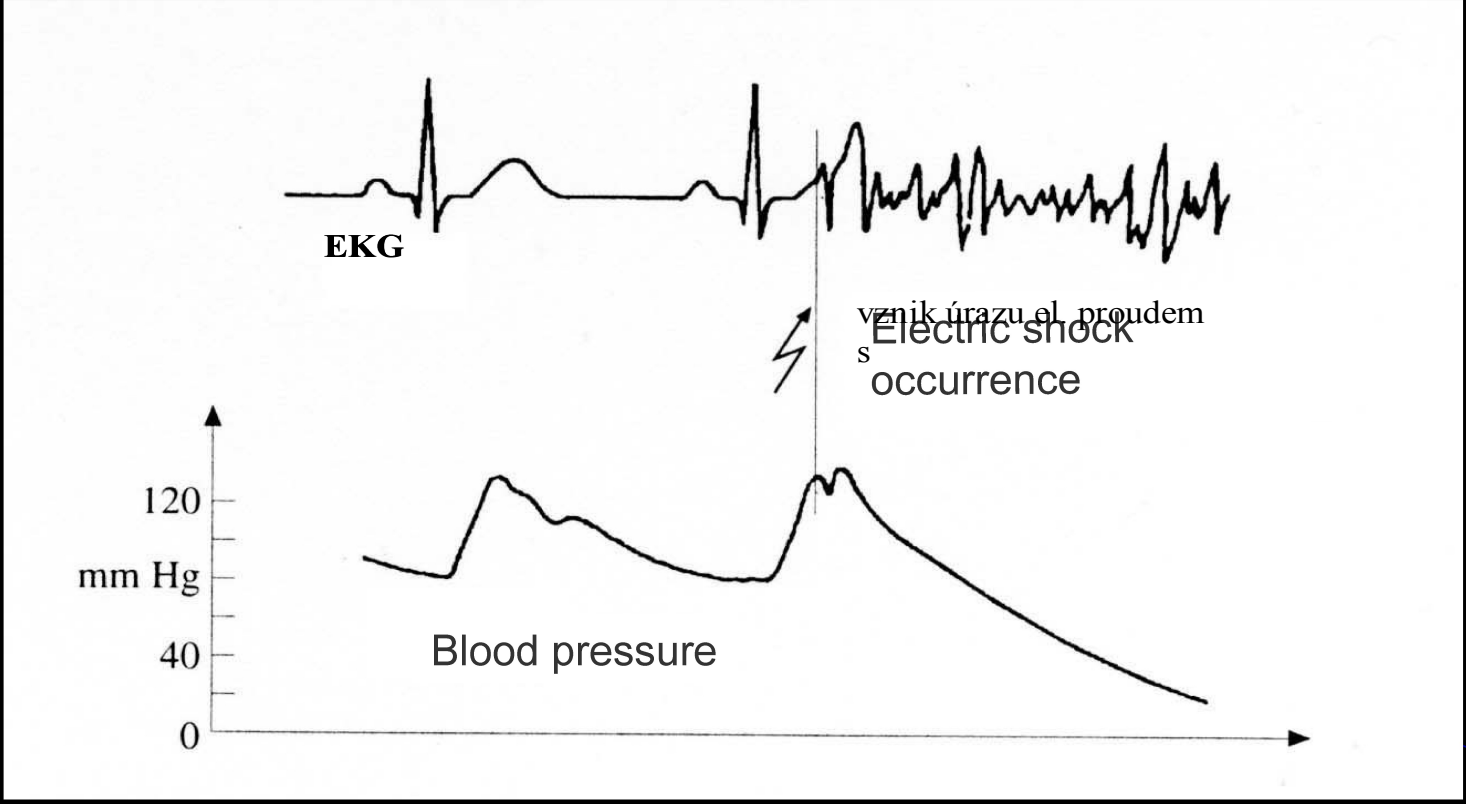
- **Organizational measures** — The technical skills (qualification degree) of workers performing work activities, internal training courses, internal work rules in laboratories.
- **Technical measures** — Exclude or significantly reduce the risk of electric shock by choice, location and construction of electrical installation and its parts.

The effects of electric current to human body

- The effects generally relies on many aspects :

- Type of electric current (AC – worse, DC)
- Magnitude of electric current (function of *U* and *Z*)
- AC current frequency (40-60 Hz – is the worst one)
- Impedance of human body and floor
- The trajectory of AC current
- Time of electric current exposition
- Physiological and psychical condition
- Magnitude of touch voltage

Hearth fibrillation



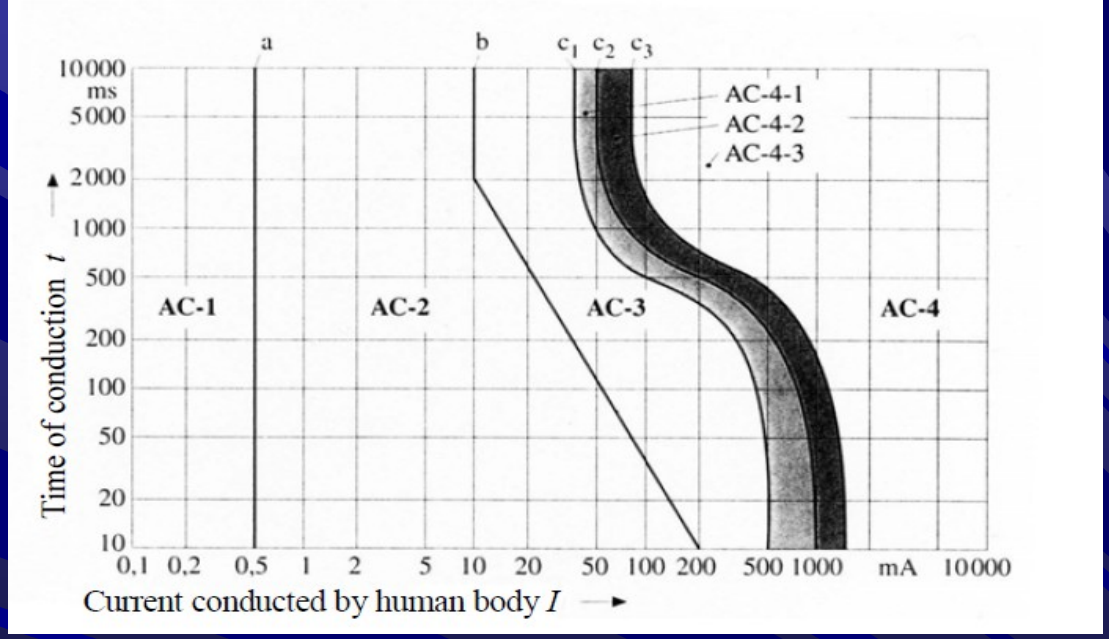
Waveform of EKG and blood pressure before and after the occurrence of electric shock

The general effects of direct and alternating current :

- Both kind of current may cause electrolysis and spasm
- AC current causes ventricular (hearth) fibrillation at lower magnitudes
- The hearth strikes at the rate of approx.. 70 pulses per min, AC current forces the strike frequency of 50 Hz

If the ventricular fibrillation occures – it results no blood circulation and stasis

Thus, AC current is considered to be more dangerous than DC current .



Range:

AC 1 usually no reaction

AC 2 ususally no pathophysiological impact

AC 3 The transitional range without fixed limits (muscle reaction, heavily breathing, usually no organic damages, no danger of cardiac fibrillation)

AC 4 The heart ventricular fibrillation with rising sensibility

AC 4-1 Threshold of fibrillation

- AC4-2 Probability of fibrillation 5%
- AC4-3 Probability of fibrillation 50%

The impact of alternating current depending to the exposition time

Magnitude of electric current :

The impact of electric current to the human body is directly proportional to the magnitude of electric current and to the duration of current conduction. The magnitude of current that is supposed not to be dangerous to the human body (formerly it was called the safe current) was set up based on long time examination in the past.The technical and economical compromise is 0,5 mA (apparatus class II hand held) and 30 mA (RCD release trip)

Current frequency :

The most dangerous ranges are: **10 - 100Hz and 200 - 500 Hz .**

Human body impedance :

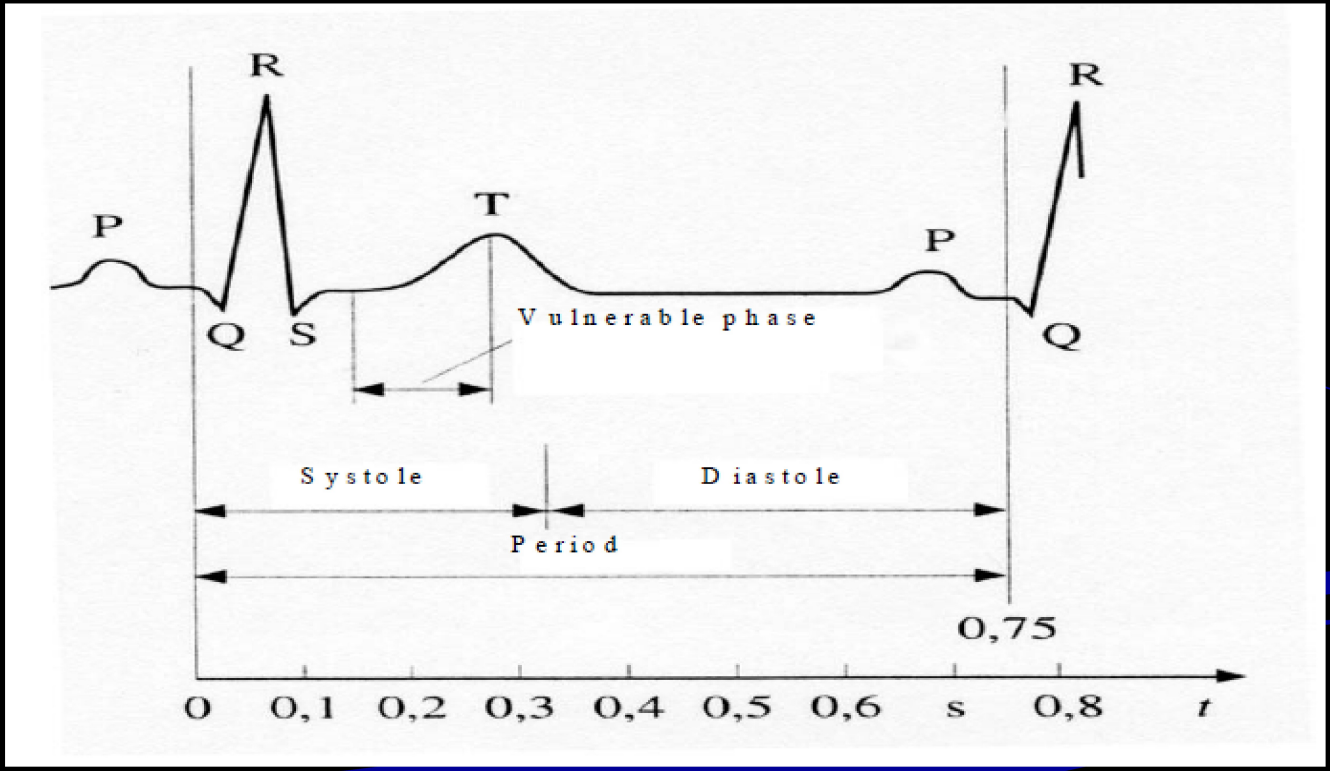
Average value for ELV is 2000 Ω, for higher touch voltages drops to 700 Ω .

Electric current trajectory:

The most dangerous are head-hand, head – leg and hand-hand

Exposition time :

The longer affect of electric current may cause the higher potential damages than shorter affects, that is understandable. Recently, the next fact was proved – if the conduction of electric current lasts 0,8 sec or more, the current hits at least one time the vulnerable phase of the heart activity socalled T-wave (in Fig. 1.2 – Electrocardiogram of heart activity). The heart is abnormally susceptible to heart arrest or ventricular fibrillation. By hitting the Vulnerable phase (T-wave) multiple times, the risk of ventricular fibrillation increases.



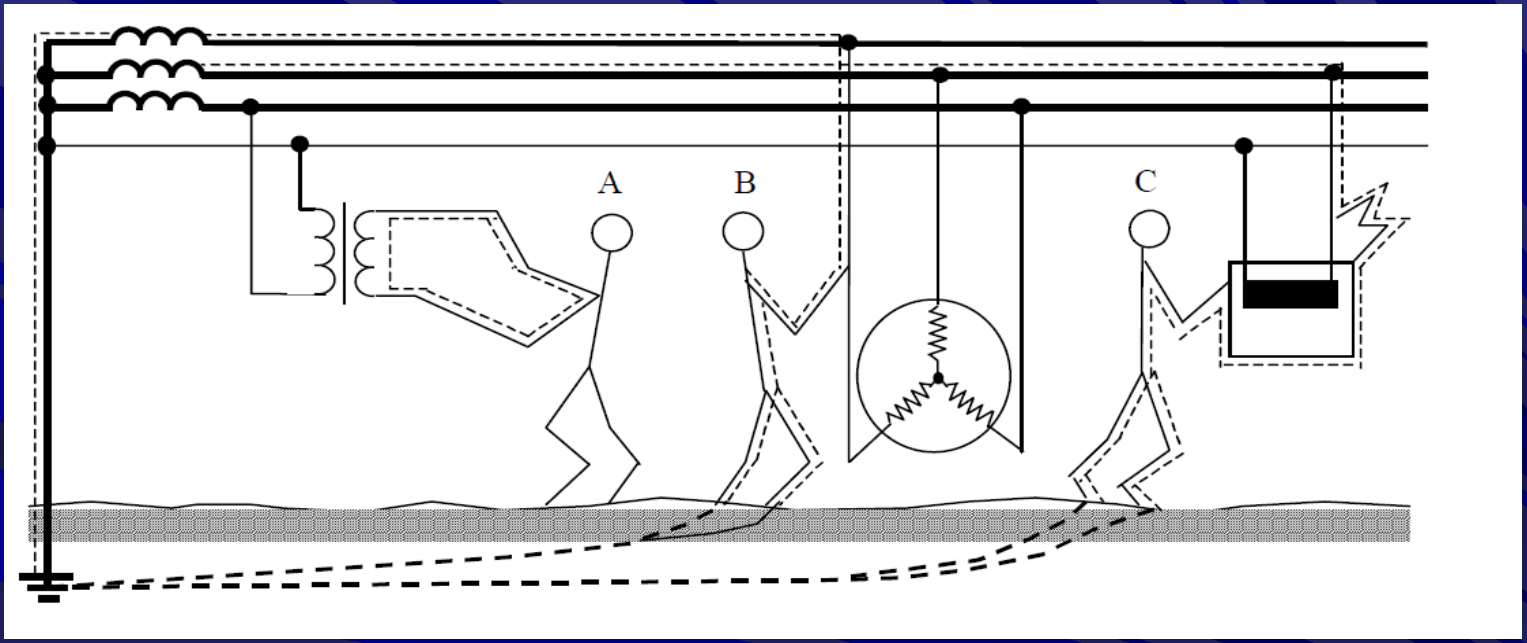
Physiological and psychical condition of organism :

The impedance of human body is given by the physiologic structure of organism, and thus, it is different for each individual. However, the impedance varies at the same individual depending on his psychical condition. The worse the psychical condition is (means e.g. conditions of exhaustion, depression etc.), the more the impedance decreases (down to level 700 Ω). That causes the increasing magnitude of electrical current and danger of higher damages.

Magnitude of touch voltage:

All organs of human body have not at the same conductivity and have different sensibility to electric current. The skin may be considered as imperfect insulation coating of human body, because it has approximately 20 times lower conductivity than inner organs of human body. However, by the influence of touch voltage higher than 60 V, the skin looses this feature grasually. This reality has essential influence to set up the limits of safety voltages.

Hazardous contacts with electrical apparatus



A .) *Two-pole contact*

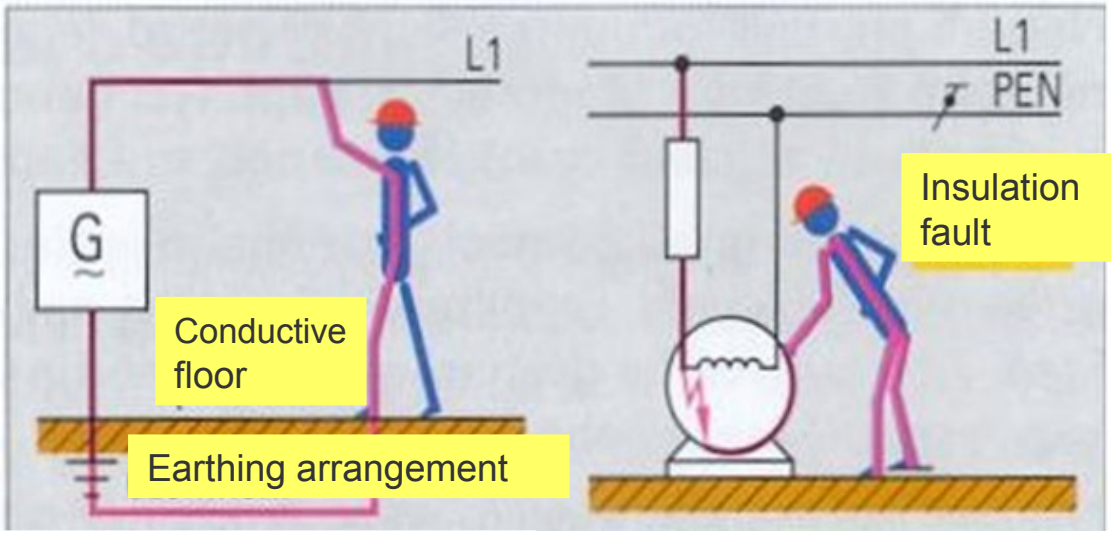
B .) One-pole contact

Contact :

1 . Unintentional (direct)

2 . Intentional (indirect)

Direct and undirect touch

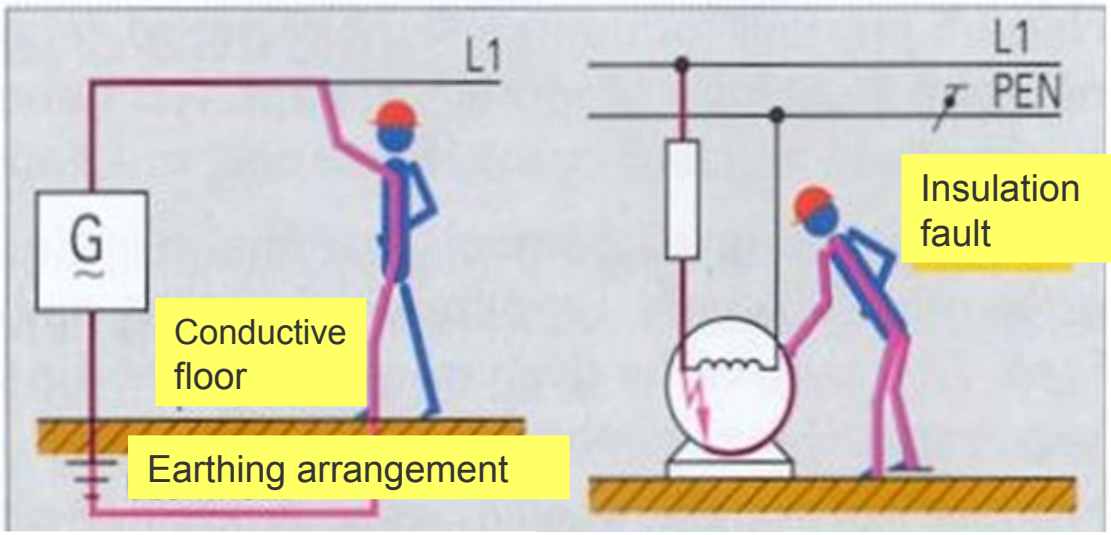


Direct contact e.g. with line bare conductor

Indirect contact e.g. with metal cover of electrical machine in service in case of insulation fault

Direct contact (contact with live part) – the contact of a person or an animal with the live part of electrical installation (e.g. bare busbar conductor). The technical measure against direct contact is basic protection

Direct and undirect touch



Direct contact e.g. with line bare conductor

Indirect contact e.g. with metal cover of electrical machine in service in case of insulation fault

Undirect contact (contact with exposed conductive part during fault) – The contact with exposed conductive part of electrical installation, that became live because of insulation fault (the fault of basic protection). The technical measure against indirect contact is the fault protection

The basic division of electrical equipment and installations

Division based on intended use (purpose) :

- Power equipment
- (Tele)communication equipment
- Control equipment
- Special equipment

Division according to risk of electric shock and voltage level :

- Power installations (LV, MV, HV)
- ELV installations

According to power supply :

- Direct current
- Alternating current

The categories of voltage levels

The category of voltage level	The sign of voltage *(in Czech)*	The name of apparatus *(in Czech)*	Nominal voltage		
			In the solidly earthed neutral system		In the isolated neutral system
			Between the conductor and earth ground	Between conductors	Between conductors
I	mn *(malé napětí)*	The apparatus of extra low voltage - ELV *(zařízení malého napětí)*	Up to 50 V[2] including	Up to 50 V[2] incl.	Up to 50 V[2] incl.
II	nn *(nízké napětí)*	The apparatus of low voltage - LV *(zařízení nízkého napětí)*	over 50 V up to 600 V including	over 50 V[1] up to 1000 V[2] incl.	over 50 V[1] up to 1000 V[2] incl.
A	vn *(vysoké napětí)*	The apparatus of high voltage - HV *(zařízení vysokého napětí)*	over 0,6 kV up to 30 kV	over 1 kV up to 52 kV	over 1 kV up to 52 kV

Legend – the HV (high voltage) is often called MV (medium voltage) in many countries

The categories of voltage levels

B	vvn *(velmi vysoké napětí)*	The apparatus of very high voltage *(zařízení velmi vysokého napětí)*	over 30 kV up to 171 kV	over 52 kV up to 300 kV	over 52 kV up to 300 kV
C	zvn *(zvlášť vysoké napětí)*	The apparatus of extra very high voltage *(zařízení zvlášť vysokého napětí)*	-	over 300 kV up to 800 kV incl.	-
D	uvn *(ultra vysoké napětí)*	The apparatus of ultra high voltage *(zařízení ultra vysokého napětí)*	-	over 800 kV	-

Legend: Similarly as shown in the previous slide

- the term HV (high voltage) is used in many countries for voltages above the MV range (any value over 52 kV)

- in EN 50110 the term HV (high voltage) is occasionally used for any voltage above LV range

1) The telecommunication apparatus with voltage between conductors up to 85 V including are considered to be the apparatus of mn (extra low voltage - ELV).

2) For the direct current installation the limit between the extra low voltage (ELV) and low voltage (LV) is 120 V, the limit between the low voltage and high voltage is 1500 V for direct current installation.

Main safety rules for operating electrical installation in university laboratories by students

The basic commitments of students:

- Students shall pass the prescribed exam prior to their supposed work activity in particular laboratory. (That means to participate lessons from the given subjects (The work safety in laboratories FEI and The work safety in electrical engineering), and successfully pass exam from these subjects.
- Students are obliged to keep all Laboratory rules.
- Students are not allowed to enter the laboratory without previous agreement of teacher, who guides the respective laboratory measurement.
- Students are not allowed to connect any electrical apparatus to supply voltage without previous check and agreement of teacher, who guides the respective laboratory measurement.

- In case that student feels indisposition or other health problems, he/she is obliged to interrupt his/her activity (with electrical apparatus) and immediately inform the teacher
- Students are obliged immediately, even without previous agreement of teacher, to switch off the main safety switch, that disconnects all supplies to laboratory electrical apparatus in case of electric shock or fire occurrence Simultaneously thy are obliged to inform the teacher
- Each student shall be acquainted with the laboratory task that he is given to measure, with the position of main safety switch and the position of extinguisher.
- Students shall keep the safety distance from the live parts with voltage higher than ELV (50V), the distance depends on the magnitude of the voltage of active parts (for the low voltage at least 20 cm.)

The basic rules of first aid by electric shock

In case of electric shock, the following steps are required

1 . Isolate the electricity (disconnect, move – pull away live wire with dry non-conductive material).
Keep in mind your own personal safety. For MV conductors mind the risk of step voltage also

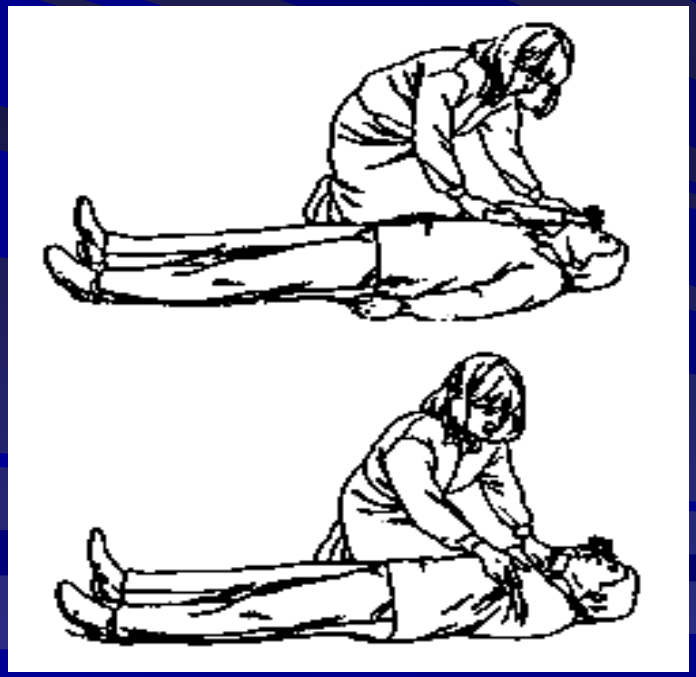
2 . Send for medical assistance and commence basic life support (do not leave the victim alone)

3. Continue basic life support, if casualty is unconscious (but breathing) turn into recovery position

3 . Inform the person nominated in control of work activity

5 . Write a report of electric current accident.

- **Insulate** : switch off, pull the flexible cord out of socket
- Shake gently, shout loudly
- If unconscious, turn on back, clear and open airway, stop hard bleeding
- Check breathing (lean victim's head back during check)
- If causalty is breathing, turn into recovery position



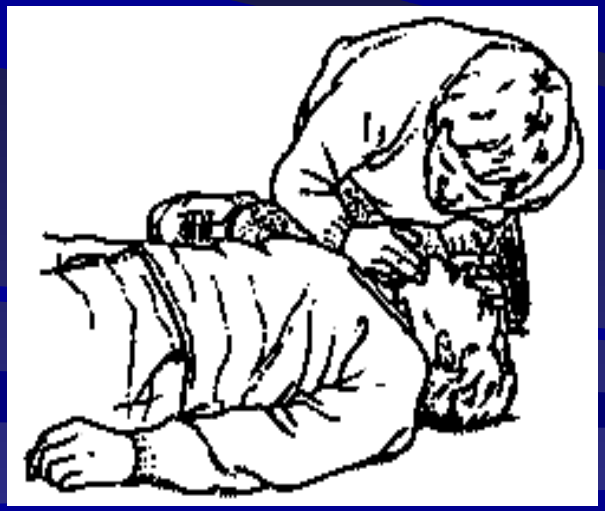
Recovery position

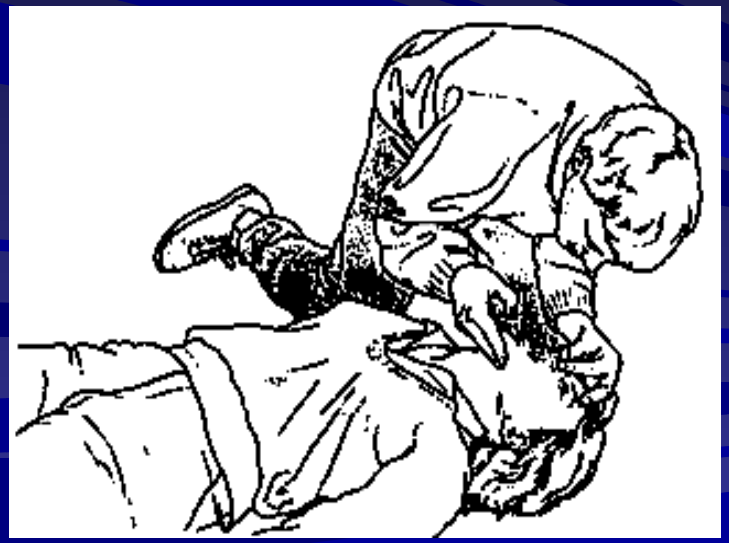
- CPR – Check breathing – look, listen and feel for up to 10 seconds, if not detected or irregular (i.e. agonal breathing, common in cardiac arrest) commence CPR

  NB – check & clean airways first !!!, lean head back

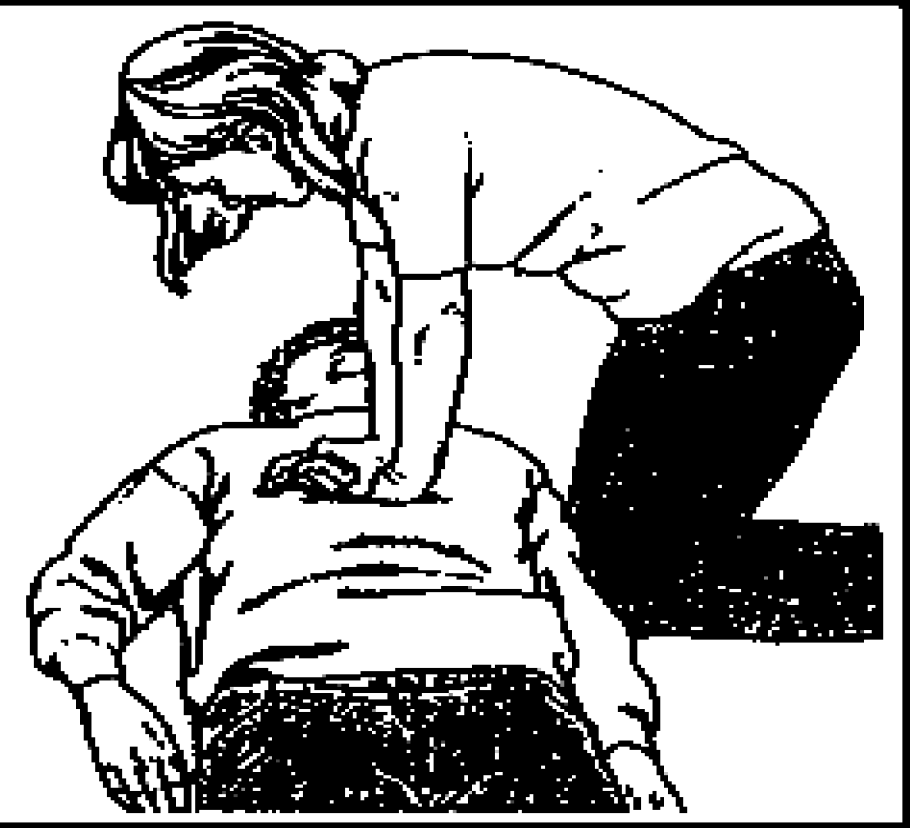
- The rescue breathing is voluntary (not necessary)
  - Rate of hearth compression 100 per minute.
  - If combined with breathing 30 compressions + 2 breaths

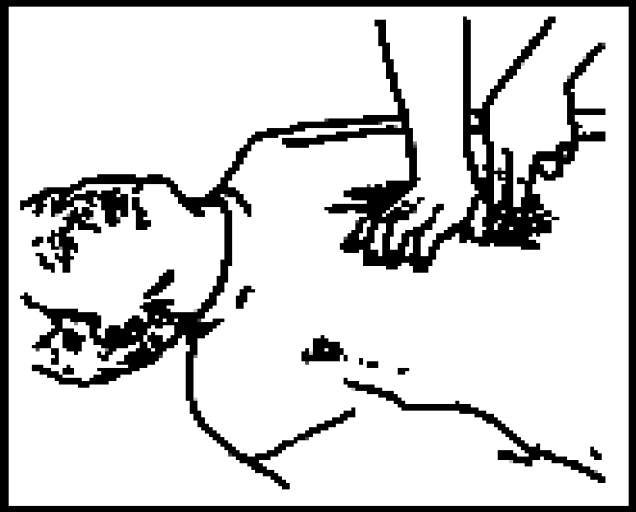
.





- **CPR – compression technique:**
  Note – See hands are stretched, compression depth is ~ 4-5 cm





Response

Check airway,
remove obstructions

Check breathing (max 10 s)

Note – head is leaned back (the airways are now open)

CPR (breathing not necessary)

CPR

If no signs of life – commence CPR:
– Place heel of hand on lower half of breastbone, with fingers pointing across chest
– Position other hand on top of first hand on chest and interlock fingers. Raise fingers off chest, hands are stretched.
– Commence compressions – compress about 1/3 of the chest depth, i.e. 4-5 cm
– Complete 30 compressions in 15-20 seconds (about 2 compressions within 1 second) then give 2 rescue breaths
– Continue CPR until:

- Signs of life return
- A defibrillator is to be used
- Medical aid arrives and takes over
- Total exhaustion of rescuer

Defibrillator (if available), follow instructions

The use of AED (if available)

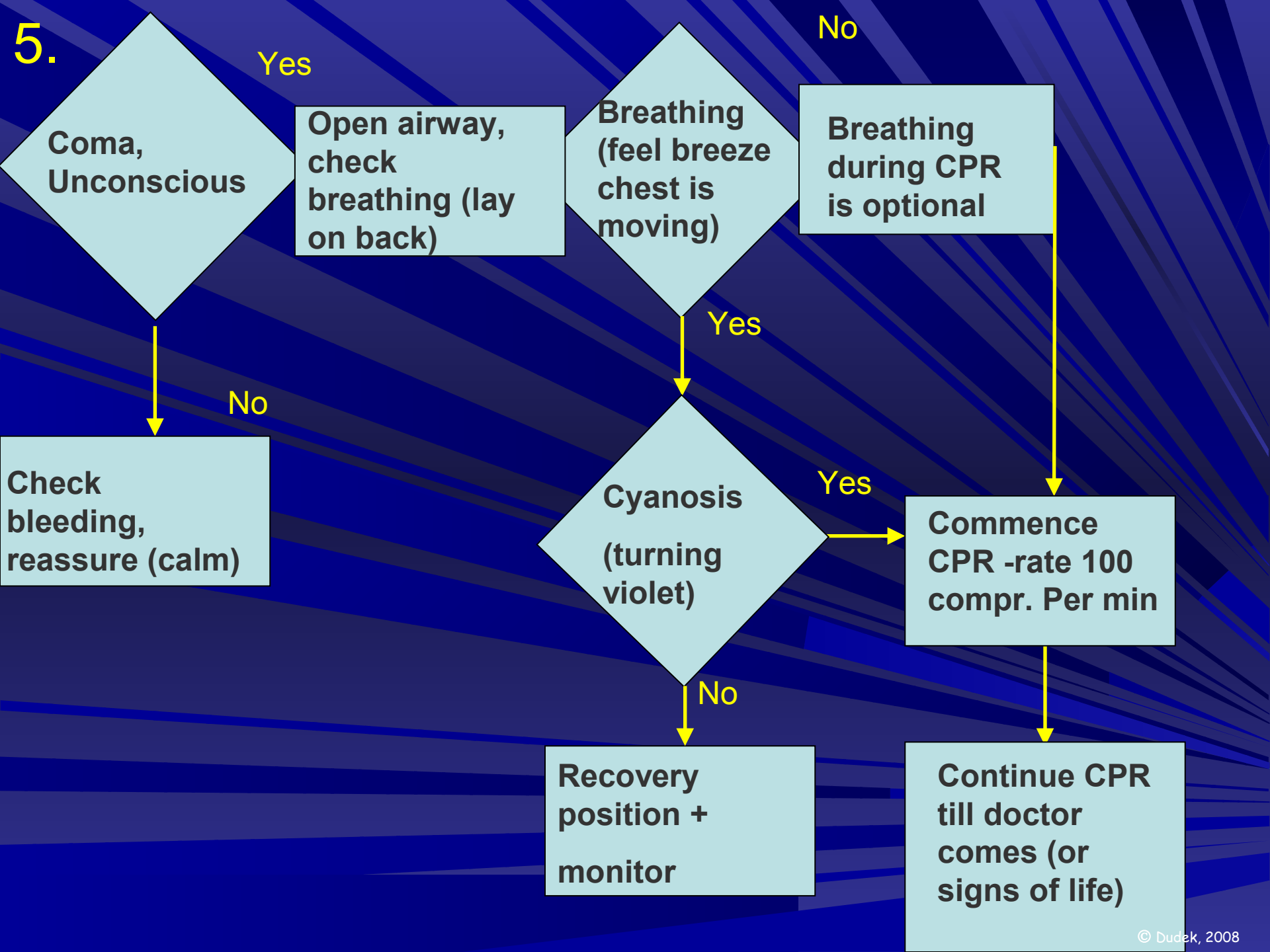
1. Extricate the casualty out of the reach of electric current
2. Shake, shout – check response
3. Clean and clear the airways
4. If not breathing, bring AED, follow the instructions
5. Open defibrillator, stick electrodes, switch AED on

a) analysis of the EKG (6~9 s), do not touch casualty

b) either preparation for defibrillation or order to commence CPR and after some time again step a)

c) keep hands off the casulty, press button – defibrillation

d) follow the instruction – either recovery position or commence CPR, then step a)


5.
Coma, Unconscious
Yes
Open airway, check breathing (lay on back)
Breathing (feel breeze chest is moving)
No
Breathing during CPR is optional
Yes
No
Check bleeding, reassure (calm)
Cyanosis (turning violet)
Yes
Commence CPR -rate 100 compr. Per min
No
Recovery position + monitor
Continue CPR till doctor comes (or signs of life)

European Resuscitation Council

www.erc.edu
info@erc.edu

Basic Life Support & Automated External Defbrillation

Check response

Shake gently
Shout loudly

If not responsive

Open airway & check breathing

If breathing normally, place in recovery position*

If not breathing normally

Call 112

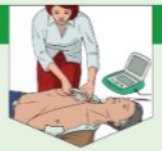
*Recovery position

If unconscious & breathing normally
- Place in recovery position
- Call 112
- Recheck breathing regularly

Start CPR immediately

Place your hands in the centre of the chest
Deliver 30 chest compressions:
press frmly at a rate of 100/min
Seal your lips around the mouth
Blow steadily until the chest rises
Give next breath when the chest falls
Continue CPR

30:2



Activate the AED & attach pads - Don't interrupt CPR

Follow the voice prompts without delay
Attach one pad below the left armpit
Attach the other pad below the right
collar bone, next to the breastbone

Stand clear & deliver shock

Nobody to touch the victim
- during analysis
- during shock delivery

©ERC

If the victim starts to breathe normally, stop CPR.
If still unconscious, turn him into the recovery position*.

Published October 2007 by European Resuscitation Council Secretariat VZW, Drie Eikenstraat 661, 2650 Antwerp, Belgium
Product reference: POSTER-05-BLS/AED-01-01-EN

Extinguishing of electrical installation

Announce the occurrence of fire :

Immediately, based on progress of rescue activities, it is necessary to announce every event (electric shock/ fire) to person nominated in control of work activities

It is highly recommended to disconnect all power supplies before extinguishing the fire (note – emergency lights cannot be disconnected, some sockets and light circuits may be supplied from different switchgear assembly)

Extinguishing of (potentially) live LV installation:

- Snow type fire extinguisher (!risk of frost-bite)
- Powder type fire extinguisher
- Halon type fire extinguisher

Do not use water, foam type.

Extinguishing of electrical installation

Mind in case of fire

The risks for people in case of fire are coming from:

- Smoke – low visibility, loss of orientation
- Smoke – toxic smoke, suffocation
- Panic – impossible to evacuate people
- Burn of people

If you are unable to extinguish the fire yourself - The highest priority is to save own life and lives of other people.

Danger: Toxic gas may present in smoke – risk of asphyxiation

- There is a table in every laboratory where the phone number to which the occurrence of fire shall be announced. The number is 3111 (internal university number).
- In general in Czech republic for fire, police and medical help the unique number 112 is valid

Local safety rules for PC classrooms and PC laboratories

- The objective is to acquaint students with local safety rules for particular classrooms
- Students are required to sign an instruction record at the end of this lecture
- Persons who haven't been provably instructed with the local safety rules are not permitted to access these classrooms

Local safety rules for PC classrooms and PC laboratories

1. Types of PC classrooms and PC laboratories

- PC Classroom – the room in which the lecture is held using PC. Persons are supposed to operate electrical equipment according to instruction manuals (switch on/off etc.)
- PC laboratories – the rooms in which, besides to operation aforementioned, the electrical work on live parts of extra low voltage is supposed (programming PLC, microcontrollers, signal processing and measurement) is performed, as well as dead work e.g. hardware configuration, replacement of HW inside PC etc..

Local safety rules for PC classrooms and PC laboratories

- Important note

There are also other types of school laboratories than only PC classrooms and PC laboratories at the Faculty of Electrical engineering and computer science.

These laboratories have their own particular laboratory rules and students are obliged to pass the instruction/ training before entering these rooms, this is not the subject of this training. The reason is due to different risks occurrence in these rooms.

Local safety rules for PC classrooms and PC laboratories

- Restricted access

Only provably instructed persons are supposed to have access into laboratories.

The access under the influence of alcohol, drugs etc.. is strictly prohibited.

It is possible to enter these rooms only with approval of person responsible for laboratory, or person in charge with lecture.

The coats, jackets shall be stored in cloakroom, dedicated cupboards or place intended for taking off these clothing.

Local safety rules for PC classrooms and PC laboratories

The local safety rules for both types of classrooms:

- Students shall work according to the teacher's instructions and permission;
- In the case that some appliance/installation is damaged (or in doubt) students shall immediately inform the teacher/responsible person;
- It is possible to leave the room only after prior noticing/approval of the teacher;
- Any injuries shall be announced and recorded by the teacher;
- It is prohibited to perform work without approval or permission.

Local safety rules for PC classrooms and PC laboratories

- In case of student's indisposition (physical, psychical), student shall inform the teacher in order to prevent injuries;
- Students may bring their own electrical appliance (notebook etc.) with approval of the respective teacher, the responsible for safety of these equipment is the owner him/herself;
- In case of the equipment damage caused by breaking the safety rules, not following the teacher's instruction, laboratory measurement manual, etc., the student may be asked to pay for the repair;
- The fire shall be announced to internal phone No. 3111 and if possible quenched using dedicated extinguishers.

Additional requirements to PC laboratories

- Students are obliged to acquaint with the scheduled laboratory task in advance using appropriate learning/study materials, if they are provided;
- Any electrical work may be commenced only after approval (notification) of the person nominated in control of a work activity;
- The connection of laboratory exercise or measurement devices (unless explicitly specified) shall be performed in dead state only, the person nominated in control a work activity may require the verification before circuit energizing;
- In general live working is supposed only in SELV and PELV circuits;
- Live working may be performed by students only for simple approved procedures and measurement using portable measuring devices, the more complex live work procedures are restricted to SELV or PELV circuit with adequate short-circuit protection and with approval of the teacher.

End of lecture

- Thank You for Your attention
- Have a nice day