Electricity

Effects on the Human Body

(Review)

Types of Electrical Hazards

- Shock
- Arc
- Blast

Shock

- Occurs when the body becomes part of the circuit
- There must be an entry and an exit for current to travel through the body
- The current's exit point is often referred to as the "Second Point of Contact"
- The difference between barely sensing electrical current and death is less than a 100 mA

Current effect on a 150 Lb. man

1-3 mA	Faint tingle
3-10 mA	Strong involuntary reactions. Not painful
10 mA	Painful shock. This is called “Freezing current” or “Let Go” range
30 mA	Extreme pain, stoppage of breathing. Can not Let GO! Frequently fatal
75 – 250 mA	Fibrillation, Probably fatal
4 amperes	Heart paralysis

As little as 100mA difference between feeling and death

Severity of Shock

- Three primary factors determine severity
- #1- the amount of current through the body
- #2 - the path of the current takes through the body
- #3 - the length of time the current flows in the body

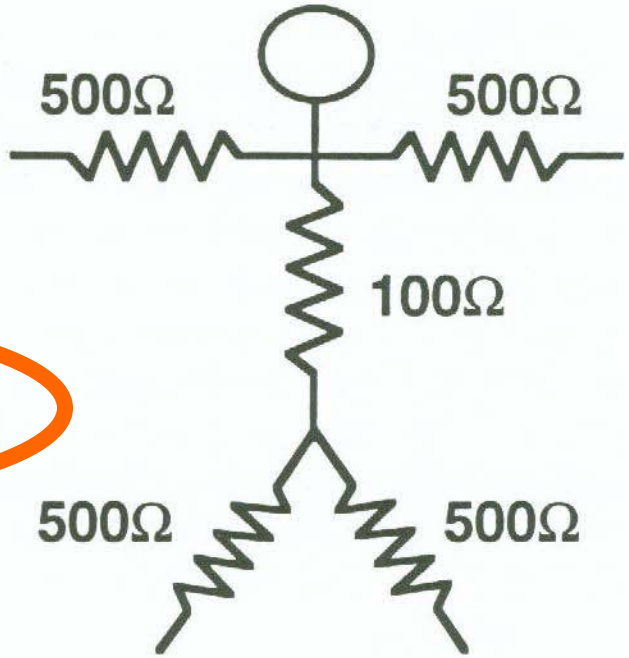
Severity of Shock

- Most common injury is a burn
- Small surface wounds are common (misleading)
- Most damage is internal from the heat generated by the current flow
- Destruction of nerves, tissues, and muscles
- Electrical burns are most serious, seek medical attention immediately

Effects on the Human Body

HUMAN BODY RESISTANCE

- Hand to hand 1000Ω
- 120 volt
- Formula I = E/R
- 120/1000 = 0.120 amps or 120 ma.



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Effects on the Human Body

- Dry calloused skin has the greatest resistance
- Will vary greatly between individuals
- Hands-usually calloused have the greatest resistance
- “Soft” skin, such as back of the knee may be 500 ohms or less
- Cuts, bruises, abrasions and moisture will lower the skin’s resistance substantially

Effects on the Human Body

- Except for skin, human resistance is about 250 ohms for arms and legs
- Chest cavity is between 100 – 500 ohms
- Muscular people have LESS resistance
- Skinny and fat people have more resistance
- 400-600 volts the resistance of skin fails

Electrical Burns

- **Exit Wound:** Current flows through the body from the entrance point, until finally exiting where the body is closest to the ground. This foot suffered massive internal injuries which weren't readily visible, and had to be amputated a few days later.


ARCS
BLASTS

Arcs

- Make up a substantial number of electrical injuries
- Electrical arc between metals can reach 35,000 degrees F. Four times hotter than the sun
- Next to the laser- the hottest thing on earth
- No material on earth can withstand the heat generated by an arc
- Materials not only melt, they vaporize

Arcs

- High arc currents may cause fatal burns up to 5 feet away
- Debilitating burns up to 10 feet away
- Clothing may ignite from several feet away
- Depending on fault current available, arcs generated on a 480 volt system can be just as dangerous as an arc generated on a 13,000 volt system

Blasts

- Caused by the instantaneous heating of air surrounding an arc
- Caused by the expansion and vaporization of metals in an arc
- Enough pressure to hurl a worker several feet (2200 psi)
- May hurl molten pieces of metal in all directions
- Benefit – may push worker away from arc reducing arc burns

Arcs & Blasts

- 1-2 calories will cause 2nd degree burns
- Cigarette lighter hottest point ½ to 1 cal/cm^2
- Non FR clothing 4-5 cals to ignite
- Arcs – 5 cals & up, 30-60 not uncommon
- Fatal burns can & DO happen at 10’ or less

Arcs & Blasts

- 7,000 people/yr admitted to burn center
- 2,000 severe
- 1400 Fatalities
- Bucket becomes a confined space
- Molten copper 1,800 to 2,000 degrees
- Cotton burns at 450 degrees

Burn Center

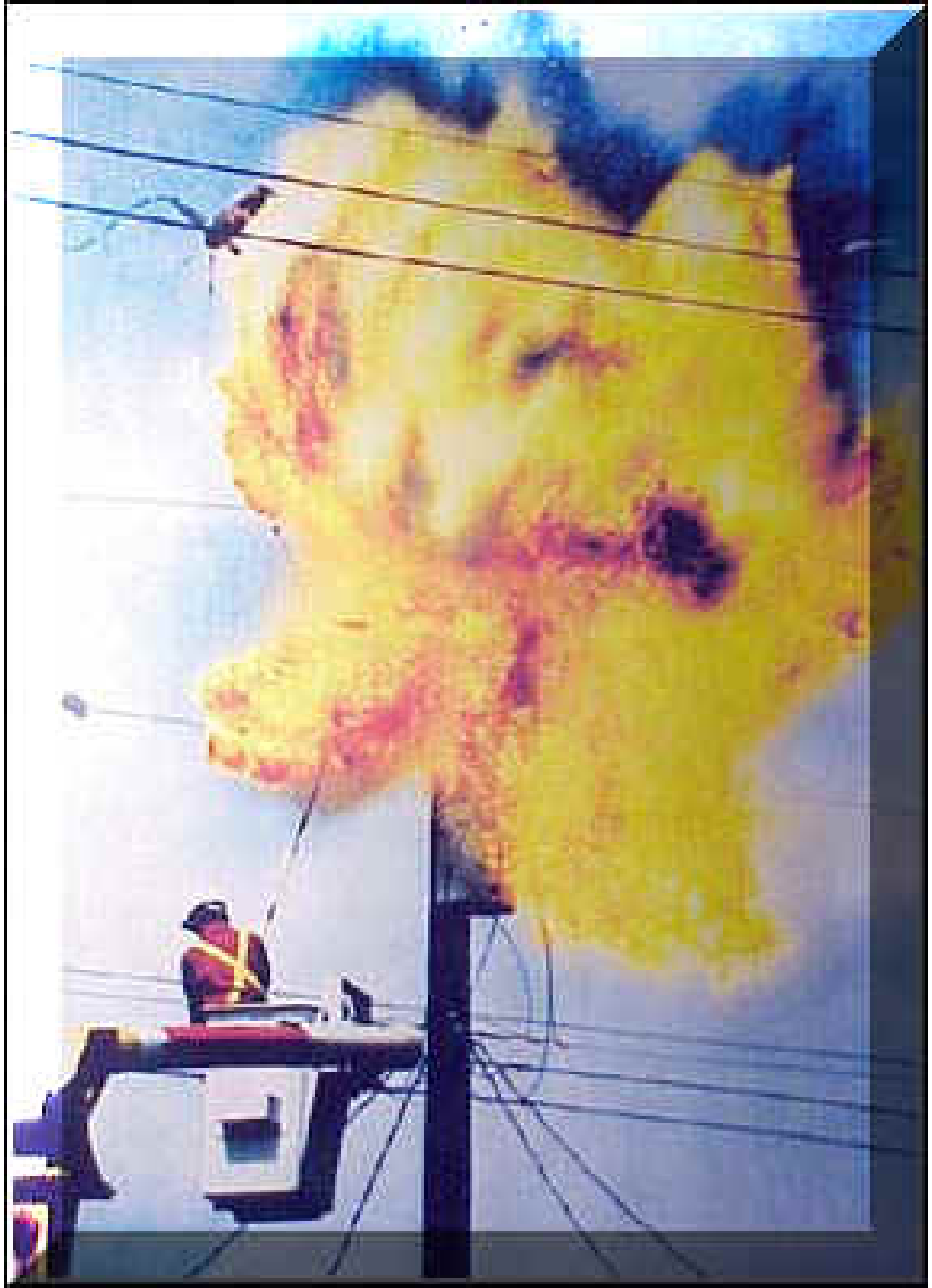
- Hospital stay – 1 ½ days per % of body burn area
- Our Industry – average stay is 19 days
- Average burn center $18,000/day
- Typical costs – $200,000 to $750,000
- Clothing ignites-usually catastrophic!!
- Clothing doesn’t ignite-often minor injuries

Tips for FR

- Fabric softener may be flammable
- Wash separate from other clothing
- Bug spray is flammable –”Deet” will degrade the material
- Always wear properly (don’t roll sleeves, etc.)
- Wear non-melting undergarments
- Remove from service when needed

Proposed Regulation

- FR-neck to toe
- Outwear required
- Hazard assessment of each job
- Inner layer must not melt (current reg)



Arcs

Video of Arcs and flashes

15 min

PIN HOLE IN THUMB OF RUBBER GLOVE (secondary glove)

EXIT WOUND

ENTRANCE WOUND

PROGRESSION OF THE SAME BURN

Involuntary Muscle Contraction

- **This worker fell** and grabbed a powerline to catch himself. The resulting electric shock mummified his first two fingers, which had to be removed. The acute angle of the wrist was caused by burning of the tendons, which contracted, drawing the hand with them.

Arc Burns

- **This man was** near a power box when an electrical explosion occurred. Though he did not touch the box, electricity *arced* through the air and entered his body. The current was drawn to his armpits because perspiration is very conductive.

Electrical Burns

- **Entrance Wound:** High resistance of skin transforms electrical energy into heat, which produces burns around entrance point (dark spot in center of wound). This man was lucky; the current narrowly missed his spinal cord.

Thermal Contact Burns

- **Current exited** this man at his knees, catching his clothing on fire and burning his upper leg.