ELECTRICAL SAFETY
MAY 22,2016

ABOUT THE PRESENTOR

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Master of Science in Business Administration (MBA)

ASEAN Charter Professional Engineer

Professional Electrical Engineer (PEE)

Plumbing Engineer (RMP)

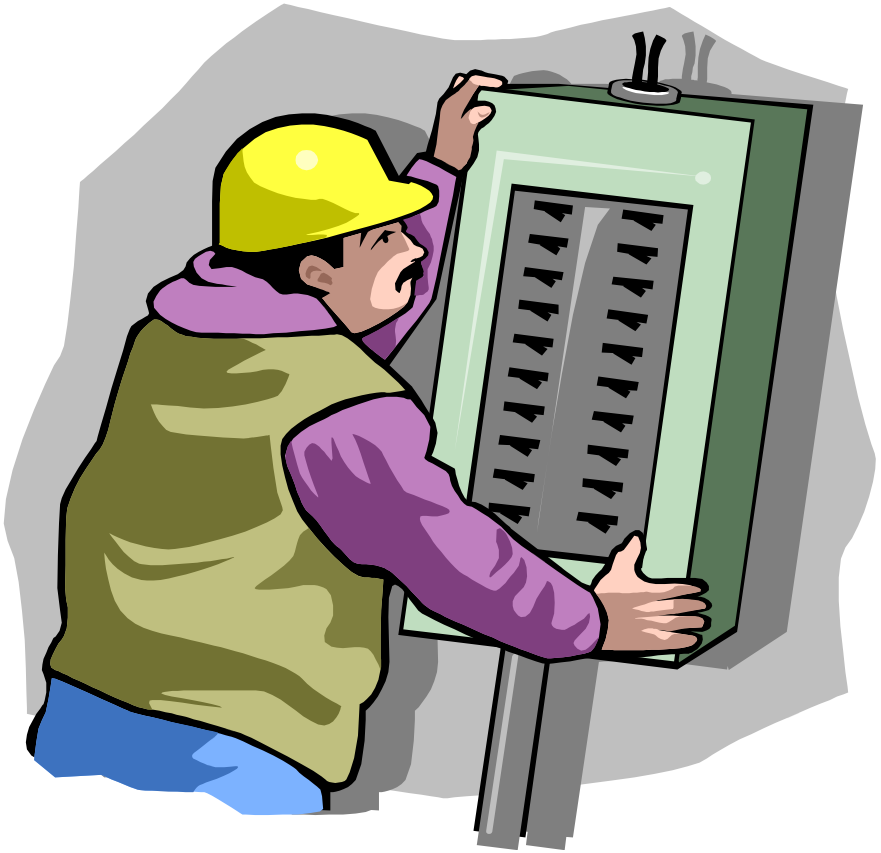
Certified Plant Mechanical(CPM)

Accredited Pollution Control Officer

- Licensed Professional Engineer with more than 40 years experience in the field of building and facility design and consultancy, construction, operations and maintenance involving various mechanical electrical plumbing and fire protection system
- 2016 PSUMP NATIONAL PRESIDENT
- 2011 IIEE NATIONAL PRESIDENT
- 2010 MITEEA Most Outstanding Alumni
- 1998 as Most Outstanding Practitioner in Industry of the Philippines
- Member : Society of Philippine Accredited Consultant
  Philippine Society of Mechanical Engineers

Recipient of Various Civic Awards : Rotary,REACT,YMCA,LOBSET and MARS

ELECTRICAL SAFETY



Module 1: Electrical Fundamentals

- Objective
  - Define electricity
  - Identify mechanisms for distributing electricity (how it travels)
  - Identify required actions to take following an electric shock.

Module 2: Engineering Controls

- Objective:

  - Identify the purpose of various engineering controls designed for electrical safety

  - The preferred method to control electrical hazards is to engineer controls into the design of equipment

Module 3: Administrative Controls

- Objective
  - Identify administrative controls that employs to prevent electric shock

Module 4 – Hazard Recognition & Avoidance

- Objective
  - Identify hazards associated with electrical systems and equipment
  - Discuss electrical accident prevention through increased awareness of surrounding conditions and Sandia requirements

SAFETY - The protection of everyone against injury, physical harm, sickness and death and/or Prevention from accident

ACCIDENT - Unforeseen event that will result to damage of property, loss of life and/or loss of time.

FIRE

- 12,301Fires recorded nationwide- source BFP(2013)
- Electrical = 2,972 or 36%
- 238 lost of lives
- P 3.1 B worth of properties
- 4% of productivity loss on industry

FAULTY WIRING

- popular reasons as causes of fires
- it s just a scapegoat or excuse for a fire incident with yet unknown origin
- It was originated from a certain insurance company to give due classification for damaged properties claiming insurance benefits
- it is the easiest way could label the cause of fire
- there is no term or terminology on Philippine Electrical Code

FAULTY ELECTRICAL WIRING

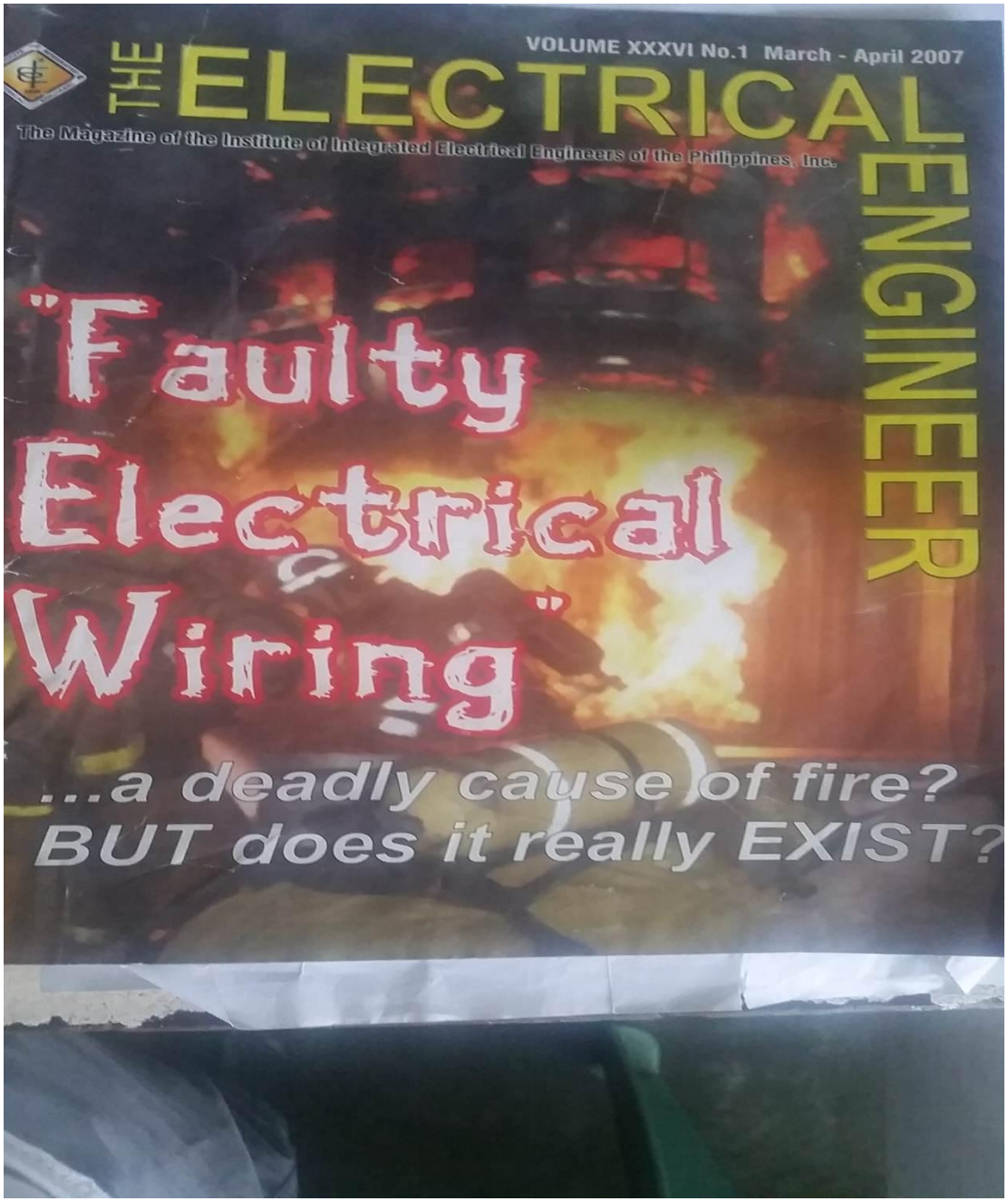
There are different signs when electrical wiring becomes faulty.

First is when the house or establishment is too old. The electrical wiring can become worn out due to time and age.

Second, an overloaded circuit where bulbs or lights start dimming and flickering.

And third, when there is burning smell with identifiable source. You should start searching and fixing faulty electrical wiring.

***Published:May27,2015 (BFD,CARAGA REGION)**


VOLUME XXXVI No.1 March - April 2007
THE ELECTRICAL ENGINEER
The Magazine of the Institute of Integrated Electrical Engineers of the Philippines, Inc.
"Faulty Electrical Wiring"
...a deadly cause of fire?
BUT does it really EXIST?

"Faulty Electrical Wiring"

"Here in the Philippines, an average of two to three massive fire cases is reported each day," says Mr. Renato Sy, Deputy Fire Chief of the Binondo-Pacb Volunteer Fire Brigade, a member brigade of the Association of Philippine volunteer Fire Brigades Inc.

"Ironically," he continues, "the number of blazes increases from five to six cases in the month of March, which is the Fire Prevention Month. At its peak season, the National Capital Region average four fire cases a day. In March 2007, 100 cases were reported. Further, in the squatter areas in Metro Manila, there are about ten incidents of fire reported every month."

And out of this disturbing number of fires, nearly 30% are "electrical in origin."

Yet, "electrical in origin" has never been used to state an electrical-related fire. Instead, reports on television and newspapers claim that "faulty electrical wiring" as among the major causes of fire-related incidents.

However, from the perspective of an electrical engineer, faulty electrical wiring as a cause of fire is just a scapegoat, an excuse for a fire incident with a yet unknown origin.

So where did this term "faulty electrical wiring" originate? According to Engr. Edward L. Mendoza, this was concocted by insurance companies to give due classification for damaged properties claiming insurance benefits. "That's the easiest way they could label a cause of fire."

It is improbable for an establishment, a residence for example, which has been inhabited for years (with all electrical connections working for years) to be reduced to ashes due to faulty electrical wiring. An electrical system won't work nor function, if, in the very first place it is faulty. Considering it does work, however, in just a while, the electrical system will crash as manifested by sparks, and worst, flames. Faulty electrical wiring as a cause of fire is implausible for a building existing for years.

Three important factors determine an efficient electrical system. These involve the construction, contractor and client. Construction deals with the electrical plan and design of the establishment by a professional electrical engineer (P.E.E.). Second, the contractor must be a duly registered electrical engineer who will closely supervise the installation process. Finally, the client, being the owner, must be very certain about the equipment, machines or appliances that he will plug into the system. These must all be of unquestionable quality and certified electrically-safe; that is, they should have passed assessment of the Bureau of Product Standards.

Engr. Mendoza assures that having complied with all these three premises, an owner, household or industry, is safe from the threats of electrical fire.

As Engr. Fe. M. Barrientos puts it in her Editor's Note on The Electrical Engineer Magazine, March-April Issue, 1999, "...if there are registered doctors to be consulted for treatment when one is sick, the same is also true when one needs to have his dwelling, educational or institutional buildings, or commercial and industrial establishments wired for electrical service. The owner should have plans designed and prepared by a duly registered electrical engineer. Where the wiring system inside and service feeders are appropriate to carry all the electrical loads, and where the overcurrent protection of equipment have adequate ratings, it is no longer reasonable for the misnomer 'faulty electrical wiring' to cause or start a fire."

Yet, safety is not a one-time deal. Its extent is almost infinite and requires an "on-guard attitude" especially for the household or industry owner.

Foremost culprit in fires with an electrical cause is improper application and usage. Anything that is used beyond its purpose or capacity is likely to malfunction. Classic examples for this are 110-volt appliance plugged into a 220-volt system, a flat iron left to overheat, and a constantly tripped over extension wire.

Relative to improper usage is overloading. In most households, this is evident in octopus connections, wherein, electrical cords web into a single connection, which in turn, is plugged into one outlet.

On the other hand, Engr. Robinson S. Uy observes

... a faulty term

MALACAÑAN PALACE

MANILA

BY THE PRESIDENT OF THE PHILIPPINES

PROCLAMATION NO. 193

DECLARING THE MONTH OF MAY OF EVERY YEAR AS THE ELECTRICAL SAFETY MONTH

WHEREAS, many lives and properties are lost due to fires and electrocution;

WHEREAS, most of these fires and incidents of electrocution are attributed to "faulty electrical wiring;"

WHEREAS, the main reason for the occurrence of fires and electrocution from electrical causes is not faulty wiring but ignorance in the use of electrical appliances and gadgets such as overloading of electrical outlets and the use of counterfeit electrical products such as circuit breakers, power strips, extension cords, batteries and holiday lights that can cause fires, explosions, shocks, and electrocutions;

WHEREAS, economic losses brought about by fires contribute to reduced productivity and therefore affect the economy of the country;

WHEREAS, there is a real need to increase public awareness on electrical safety and educate our people in the safe use of electrical appliances and gadgets and to bring to their consciousness the importance of applying these safety practices;

WHEREAS, the Bureau of Product Standards (BPS) under the Department of Trade and Industry (DTI) is the National Standards Body of the Philippines, mandated to develop, promulgate, implement and coordinate standardization activities with electrical products.

WHEREAS, the Institute of Integrated Electrical Engineers of the Philippines, Inc. (IIEE) has entered into an agreement with the Singapore-based International Copper Association-Southeast Asia (ICA-SEA), a non-profit organization, to conduct electrical safety awareness campaign in the country and to provide the opportunity to share best practices and help establish good. standard in electrical system in the Philippines; and

WHEREAS, an Electrical Safety Month in May would amplify and reinforce consciousness on electrical safety.

NOW, THEREFORE I, BENIGNO S. AQUINO III, President of the Philippines, by virtue of the powers vested in me by law, do hereby proclaim May of every year as the **ELECTRICAL SAFETY MONTH.**

It is further proclaimed that the IIEE and BPS shall conduct programs and activities on electrical safety throughout the year, in coordination and subject to the approval of the National Disaster Risk Reduction and Management Council (NDRRMC).

IN WITNESS WHEREOF, I have hereunto set my hand and caused the seal of the Republic of the Philippines to be affixed.

DONE in the City of Manila, this 27th the day of June in the year of Our Lord, Two Thousand and Eleven.

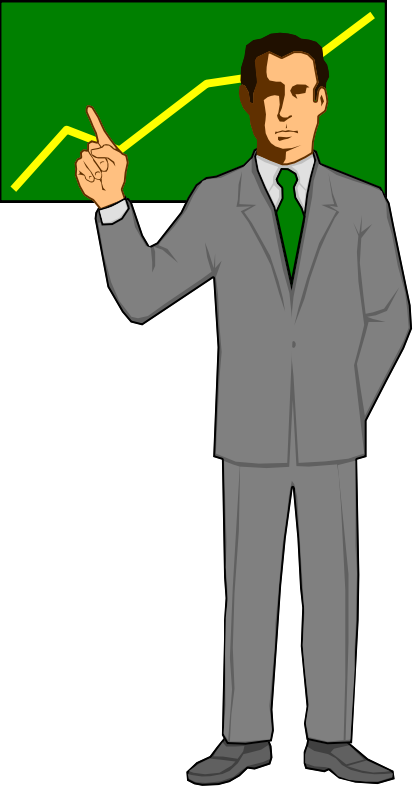
(Sgd.) **BENIGNO S. AQUINO III**

By authority of the President:

(Sgd.) PAQUITO N. OCHOA JR.

Executive Secretary

The Philippine Electrical Code is used nationally as the basis for safeguarding persons, buildings and its contents from hazards that may arise from the use of electricity. The Code contains provisions which are considered necessary for safety and thus is used as basis for legal enforcement in the installation of electrical system design.



3 IMPORTANT FACTORS FOR EFFECTIVE ELECTRICAL SYSTEM

-CONSTRUCTOR –DESIGNER

-CONTRACTOR –IMPLEMENTOR

-CLIENT-MUST BE KNOWLEDGEABLE WHAT MACHINE ,EQUIPMENT OR APPLINCES THAT WILL PLUG TO THE SYSTEM

What is Electricity?

- **Electricity is a source of energy to power devices (e.g., lights, electrical drill, or a computer)**

- **If you compare electricity to water, voltage is the water pressure and current is the rate of flow**
  - **Just as with water, the higher the voltage (pressure) or greater the current (flow rate), the more dangerous electricity becomes**

Two Basic Types of Electrical Energy

- **Alternating Current (AC)**
  - **Power sources are generally supplied by generators found at hydroelectric, coal fired, or nuclear power plants**
  - **AC energy is distributed by above or underground power lines for end use in home, commercial, and industrial applications**

- **Direct Current (DC)**
  - **Power sources are generally supplied by batteries**
  - **Batteries in cell phones, lap tops, flashlights, Uninterruptable Power Supplies (UPS) or vehicles are sources of direct current (DC)**

TERMINOLOGY:

CURRENT - flow of electricity through a circuit
AMPERE - unit of electric current; Symbol is “I”
RESISTANCE - restricts flow of current. Unit of resistance is Ohm.
IMPEDANCE - measure of complex resistive and reactive attributes of component in an AC circuit.
VOLT - unit of electric pressure; Symbol is “E
WATT - unit of electric power; Symbol is “W.”

OHM’s LAW :

I = E/R ; P=IE

=watt

CIRCUIT - flow of electricity through wires from 1 or more outlet and back to source.

FUSE - safety device used to cut off electricity when current flowing exceeds its rated capacity .

CIRCUIT BREAKER - automatic safety device used to break flow of electricity.

SHORT CIRCUIT - over current resulting from fault between live conductors.

CAPACITOR - a device with two conductors separated by insulator which maybe solid, liquid or gas

INDUCTOR - it is a coil of insulated wire or " magnet wire" wound on any magnetic or semi-magnetic materials.

CONDUCTOR - substance capable of conveying electric current. Copper wire is usual example.

BARE CONDUCTOR - no insulation or covering.

COVERED CONDUCTOR - covered with 1 or more layers of insulation.

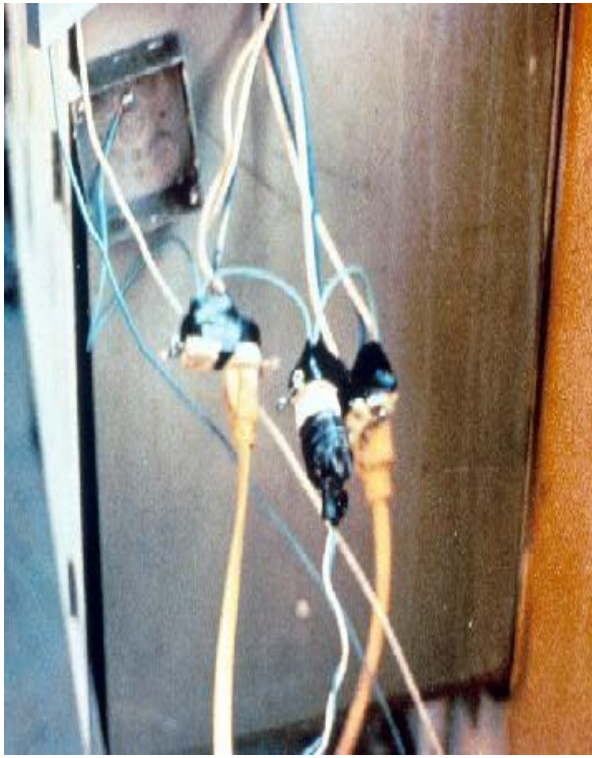
INSULATOR - material that will not permit the passage of electricity

CONDUCTOR GAUGE - system for conductor sizes in American Wire Gauge (AWG) or mm^2 diameter.

FREQUENCY - number of periods per unit time in cycles per seconds or Hertz. For AC power lines, widely used frequency is either 60 and 50 Hz.

Electrical accidents are caused by a combination of three factors:

1. Unsafe equipment and/or installation,
2. Workplaces made unsafe by the environment, and
3. Unsafe work practices.



Control – Close Openings

- Junction boxes, pull boxes and fittings must have approved covers
- Unused openings in cabinets, boxes and fittings must be closed (no missing knockouts)

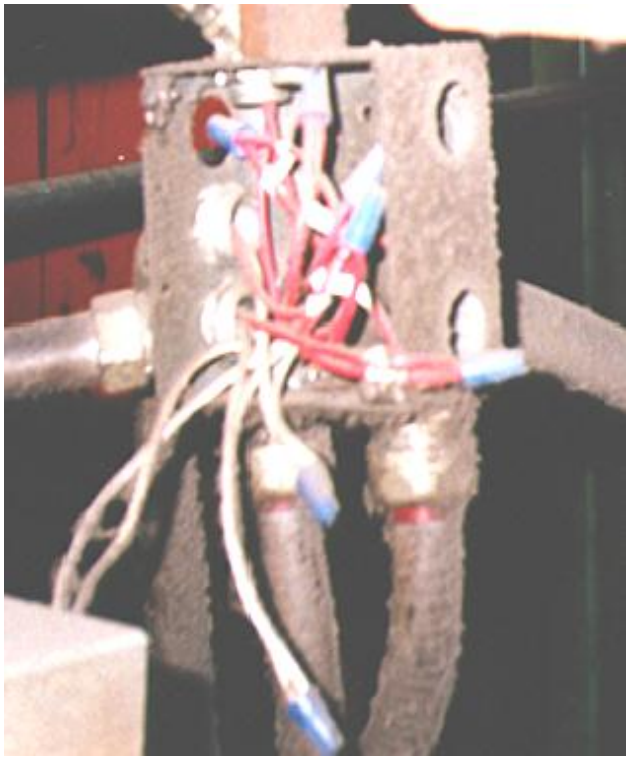


Photo shows violations of these two requirements

Hazard – Damaged Cords

- **Cords can be damaged by:**
  - **Aging**
  - **Door or window edges**
  - **Staples or fastenings**
  - **Abrasion from adjacent materials**
  - **Activity in the area**
- **Improper use can cause shocks, burns or fire**

HAZARDS RELATED TO ELECTRICAL WORK

1. **Death** — due to careless and unsafe electrical work habits w/c can result in fatal accidents (e.g. electrocution).

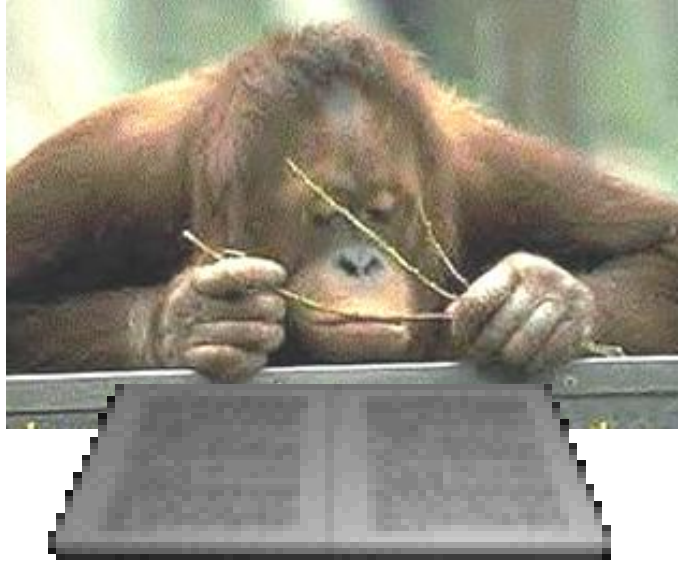
2. **Burns** — due to accidental shorts or faults of electricity that blow slag or molten metal which can burn.

3. **Fractures** — working on ladders or working on height/elevation situation can result in falls due to electric shock.

4. **Muscle Tear** — due to heavy and bulky electrical equipment

5. Sterility — due to electromagnetic radiation

MYTHS & MISCONCEPTIONS ON ELECTRICITY



- **Electricity takes the path of least resistance.**
- **Electricity wants to go to ground.**
- **If an electric tools falls into a sink or tub of water, the item will short out.**
- **AC reverse polarity is not hazardous.**
- **It takes high voltage to kill; 120 volts is not dangerous.**
- **Double insulated power tools are doubly safe and can be used in wet and damp locations.**

COMMON ELECTRICAL SAFETY VIOLATIONS

1. Not guarding live parts of 50 volts or more.

2. Not having reliable equipment grounds run with the circuit supply conductors.

3. Using extension cords in place of permanent wiring.

4. 110 volt appliance plug to 220v that will overhead the wires.

5. unattended appliances such as :
   - electric oven
   - flat iron
   - electric fan
   - water heater

6. Failure to de-energize equipment before working on it.

WHAT DANGEROUS ELECTRICITY CAN DO?

Electricity flowing through the body can cause:

1. **shock**
2. **involuntary muscle reaction**
3. **paralysis of muscles**
4. **burned tissues and organs**
5. **Death**

Electricity can also:

1. **damage sensitive equipment**
2. **ignite combustible materials**

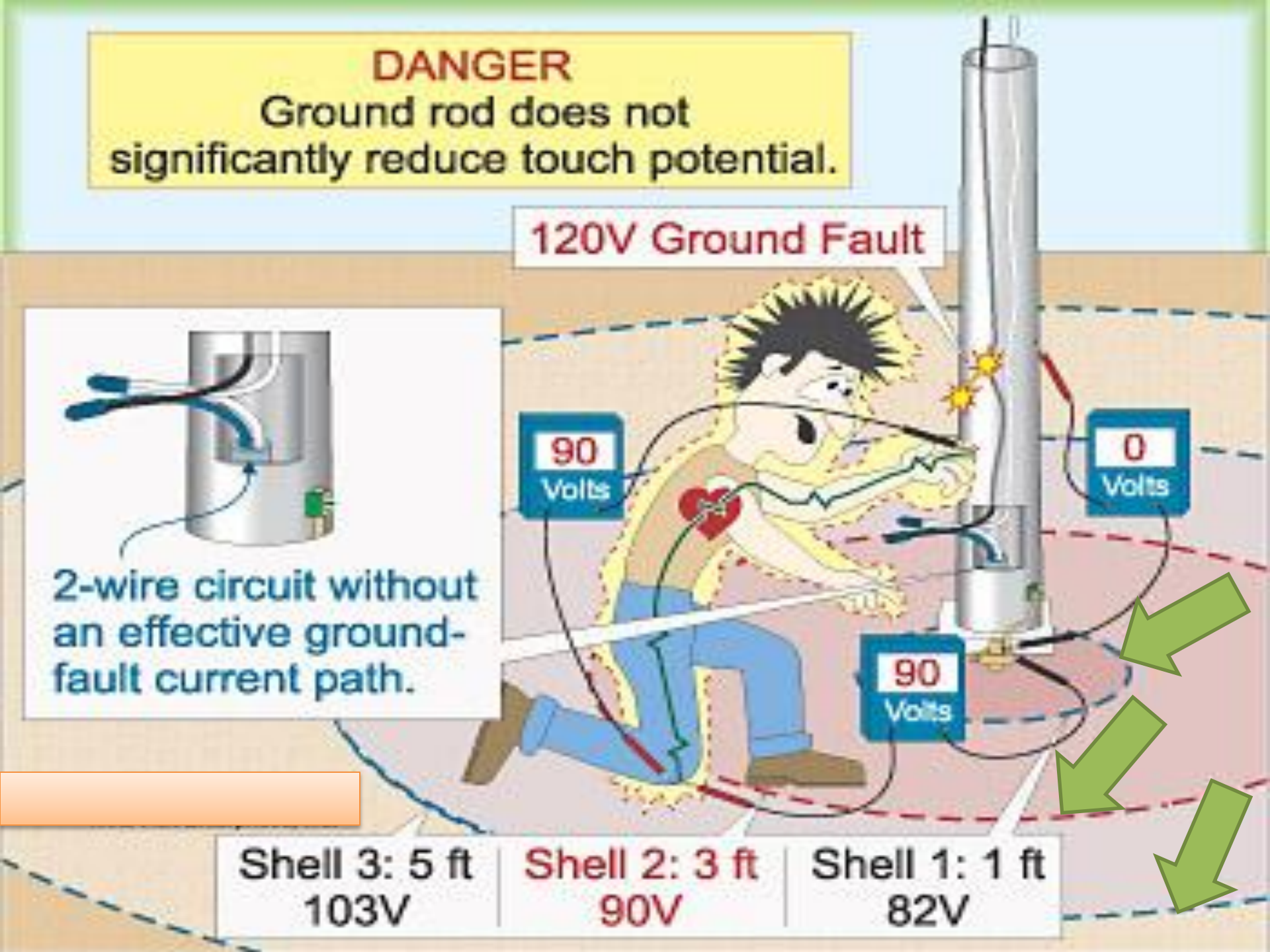
GROUNDING

The permanent joining of metallic parts to form an electrically conductive path that ensures electrical continuity and the capacity to conduct safely any current likely to be imposed.

- **Grounding and bonding is the single most important practice for the protection of people and property. The National Electric Code (NEC), NFPA 70, defines grounding and bonding and provides requirements for the grounding of a building's electrical system**

- **The primary goal of the grounding system throughout any facility is electrical SAFETY. Secondary are effective lightning protection(Sec. 2.90), diminishing electromagnetic coupling (EMC), and the protection against electromagnetic pulses (EMP).**

DANGER
Ground rod does not significantly reduce touch potential.



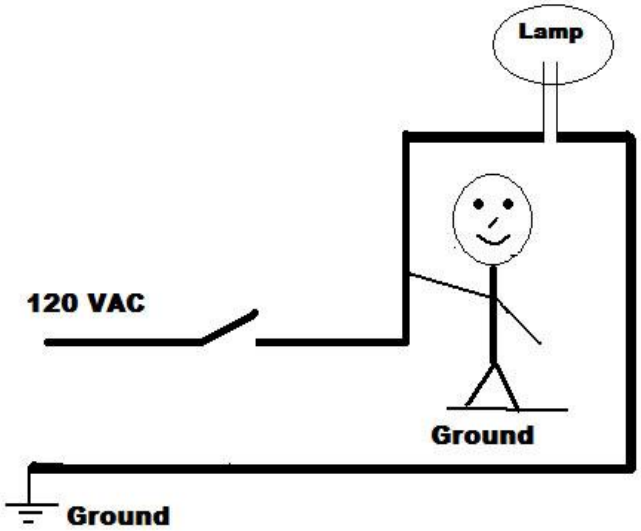
2-wire circuit without an effective ground-fault current path.

GROUNDING

- **Grounding creates a low-resistance path from a tool to the earth to disperse unwanted current.**

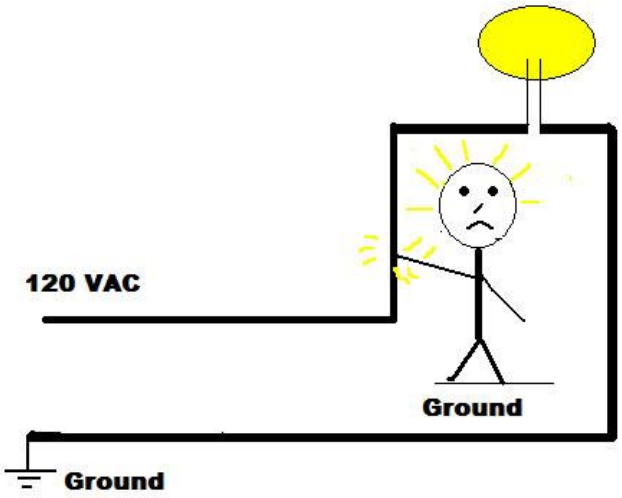
- **When a short or lightning occurs, energy flows to the ground, protecting you from electrical shock, injury and death.**

Electrical Shock



Open circuit with worker grounded

Worker receiving electrical shock from lighting circuit



FACTORS VARYING EFFECTS OF CURRENT

The effects of electric current on the human body can vary depending on following factors:

1. **Source characteristics -** current, frequency and voltage of all electric energy sources.
2. **Body impedance** and **current's pathway** through the body.
3. How **environmental conditions** affect the body's **contact resistance**.
4. **Duration** of the contact.

Damp or dry?

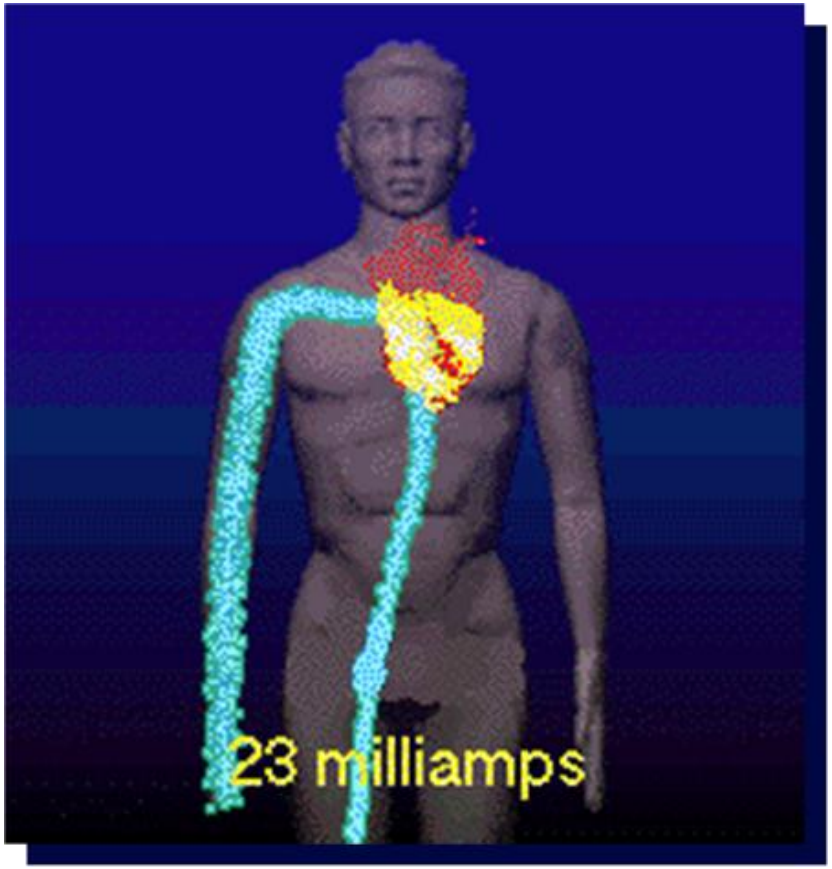
Critical path is the chest cavity

Bare foot or w/ shoes?

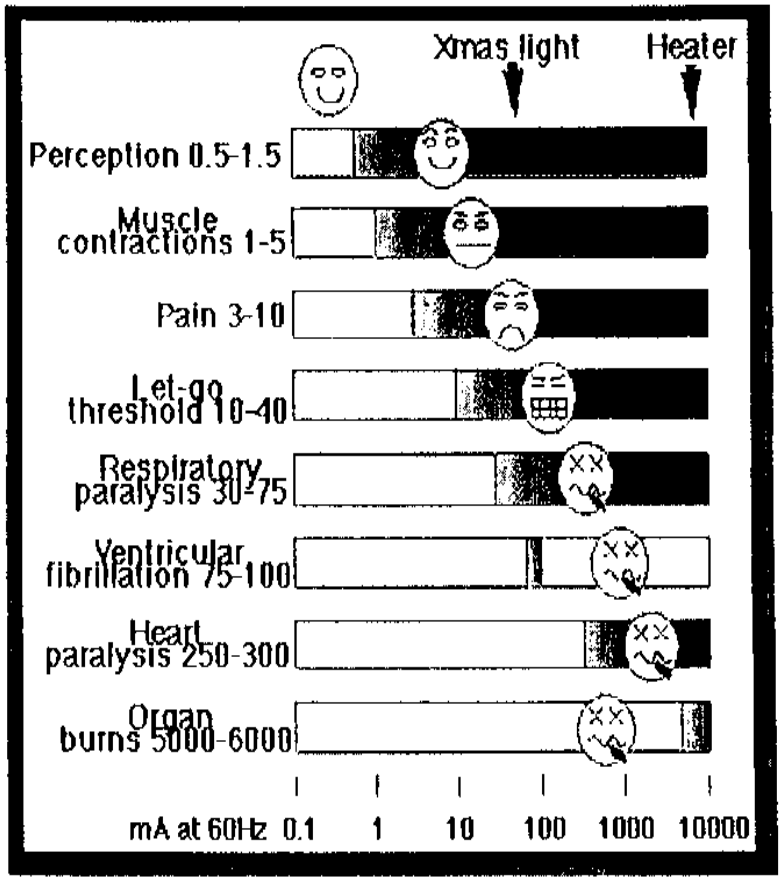
Hazard – Improper Grounding

- **Tools plugged into improperly grounded circuits may become energized**
- **Broken wire or plug on extension cord**
- **Some of the most frequently violated OSHA standards**

Current flows through the body from the entrance point, until finally exiting where the body is closest to the ground.



Immediate Effects of Current on Human Body



Physical Injuries

- broken bones, falls and muscle damage;
- at 10 mA, muscles clamp on to whatever person is holding.

Nervous System Effects

- stop breathing at 30-75 mA;
  - fibrillation at 75-100 mA (where heart is twitching; no blood flow to the body; heart can be damaged)

Burns

- from current flowing on tissues
- from arcs (40,000-35,000ºF)

Effects of DC/AC on Body & Incident Severity

	Direct current (mA)		Alternating current (mA) 60 Hz		10,000 Hz		
Effect/feeling	**150 lb**	**115 lb**	**150 lb**	**115 lb**	**150 lb**	**115 lb**	**Incident severity**
Slight sensation	1	0.6	0.4	0.3	7	5	None
Perception threshold	5.2	3.5	1.1	0.7	12	8	None
Shock not painful	9	6	1.8	1.2	17	11	None
Shock painful	62	41	9	6	55	37	Spasm, indirect injury
Muscle clamps source	76	51	16	10.5	75	50	Possibly fatal
Respiratory arrest	170	109	30	19	180	95	Frequently fatal
=>0.03-s vent. fibril.	1300	870	1000	670	1100	740	Probably fatal
=>3-s vent. fibril.	500	370	100	67	500	340	Probably fatal
=>5-s vent. fibril.	375	250	75	50	375	250	Probably fatal
Cardiac arrest	--	--	4000	4000	--	--	Possibly fatal
Organs burn	--	--	5000	5000	--	--	Fatal if it is a vital organ

[a] See Ref. 1 at the end of this appendix.

STATIC ELECTRICITY

WHY MINIMIZE STATIC SHOCK?

You may be injured by the reaction to the shock even though the shocks are not hazardous!

WHAT YOU CAN DO?

1. Never clean the glass face of your computer monitor while the computer is “on.”
2. Never allow any electrical powered office equipment to become wet while it is “on.”
3. Never turn on any electronic equipment when it is wet.

Arc Flash/Blast

- Arc Flash/Blast occurs when an energized source comes in contact with a grounded source creating an unexpected release of energy in the form of noise and pressure.

- Effects of Arc Flash/Blast - may cause severe burns, eye and hearing damage

First Aid Treatment on Electric Shock

1. Safely remove the victim from contact with the source of electricity.

2. Call for medical assistance.

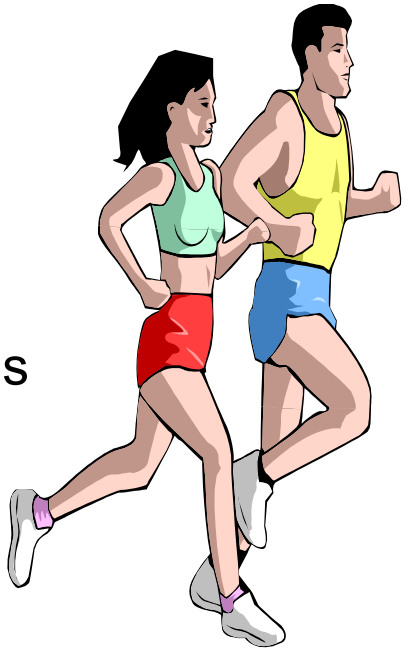
3. Check victim’s breathing and heartbeat.

4. Administer first aid for electric shock and burns as necessary.

5. Always continue treatment but only within your ability until medical help arrives.

SAFETY PRECAUTIONS & HAZARD CONTROLS

1. Use BPS or internationally-approved electrical components
2. Be sure all current carrying electric lines are well insulated.
3. Know where all emergency shutdown switches are located.
4. Watch out for burned wires on electrical devices.
5. Never touch a conductor without first testing.
6. Look for loose conductors in electrical systems.
7. Don’t make any repair to any electrical eqpt until all power has been disconnected or the breaker has been turned off.
8. Make proper grounding of electrical equipment and tools
9. Don’t operate electrical parts with wet gloves or wet clothing;
10. Never work alone when working with more than 50 volts.
11. Licensed electrical engineer to handle high voltage (greater than 750 V) and licensed electrician on other electrical works



SAFETY PRECAUTIONS & HAZARD CONTROLS

GROUND FAULT CIRCUIT INTERRUPTER (GFCI)
When the GFCI works properly, the power is cut of so fast that the shock can be reduced to a few microseconds.
GFCI is:

1. **Personal safety device.**

2. Mandatory required on 15-20 A receptacle outlets used for temporary power supply on construction sites and on areas specified in PEC (usually “wet” areas).

3. Stops current before severe personal injury occurs.

.

Control – Use GFCI (ground-fault circuit interrupter)

- **Protects you from shock**
- **Detects difference in current between the black and white wires**
- **If ground fault detected, GFCI shuts off electricity in 1/40th of a second**
- **Use GFCI's on all 120-volt, single-phase, 15- and 20-ampere receptacles, or b an assured equipment grounding conductor program.**

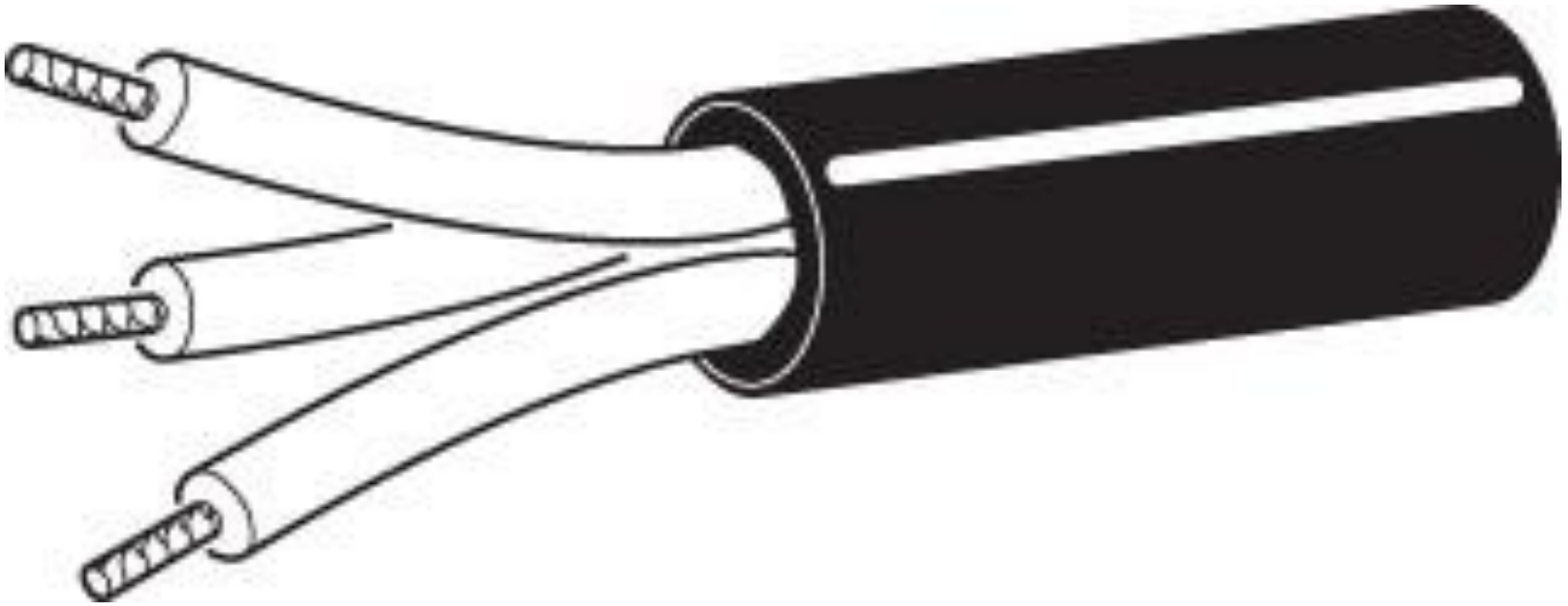
Electrical Lockout/Tagout (LOTO)

- The most important administrative control is Lockout/Tagout

- If you see a lock on an electrical circuit, do not attempt to operate the circuit.
- To gain access to a locked & tagged out circuit, contact the person named on the tag. Do not remove the tag or restore the circuit without approval. If and when possible, a qualified worker will restore the circuit in accordance with the LOTO procedure.
- Electrical locking devices may be installed on a cord, switch, breaker, or disconnect device: look before you operate the equipment.
- Be sure to follow your company's LOTO program.

Pre-Work Briefings

- A pre-work briefing is the best way to identify hazards, answer questions, and plan work.
- They improve productivity, reduce accidents/injuries, and improve communications between all levels of the organization

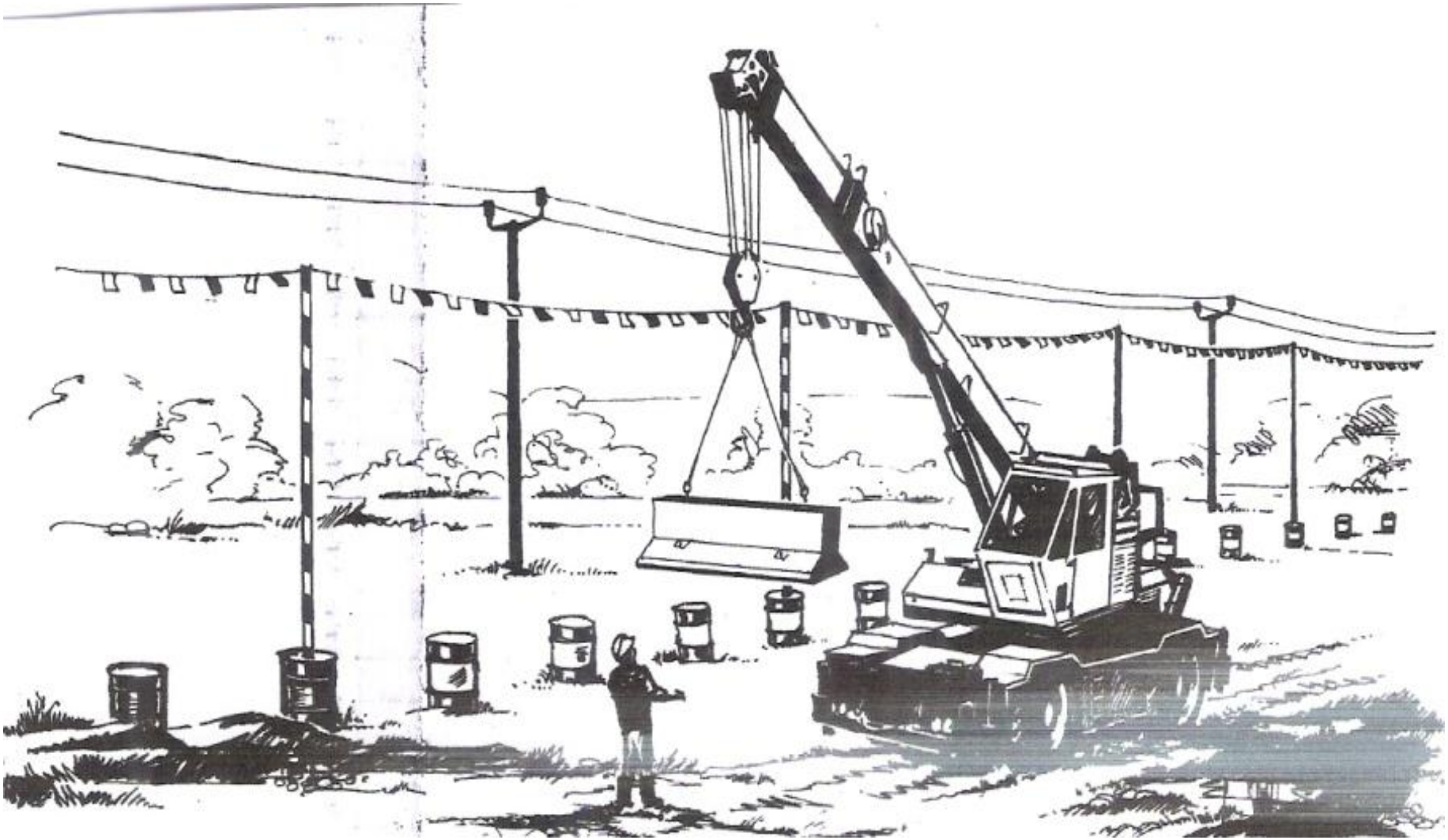


Inherent protection against direct contact by insulation of a 3-phase cable with outer sheath

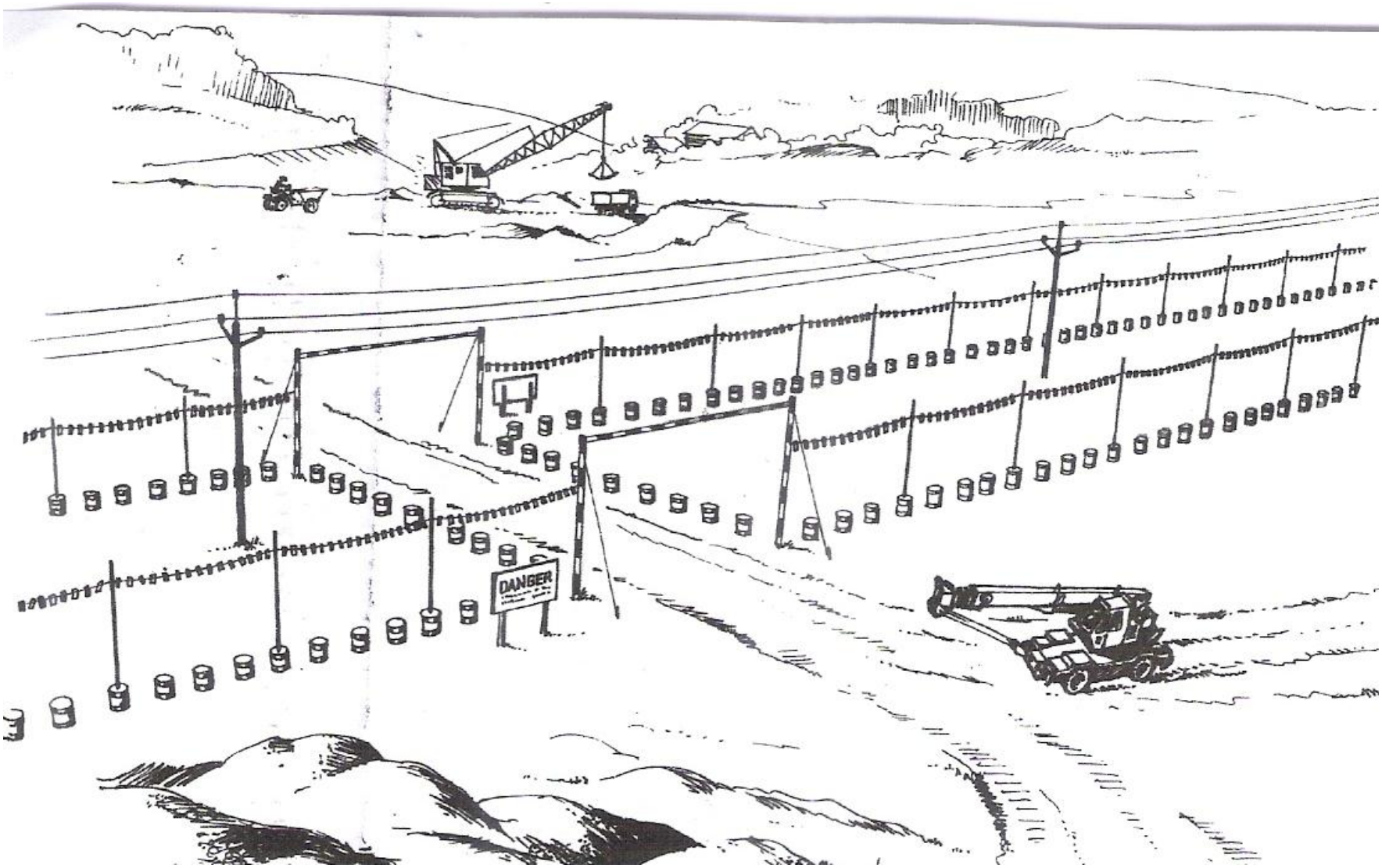
Construction Cable

Table 1: Minimuim Distance for Voltage Ranges	
Voltage range* (phase to phase)	Required minimum distance between workers and exposed, energized parts
300V and less	**Avoid contact**
>300V ≤750V	1 ft. 0 in. (30.5 cm)
>750V ≤2kV	1 ft. 6 in. (46 cm)
>2kV ≤15kV	2 ft. 0 in. (61 cm)
>15kV ≤37kV	3 ft. 0 in. (91 cm)
>37kV ≤87.5kV	3 ft. 6 in. (107 cm)
>87.5kV ≤121kV	4 ft. 0 in. (122 cm)
>121kV ≤140kV	4 ft. 6 in. (137 cm)

MEGGER : 500VDC OR GREATER
#14 or # 12 ------- 1 MEG or better
For larger conductor based on ampacity :
25A - 50A…… 250,000 ohm
51A – 100A …… 100,000 ohm
101A - 200 A ……50,000 ohm
201A – 400A ……25,000ohm
401 A – 800 A …….. 10,000 ohm
Over 800A …. 5,000 ohm
*Good only for conductor rated at 600v
For insulation other than 600 v , the reading not less than 1,000 ohm/volts required
HI-POT Test:
Rating X 1.5 say 35KV x 1.5 = 52.5 KV
Not to exceed 6uA optional if current is increasing or not
35KV cable test 49 KV w/o failure at least 5min.



Sites where there were no passage under the line



Sites passing under the lines

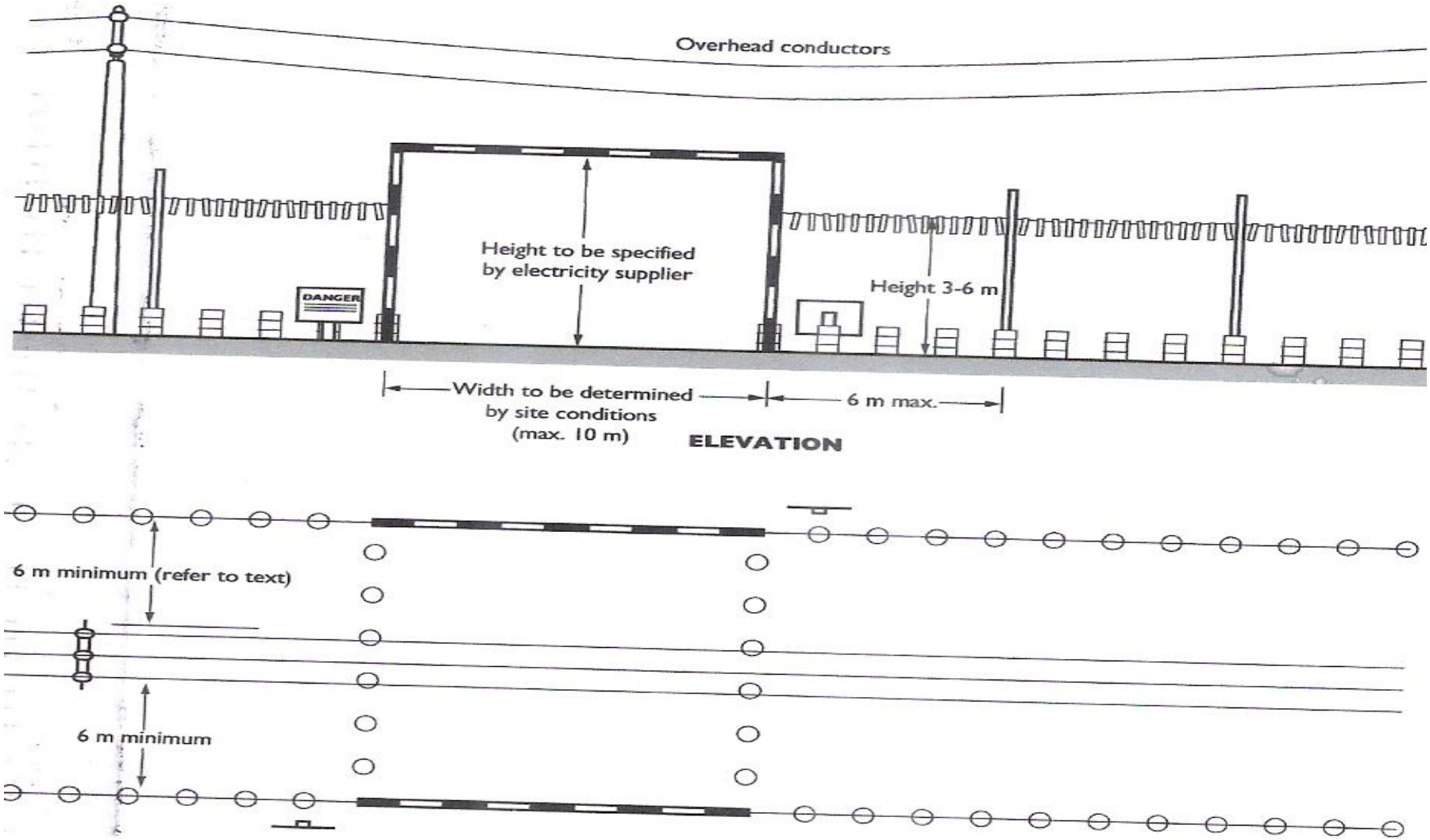
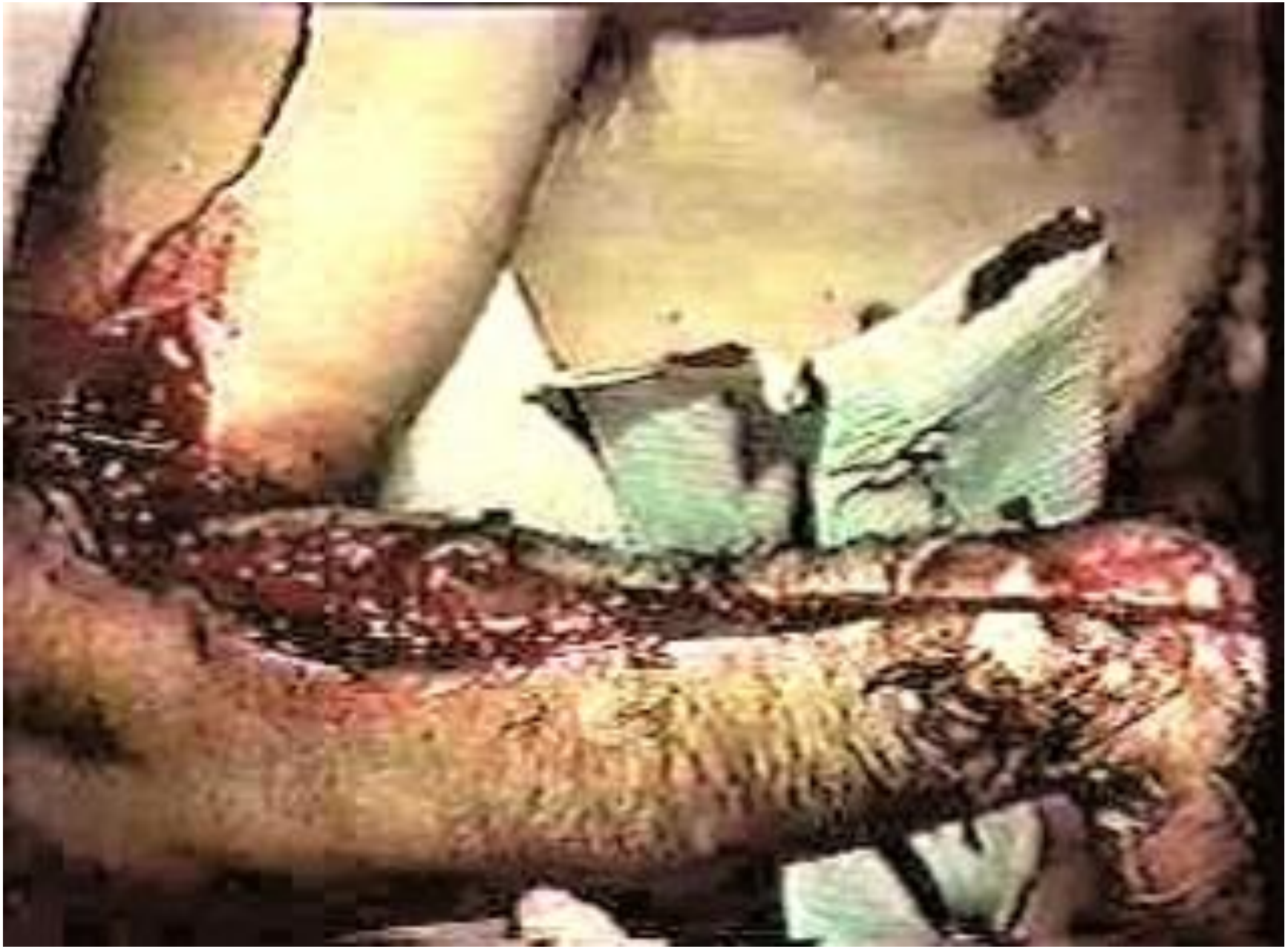
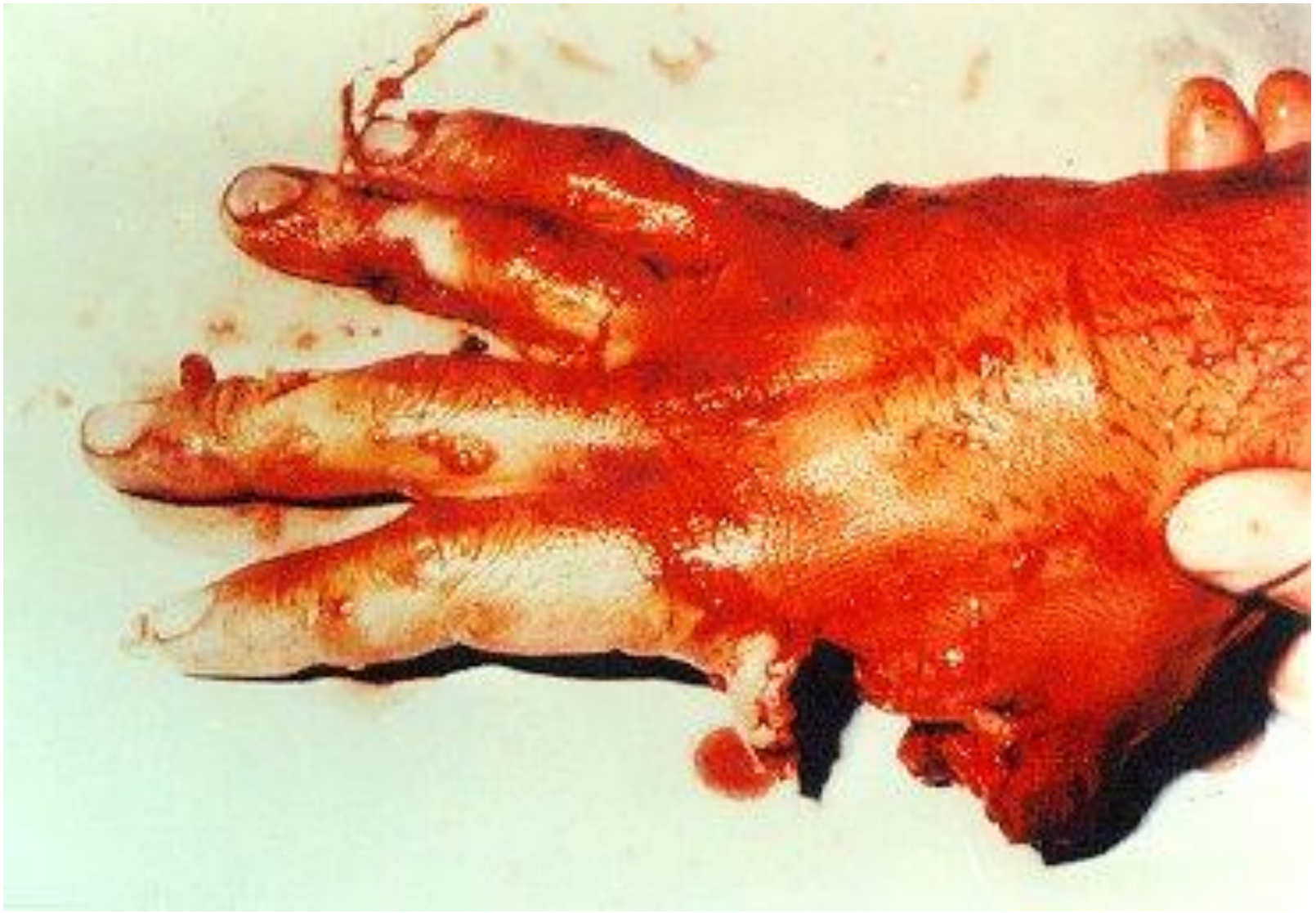

Overhead conductors
Height to be specified
by electricity supplier
DANGER
Height 3-6 m
Width to be determined
by site conditions
(max. 10 m)
6 m max.
ELEVATION
6 m minimum (refer to text)
6 m minimum

PHOTO ALBUM OF

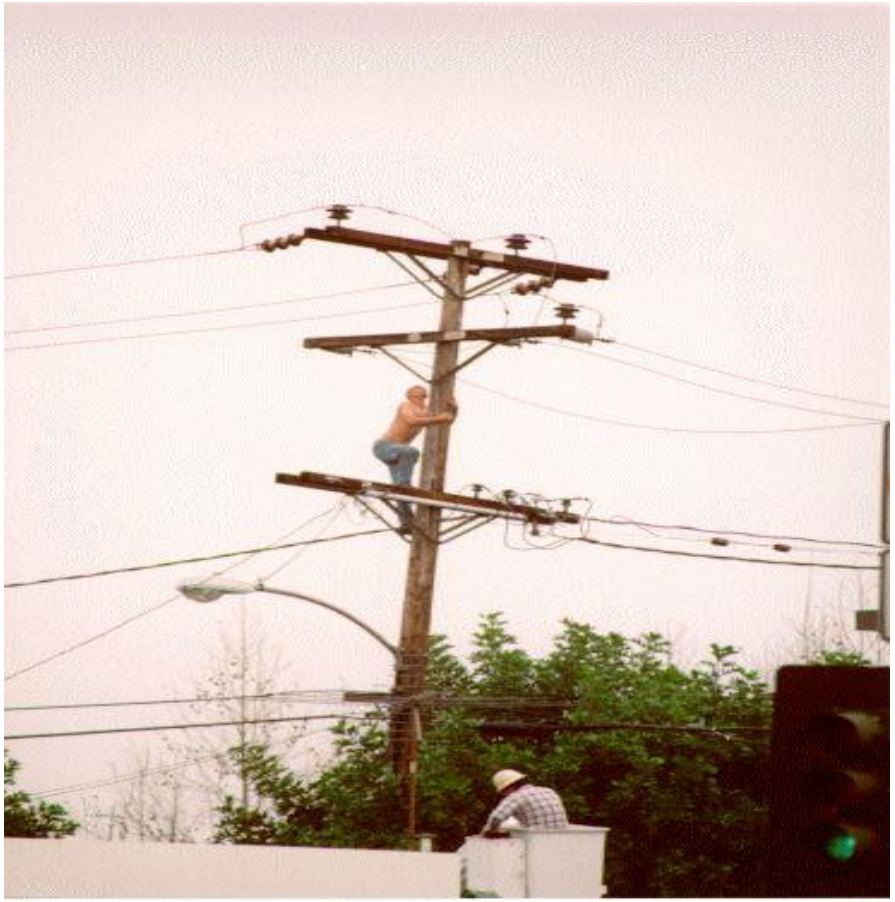
ELECTRICAL ACCIDENTS





Explosion victim blackened by blast.

Electrocution caused by grasping high power cable. Gresham: Color Atlas of Forensic Pathology. 1975.



Video presentation of electrical safety practices (< 15 mins)

Worst case of electrical-related accident!

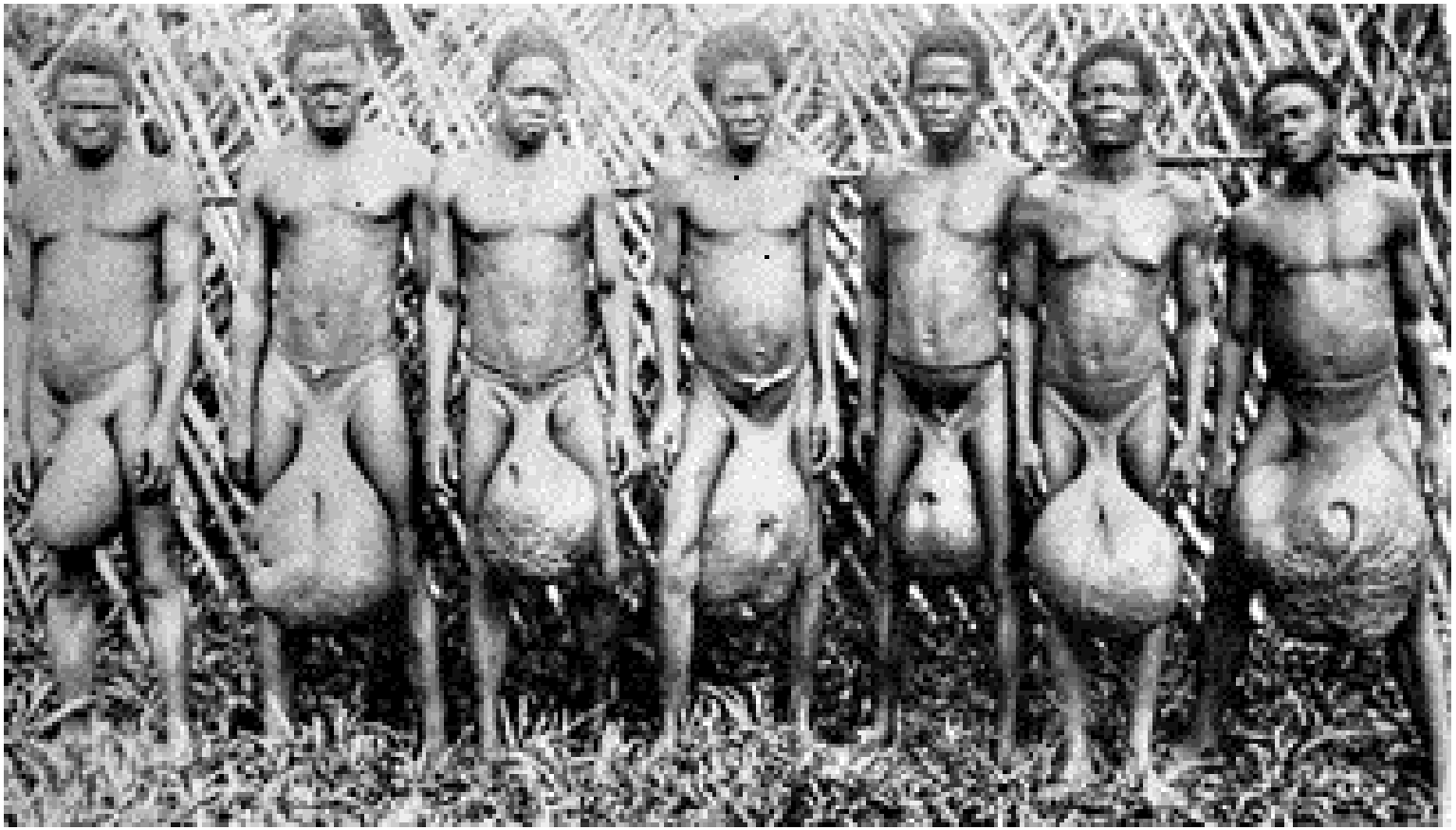
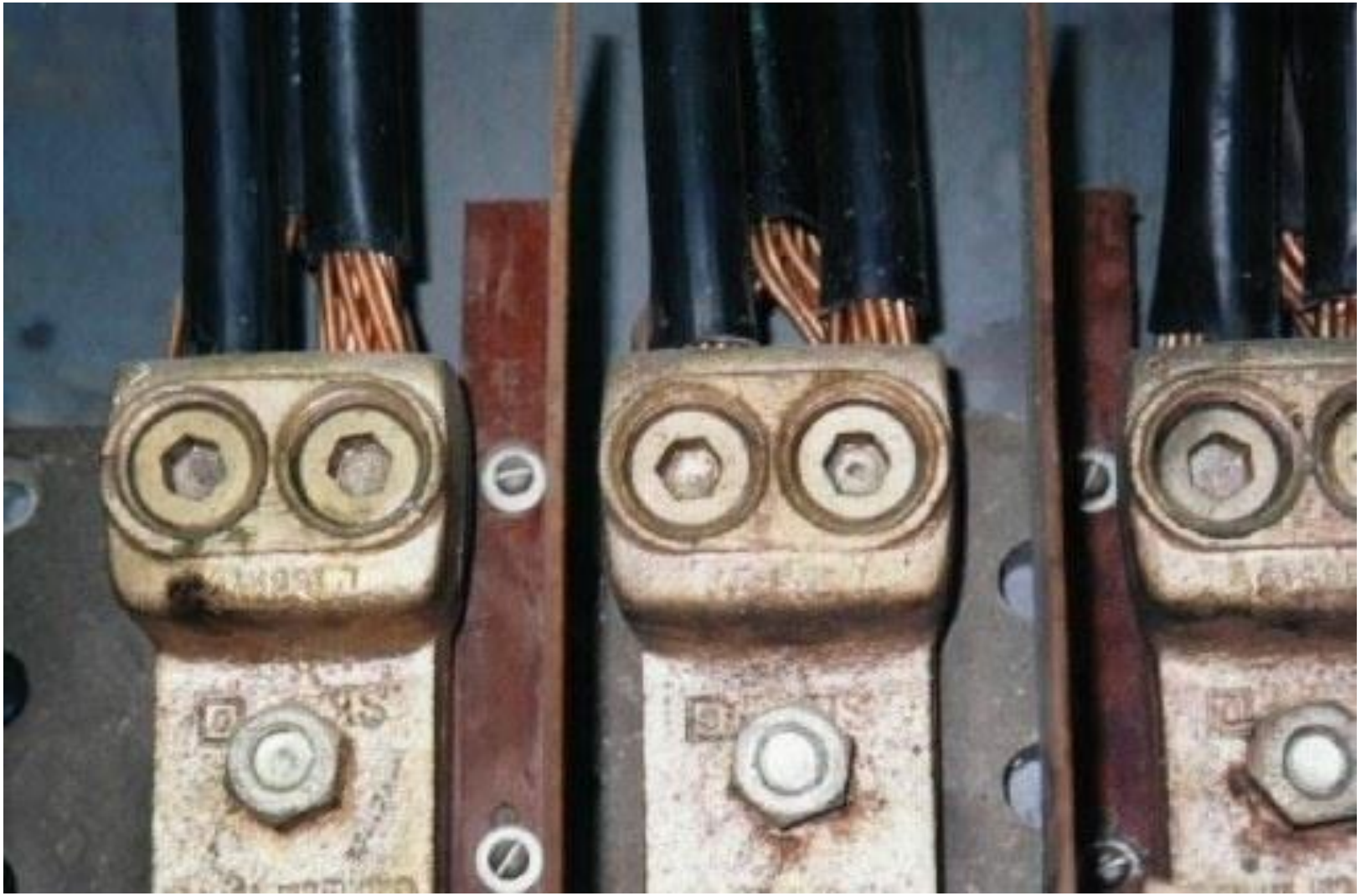
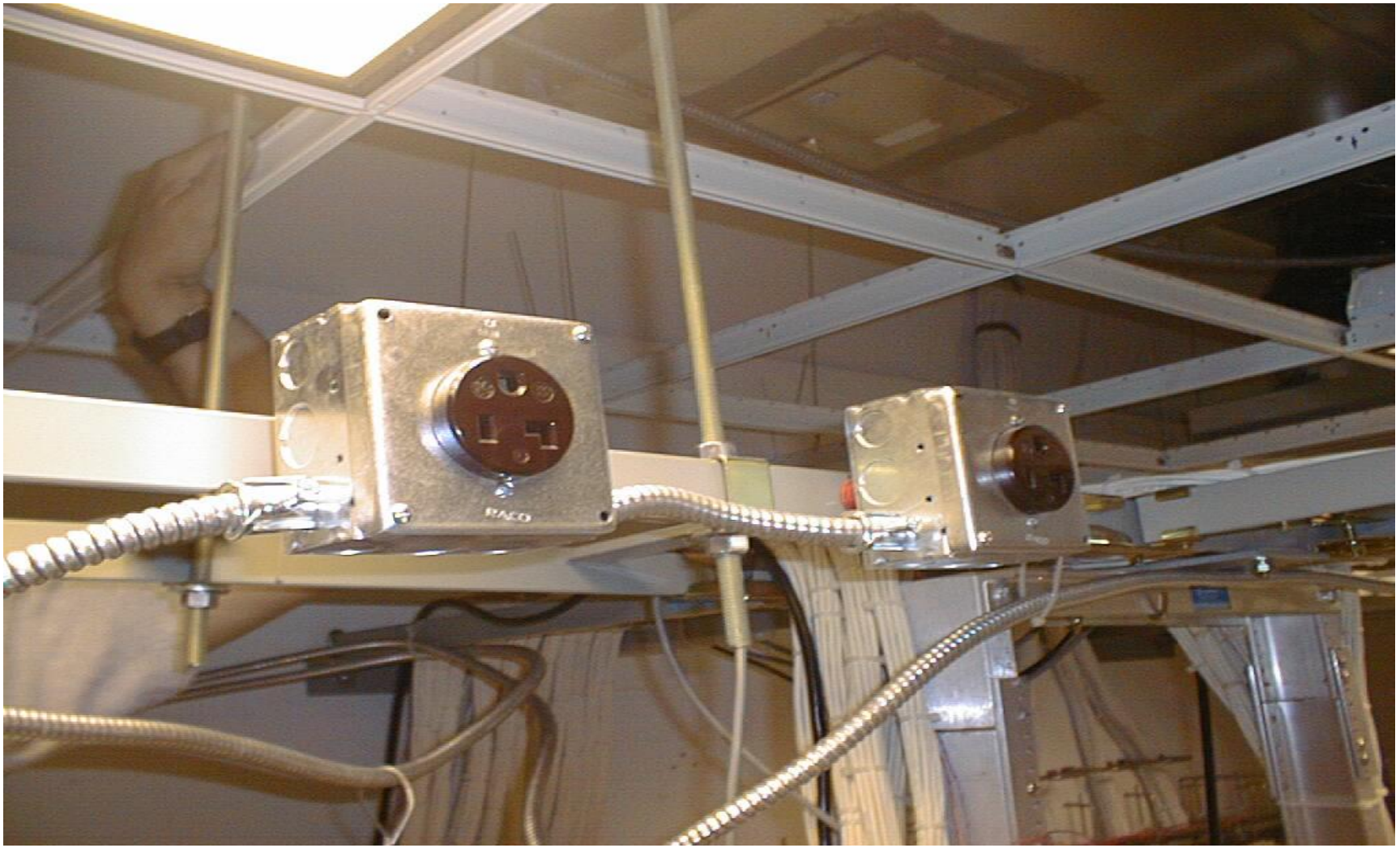
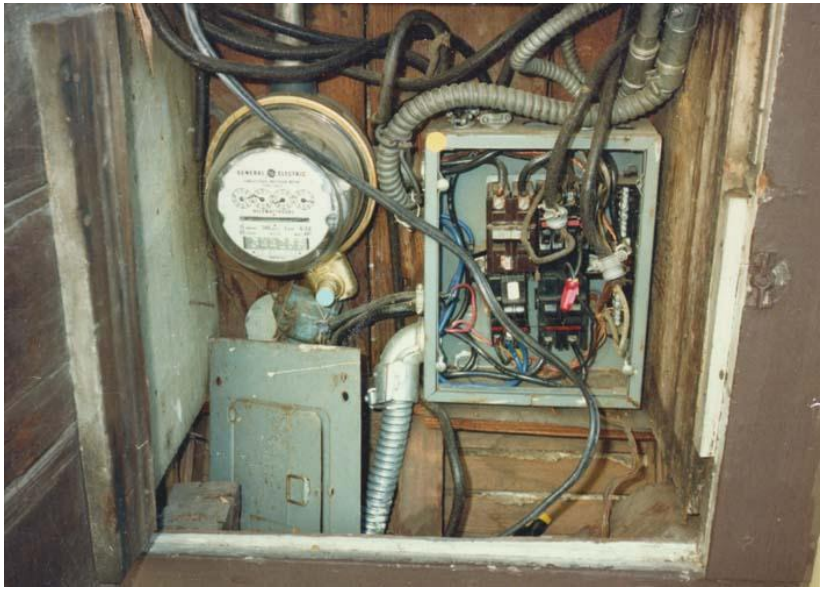


PHOTO ALBUM OF PHILIPPINE ELECTRICAL CODE(PEC) VIOLATIONS

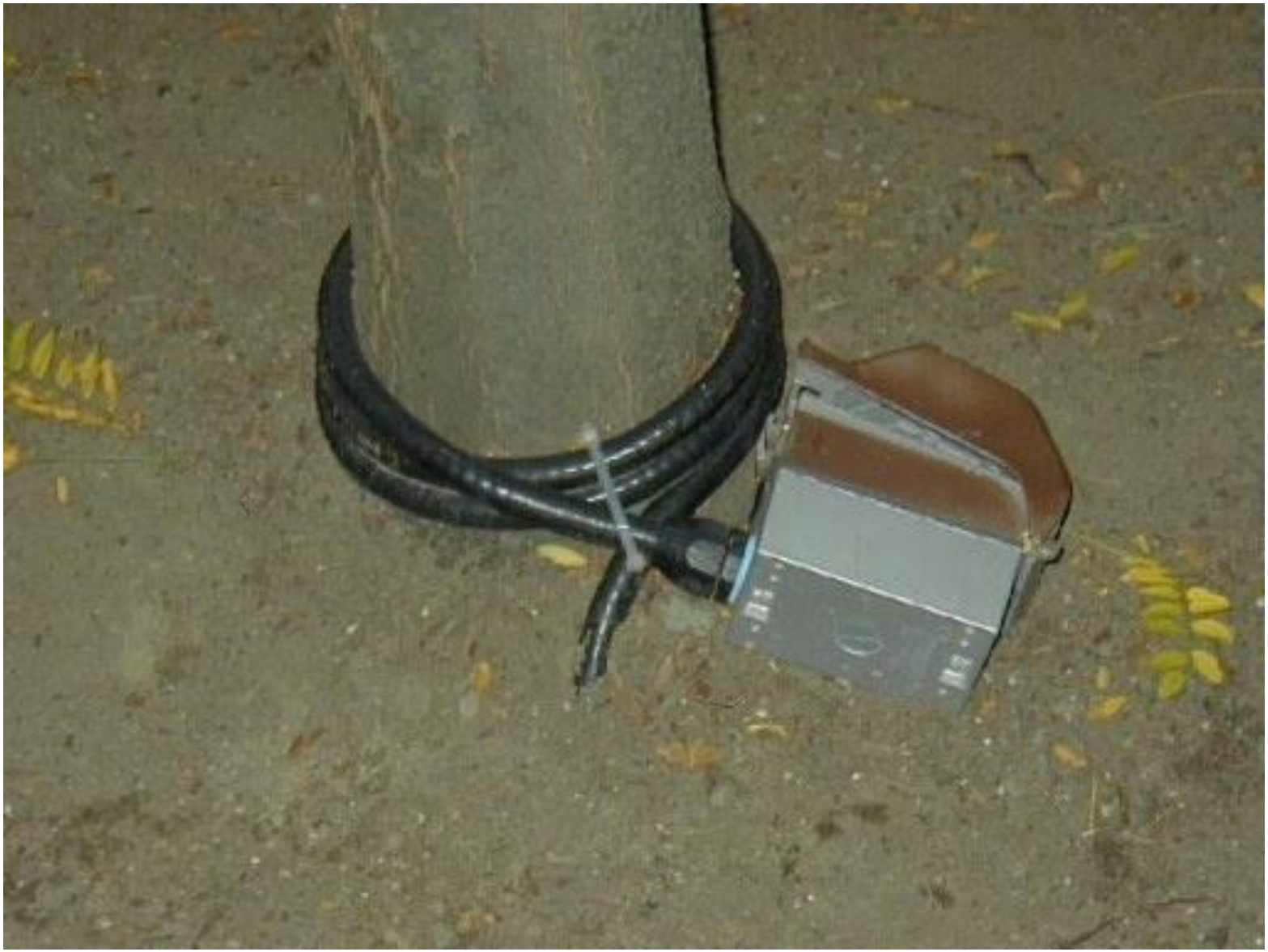


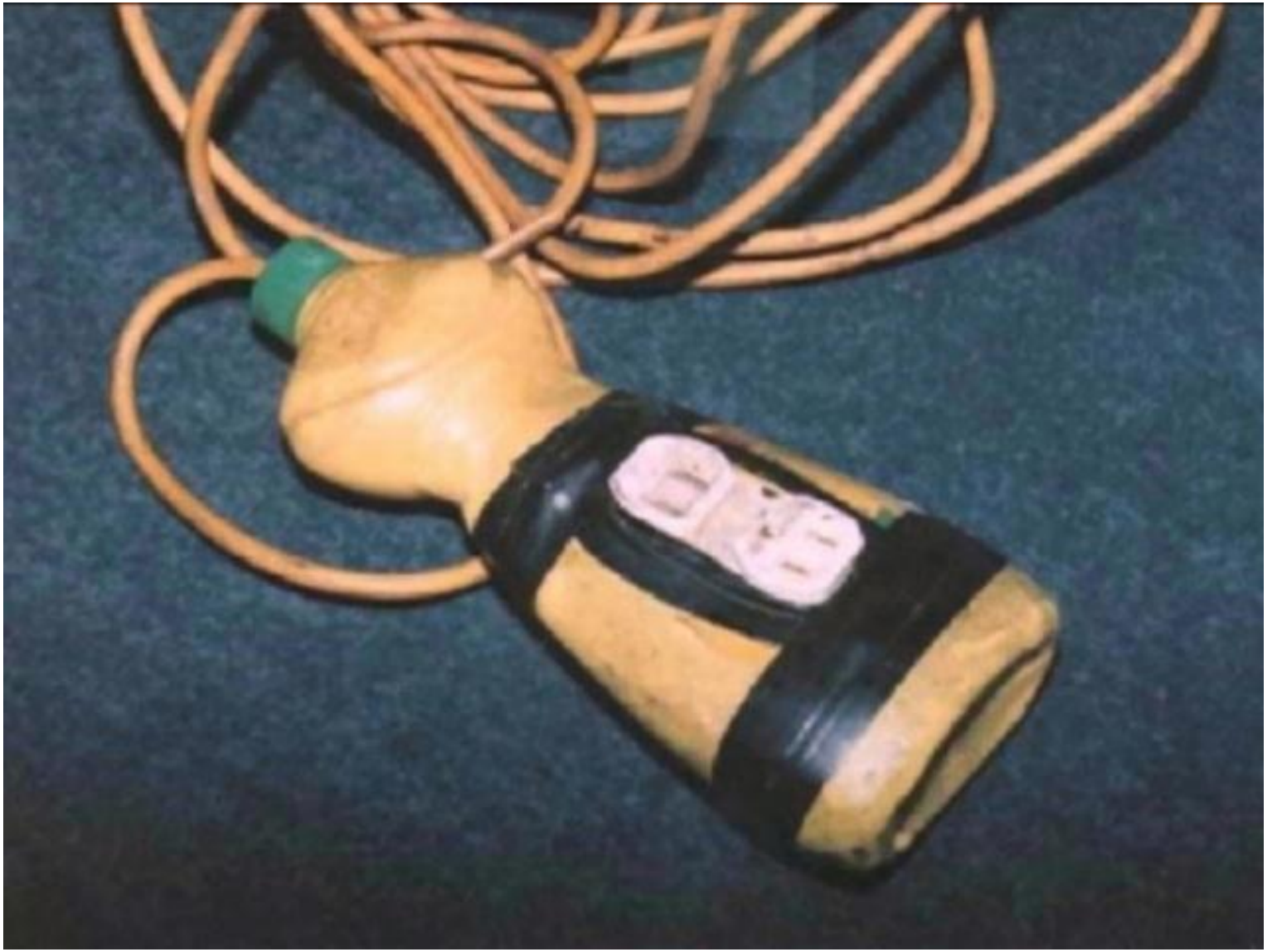

RACO

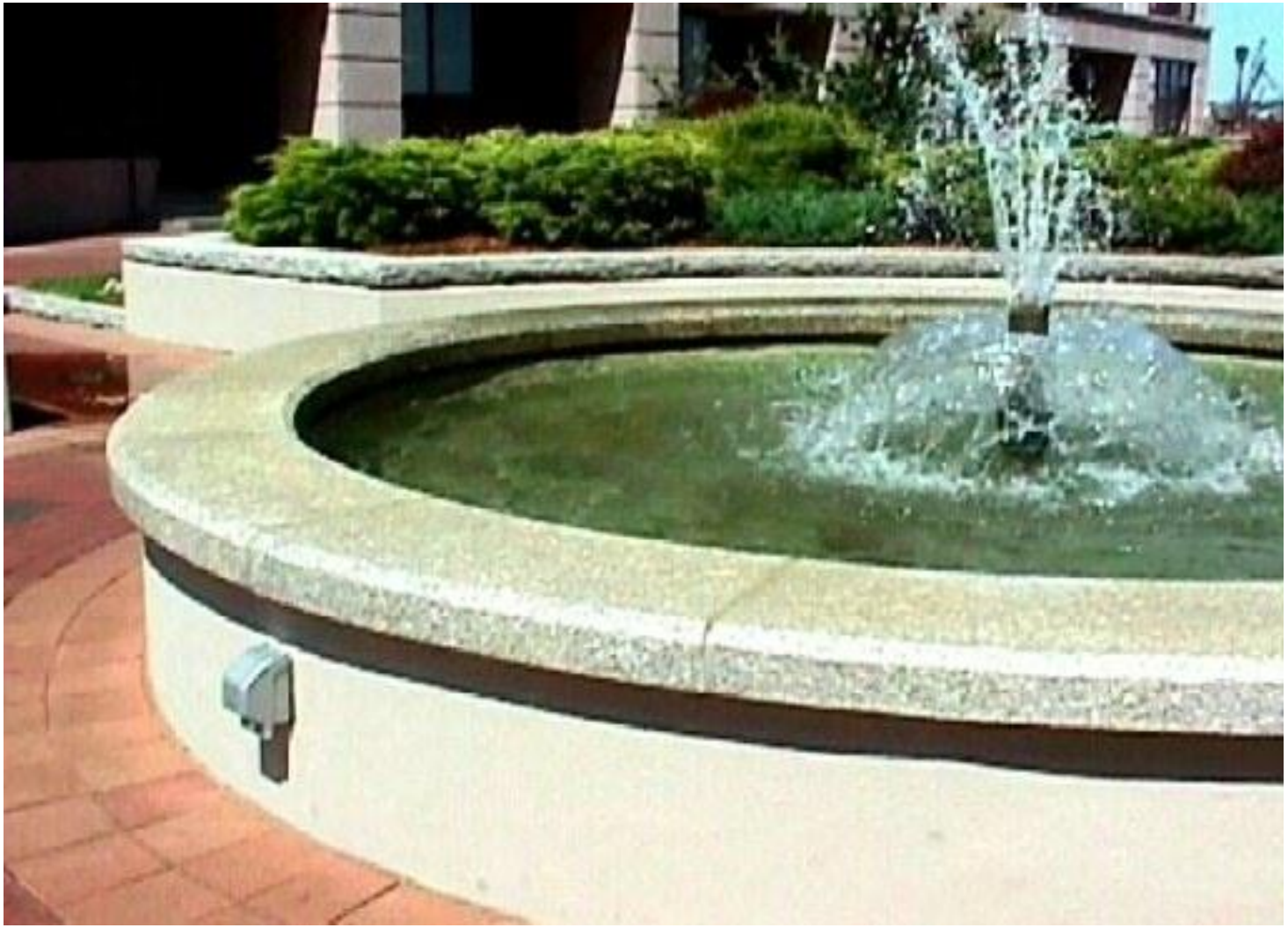

DUNCAN
141 931

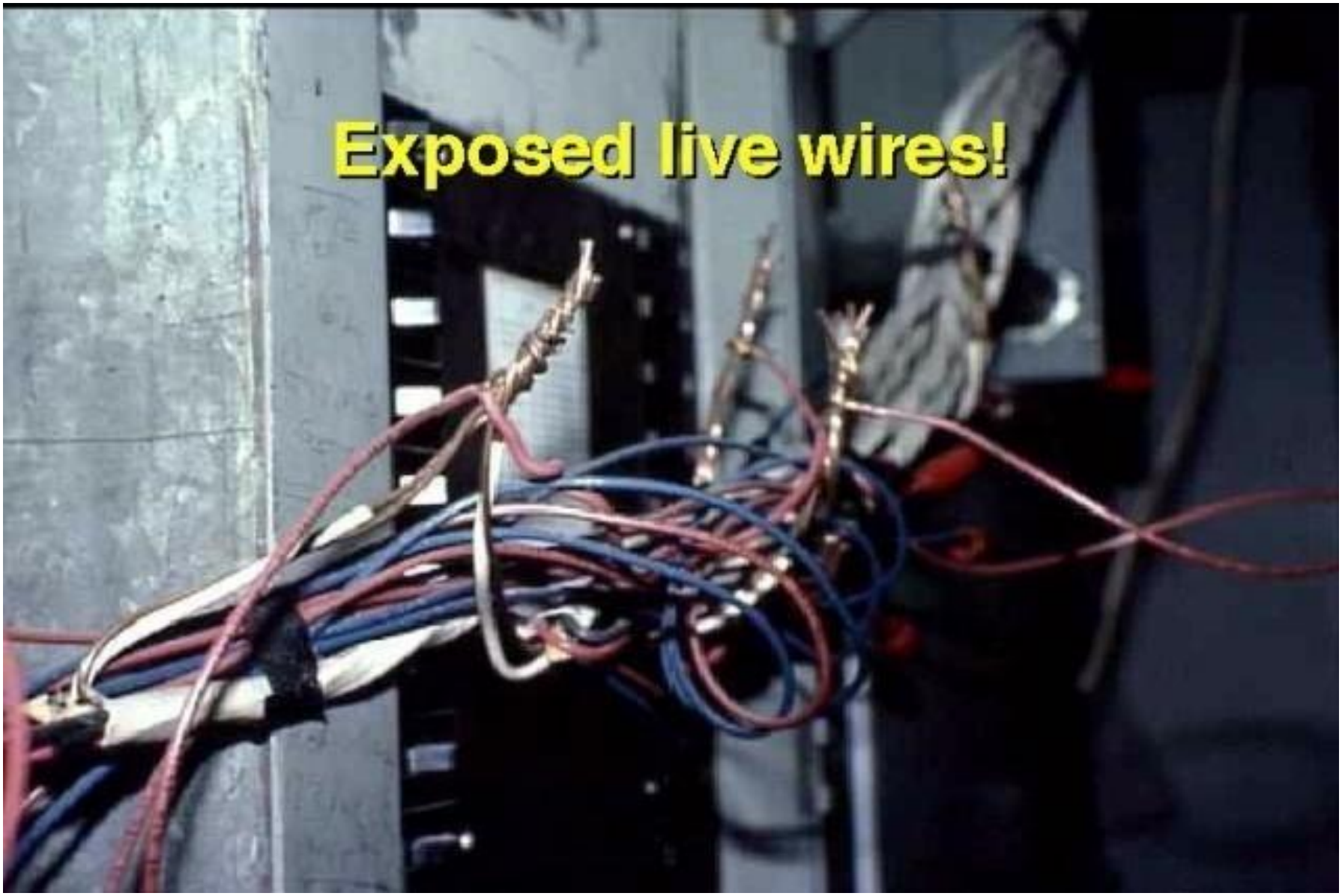



See the NEC Index under the Heading of "Fire Spread"
Use of bags not permitted!!



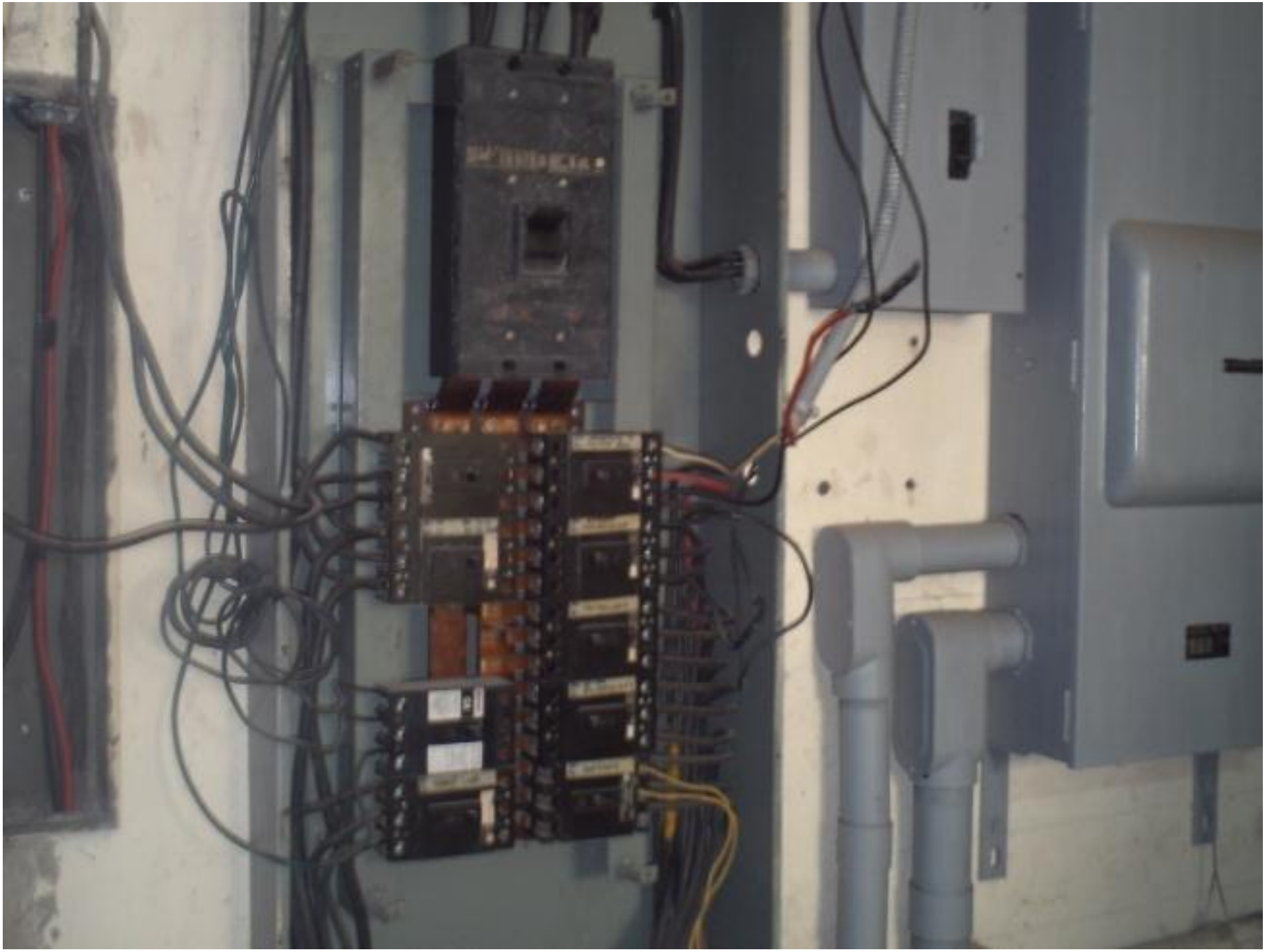


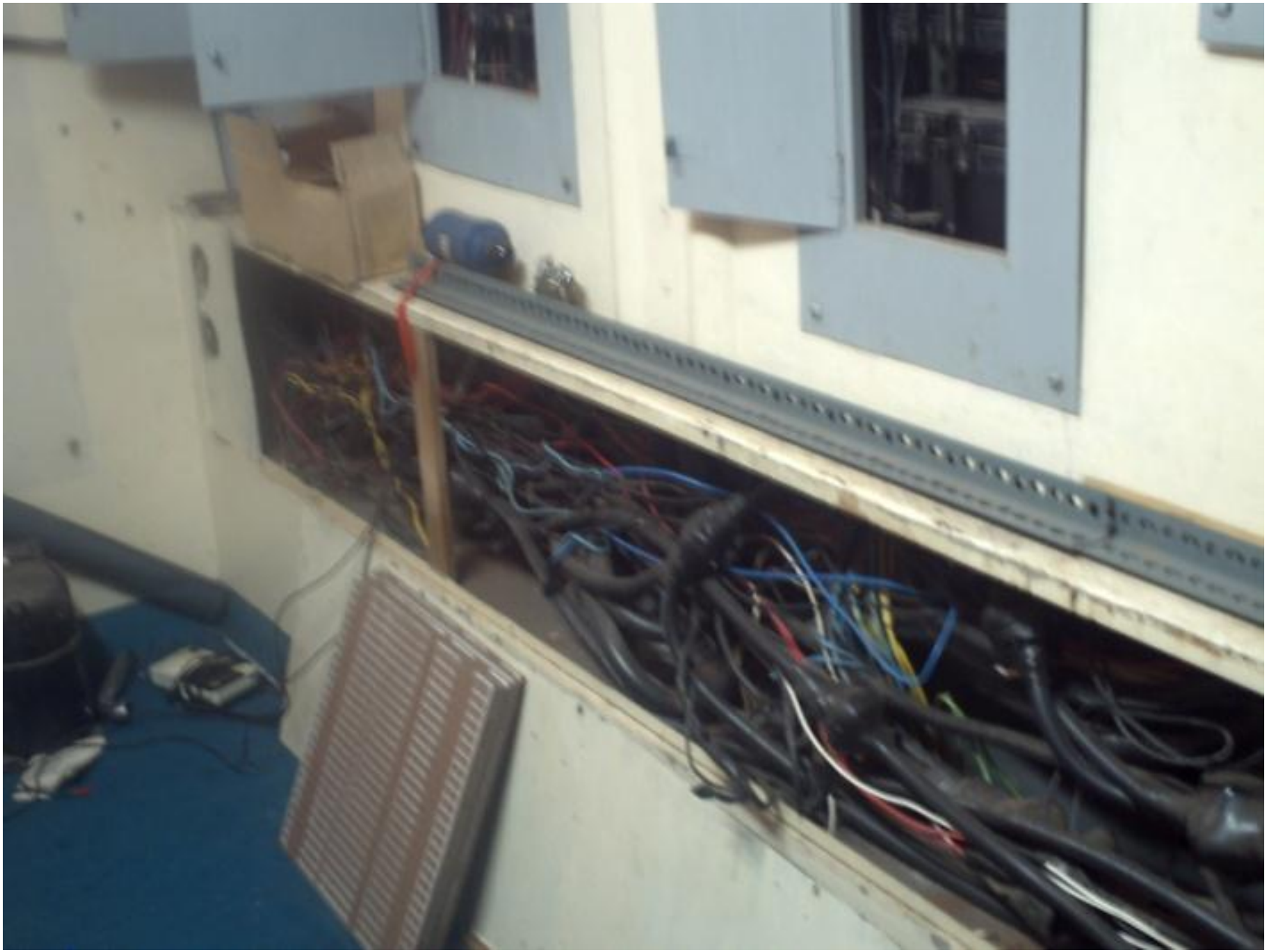



Exposed live wires!

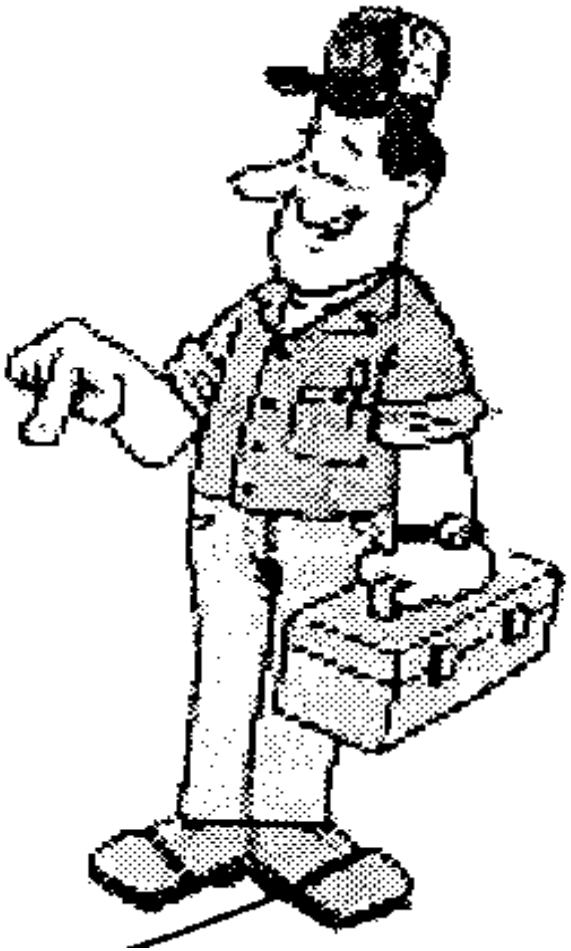

Open wires are not permitted for
branch circuits or feeders.


UNISO





Think it Alive and You will be Alive




THE
END