LAB SAFETY MANUAL

UNLV Department of Computer and Electrical Engineering

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LAB SAFETY RULES

1. Safety takes priority over all experiments and lectures in the lab. You are not allowed to use any equipment that does not work properly or appears dangerous or broken. Anyone who tries to pressure you to use this equipment must be directly reported to the lab director.

2. No food or drinks are allowed in the lab. Sealed bottles of water are acceptable, but are to be kept as far away from live circuits as possible.
   - Liquids and food are distractions which clutter the area, Liquids also greatly reduce the resistance of the flow of electricity in electrical circuits, but more importantly the human body by approximately an order of magnitude

3. Any experiment that requires a power supply will require at least TWO people in the lab.
   - If you are unconscious, and alone you can't get help. If no lab partner or T.A./G.A. is available, come get me or reschedule another time to work on the lab. I would rather you turn in a lab late, than work in unsafe conditions.

LAB SAFETY RULES

4. Absolutely NO crossing wires from desk to desk. This includes power cables, banana jacks, probes, etc
   - This is an accident begging to happen.

5. Cell phones are permitted, but you must step away from the work bench when using it.
   - Distractions cause accidents, accidents cause injuries

6. Both sets of lights must be on in the lab while using any lab equipment.
   - Darkness causes accidents due to poor visibility

LAB SAFETY RULES

7. Ten minute casual breaks are to be taken every hour of working in the lab
   - Research has shown there is a limitation of approximately one hour of maximum focus before an individuals mental ability is reduced. Take a break and refresh your mind.

8. Check and Double check all your equipment is turned off when leaving the lab. Your T.A. should review that your station is powered down correctly
   - By powering off your workstation, you are eliminating the possibility that someone in the lab following you will get injured by mistakenly touching a power supply.

LAB SAFETY RULES

9. Computers and lab station are only to be used for academic work. Use common sense. Occasional email checking is acceptable, but having groups playing 'World of Warcraft' or spending hours watching YouTube is unacceptable.
   - There are expensive software licenses on the lab computers and students should be able to access them as frequently as possible.

10. Only trained engineering students are allowed in the lab
    - Other people can be distractions and distractions cause accidents. Exceptions may be made if you speak with the lab director ahead of time. A T.A. cannot authorize non-qualified personnel in the lab. We encourage demonstrations and bringing attention to the department, but it must be done in a controlled environment.

LAB SAFETY RULES

11. Do not use any equipment that is not working properly or known to be broken. Report missing or broken equipment immediately to the lab director

    - NEVER use equipment that you suspect is not working properly, If someone tries to make you, Let the lab director know immediately and actions will be taken

12. No student is allowed to use equipment they are not familiar with or have not been trained on. This is especially important with soldering stations.

Why is a Safety Lecture Important?

- When people enter the lab, they make a list in their mind planning on what components are needed, what datasheets are needed, and other features specific to complete the lab experiment.

- Virtually no one ever makes a effort to include a 'game plan' for safety in that checklist of things that need to be done, and it is without a doubt the most important aspect of any lab.

- We assume that everything will work as promised, errors will not be made, and distractions will not be made

Why is a Safety Lecture Important?

- People must be educated on general safety concepts and safety issues that arise from dealing with electricity.

- We do not come out of the womb knowing the dangers of the world and especially electricity

  - EX: A three year old learns about safety by trial and error. They touch a hot pan, burn their hand and learn not to do that again. Toddlers learn by performing an action, and then learning the reaction associated with the action

  - We would like to take a more assertive approach and avoid the 'toddler' method of learning. Therefore we need to educate people BEFORE an accident or incident occurs

How is this Safety Lecture Different?

- In the past, Lab directors have passively droned on and on about the importance of safety and letting students know the importance of safety.

- The system needed to be improved to educate students with deeper technical knowledge of prevention and treatment of injuries due to electricity in the labs other than the traditional "Don't kill yourself" approach.

- Accidents WILL happen. It's not a matter of if, but 'when'. Knowing how to keep a calm head, provide immediate treatment procedures, and following up with professional medical care could make the difference in an individual suffering a minor or major injury.

How are things different than before?

- Do not EVER, EVER allow any student, professor, or other person pressure you into doing something that is unsafe.
- If you have the smallest doubt on the safety of something, back away from the situation and IMMEDIATELY come to me.
- Do not be afraid to come forward. If you have a concern about the safety, there are probably others with the same concern.
- If you witness someone doing something unsafe or dangerous, immediately come to me and let me know. All safety reports will remain anonymous.
- If you directly and willingly violate safety concerns, you may be subject to receiving a zero for that days lab, and possibly failure for the course depending on the severity

Laboratory Kill Switch

- If you suspect someone is in imminent danger of getting injured in the lab, Immediately go to this big red button (near the entrance and light switches) and press the switch

- This will instantly disable power to the lab equipment

Laboratory Fire Extinguisher

- By the main entrance to the B350 lab, there is a single fire extinguisher.
- If there is a fire or sparks, take this extinguisher, aim the black cone at the fire from a few feet away and empty the contents of the extinguisher.
- It is difficult to determine when a fire has been put out or not, so we recommend emptying the contents of the extinguisher
- These cannot be reused once used, so always empty the contents of the extinguisher.

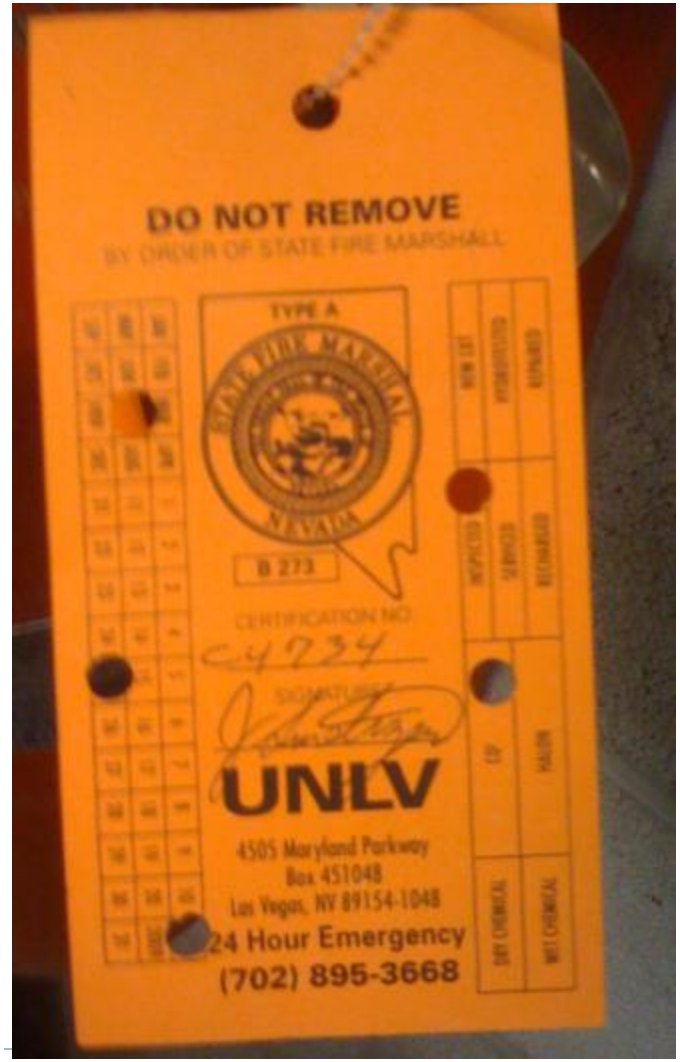
Laboratory Fire Extinguisher

- Each fire extinguisher has a card which contains information such as:

1. When the fire extinguisher was last inspected
2. When the extinguisher is due to be inspected again
3. Who performed the inspection
4. A 24 hour emergency telephone number
5. **** If this card is missing, please let the lab director know immediately

For EMERGENCIES:

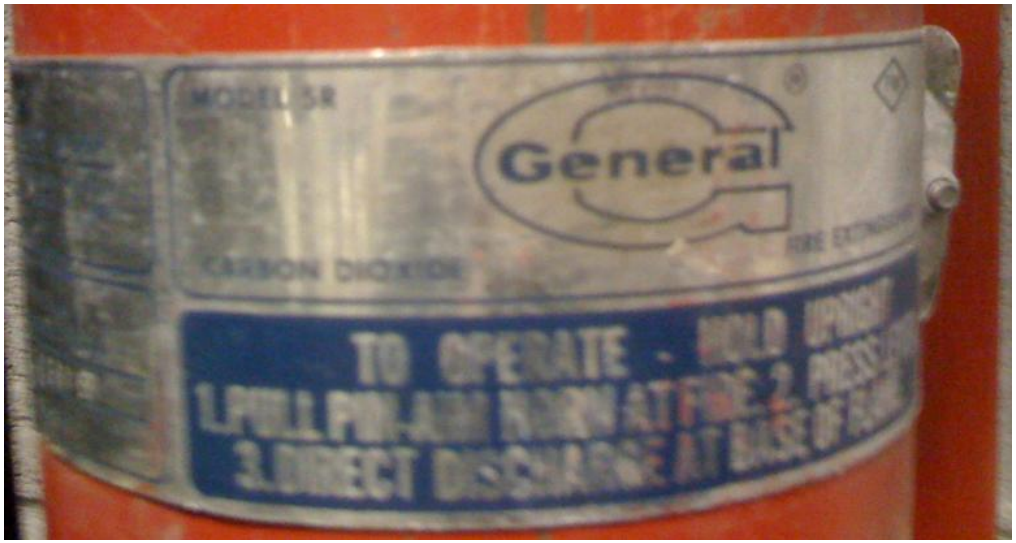
(702) 895-3668



Laboratory Fire Extinguisher

- There is a metal panel which shows instructions for operation

1. Hold Upright
2. Pull (Safety) Pin, Aim Horn at fire
3. Hold down handle to release the gas
4. Direct discharge at the base of the flame



Fire Extinguisher Classification

- Class A- These are for ordinary combustible materials such as paper, wood, cardboard, and most plastics. The numerical rating on these types of extinguishers indicates the amount of water it holds and the amount of fire it can extinguise

- Class B- Fires involve flammable or combustible liquids such as gasoline, kerosense, grease, and oil . The numerical rating for class B fire extinguishers indicates the approximate number of square feet of fire it can extinguish

- Class C- Fires involve electrical equipment, such as appliances, wiring, circuit breakers, and outlets. Never use water to extinguish class C fires- The risk of electrical shock is too great! Class C extinguishers do not have a numerical rating . The C classification means the extinguishing agent is non-conductive

- Class D- Fire extinguishers are commonly found in a chemical lab. They are for fires that involve combustible metals, such as magnesium, titanium, potassium, and sodium. These also have no numerical rating, they are designed for class D Fires only

Common Types of Fire Extinguishers

- Water Extinguishers (APW- air pressurized water)- Suitable for class A fires only

- Dry Chemical- Come in a variety of types and are suitible for a combination of class A, B, and C fires. These are filled with foam or powder and pressurized with nitrogen
  - BC- This is the regular type of dry chemical. It is filled with sodium bicarbonate or potassium bicarbonate
  - ABC- This is a multipurpose extinguisher. It is filled with monoammonium phosphate.

- Dry Chemical extinguishers have an advantage over CO2 extinguishers since they leave a non-flammable substance on the extinguished material, reducing the likelihood of re-ignition

Common Types of Fire Extinguishers

- Carbon Dioxide (CO_2) Extinguishers are used for class B and C fires. This is the type of extinguisher in the B350 lab.

- CO_2 extinguishers contain carbon dioxide, a non-flammable gas, and are highly pressurized. The pressure is so great that it is not uncommon for bits of dry ice to shoot out of the nozzle.

- CO_2 extinguishers do not work well on class A fires because they may not be able to displace enough oxygen to put the fire out, causing it to re-ignite.

Common Types of Fire Extinguishers

- CO_2 extinguishers have an advantage over dry chemical extinguishers since they don't leave a harmful residue. This makes it a good choice for an electrical fire on a computer or other favorite electronic device

- It is vital to know what type of extinguisher you are using. Using the wrong type of extinguisher for the wrong type of fire can be life-threatening

Laboratory Emergency Numbers

Laboratory Emergency Numbers

Name	Number
•911	911
•Campus Police (Emergency)	5-3668
•LVMPD	795-3111
•Ambulance Dispatch	384-3400
•Campus Operator	00
•Department	895-4183

Chemical Spill or Radioactive Material Discharge
M-F (8-5)

•Risk Management & Safety	5-4226

After business Hours

•Campus Police	5-3668

Office of Public Affairs	5-3102

Laboratory First Aid Kit

- There is a first aid kit near the door in all the laboratories.
- First aid kids are useful for even minor injuries in the lab and is there to be used as needed.

Laboratory First Aid Kit

- Shown to the right are the contents of the first aid kit.
- First aid kits aren't much good if you don't know what is in them

Laboratory First Aid Kit

- The staple of any first aid kit are various size bandages. These are useful for small cuts and burns.

Laboratory First Aid Kit

- Alcohol prep pads are typically used for cleaning the skin around an area than needs an injection.

Laboratory First Aid Kit

- For wounds bigger than typical band-aids and bandages, there are several large bandages.
- Keep in mind the skin should be disinfected before applying the bandage

Laboratory First Aid Kit

- Inside this box is a reusable chemical HOT/COLD pack.

- This can be useful in localized swelling, bad headaches, strains and sprains, and is very useful for numbing an area

Laboratory First Aid Kit

- An instant cold pack is similar to the reusable hot/cold pack but is chemically activated. This pack immediately gets cold and is fantastic for pain relief.

Laboratory First Aid Kit

- There are usually an assortment of sealed medications included in a first aid kit. In this kit are non-aspirin pain relief and antacids.
- NOTE: Be sure the packages are sealed before using

Laboratory First Aid Kit

- There is a collection of rubber gloves included in the first aid kit.

- Rubber gloves should be used when blood is present. If a wound is exposed and bleeding, the person providing medical care should wear gloves to prevent spreading of any illnesses

Laboratory First Aid Kit

- Iodine prep pads are useful to prevent infection of all types of cuts and abrasions

Laboratory First Aid Kit

- Some lab injuries are caused by unwelcome visitors in the lab
- Insect relief pads are used as an antiseptic and numbing agent for insect bites and stings.
- Due to the presence of venomous spiders in Las Vegas, try to obtain a sample of the insect that bit you

Laboratory First Aid Kit

- The most famous venomous insect in the local area is the black widow spider.
- The tell-tale sign of which is a red hourglass shape on her back.
- The venom of a black widow spider is drop for drop approximately 15 times more toxic than a rattlesnake

Laboratory First Aid Kit

- The brown recluse, or 'violin spider' would rather run than attack, but when backed into a corner is even more dangerous than the black widow.

- The bite from a brown recluse causes incredible pain to the bite area to due the total destruction of tissue.

- This type of bite causes 'necrosis' which is the complete destruction of cells, including regrowth centers. The damage due by necrosis usually must be removed surgically

Laboratory First Aid Kit

- A CPR Face Shield is included, which is sterilized with alcohol.

- CPR must only be performed by those trained in CPR

Laboratory First Aid Kit

- More assorted bandages and eye pads are included in the first aid kit.

Laboratory First Aid Kit

- Bandage Scissors and tweezers are also included.

- Tweezers are good to remove foreign objects embedded inside the skin

Laboratory First Aid Kit

- For serious wounds, the first aid kit should be used as a temporary solution until you are able to seek professional medical help.

- A large cut or burn, for example, can be disinfected, wrapped with bandage to protect the wound area, and then you can seek professional medical attention.

- Whenever you use the first aid kit, you should let the lab director know so we can help assess the situation and also restock any used items from the first aid kit

- Sometimes there are serious injuries but people decline medical help because they have a test later that day. Health is the most important thing always. We can always work with your professor to explain what happened, and why you may need to make up a test or assignment.

Laboratory First Aid Kit

- To my knowledge, no one in the department is a medical expert. We try to be trained so we can provide quick, safe, help immediately after an accident, but one should ALWAYS seek proper medical care after an injury.

- There may be long term effects that only trained medical nurses and doctors are aware of.

- You will never get in trouble for reporting an injury to myself or a T.A. Accidents happen and need to be treated seriously regardless of the severity of them.

- No one cares about the 'blame game' trying to figure out who is at fault.

Laboratory Emergency Exits

- Emergency Exits and Meeting Spot
- Inform the T.A. immediately and then calmly leave the lab IMMEDIATELY if you suspect a fire or problem.

Hazards of Electricity

- There are three types of hazards in dealing with electricity:

1. **Electrical Shock (TBE-B350)**
2. **Electrical Arc (Power Lab)**
3. **Electrical Blast (Power Lab)**

It is important as an engineer to understand the risks and dangers in working with electricity.

Just because we are working in a low voltage laboratory does not mean serious injuries cannot occur

Definitions

- **Electrical Shock**: The physical stimulation that occurs when electric current flows through the human body.

- The distribution of current flow through the body is a function of the resistance of the paths through which the current flows.

- SYMPTOMS OF SHOCK:
  - Mild tingling sensation
  - Violent muscle contractions
  - Heart arrhythmia
  - Tissue damage

Influencing Factors- Physical Condition

- The physical condition of the individual greatly influences the effects of current flow (a principle used by body fat % scales)
- A given amount of current flow will usually cause less trauma to a person in good physical condition.
- If the victim of the shock has any medical problems, such as heart or lung ailments, these parts of the body will be severely affected by relatively low currents

Influencing Factors- Current Duration

- The amount of energy delivered to the human body is directly proportional to the length of time that the current flows.

$$J = I^2Rt$$

J = Energy (Joules)

I = Current (Amps)

R = Resistance of current path (Ohms)

t = Time of current flow (Seconds)

Influencing Factors- Current Duration

- Some portion of the externally caused current flow will tend to follow the current paths used by the human body's central nervous system.
- Since the external current is much larger than the normal current flow, damage can occur to the nervous system.
- Damage to the nervous system can be FATAL even with relatively short durations of current.

Influencing Factors- Current Duration

- Generally, a longer duration of current through the heart is more likely to cause ventricular fibrillation.

- Fibrillation occurs when the externally applied electric field overlaps with the bodies natural cardiac cycle.

- FIBRILLATION- Rapid and inefficient contraction of muscle fibers of the heart caused by disruption of nerve impulses

Important Frequencies

TABLE 1.1 Important Frequency Ranges of Electrical Injury

Frequency	Regimen	Applications	Harmful effects
DC–10 kHz	Low frequency	Commercial electrical power, soft tissue healing; transcutaneous electrical stimulation	Joule heating; destructive cell membrane potentials
100 kHz–100 MHz	Radio frequency	Diathermy; electrocautery	Joule heating; dielectric heating of proteins
100 MHz–100 GHz	Microwave	Microwave ovens	Dielectric heating of water
10^{13}–10^{14} Hz	Infrared	Heating; CO_2 lasers	Dielectric heating of water
10^{14}–10^{15} Hz	Visible light	Optical lasers	Retinal injury; photochemical reactions
10^{15} Hz and higher	Ionizing radiation	Radiotherapy; x-ray imaging; UV therapy	Generation of free radicals

- Electrical Safety Handbook, P 1.4

Influencing Factors- AC and DC

- Differences of applied voltage to the human body are apparent even between DC values (0 Hz) and standard power line frequencies (60 Hz).

- When equal current magnitudes are compared (DC vs. AC), DC seems to exhibit two differences:
  1. Victims of DC shock have indicated that they feel greater heating from DC than from AC
  2. The threshold where a person can 'let go' tends to be higher for DC

Influencing Factors- Magnitude

- Higher voltages can be more lethal for several reasons, but most notably:

1. For voltages above 400V, the electrical pressure may be sufficient to puncture the epidermis. Since the epidermis (outer skin layer) is the only significant resistance to current flow, the current flow will increase dramatically when the epidermis is punctured.

2. Higher voltages are more likely to cause unpredictable arcing.

Influencing Factors- Magnitude

Condition (area to suit)	Resistance	
	Dry	Wet
Finger touch	40 kΩ–1 MΩ	4–15 kΩ
Hand holding wire	10–50 kΩ	3–6 kΩ
Finger-thumb grasp*	10–30 kΩ	2–5 kΩ
Hand holding pliers	5–10 kΩ	1–3 kΩ
Palm touch	3–8 kΩ	1–2 kΩ
Hand around $1\frac{1}{2}$-inch (in) pipe (or drill handle)	1–3 kΩ	0.5–1.5 kΩ
Two hands around $1\frac{1}{2}$-in pipe	0.5–1.5 kΩ	250–750 Ω
Hand immersed	—	200–500 Ω
Foot immersed	—	100–300 Ω
Human body, internal, excluding skin	—	200–1000 Ω

- Notice how drastically the resistance decreases as the surface becomes wet
- Notice how small the internal resistance of the human body (~500 ohms) compared to the external resistance of say a finger touch (~1 Meg Ohm)

Influencing Factors- Magnitude

TABLE 1.3 Nominal Resistance Values for Various Materials

Material	Resistance*
Rubber gloves or soles	>20 MΩ
Dry concrete above grade	1–5 MΩ
Dry concrete on grade	0.2–1 MΩ
Leather sole, dry, including foot	0.1–0.5 MΩ
Leather sole, damp, including foot	5–20 kΩ
Wet concrete on grade	1–5 kΩ

- Rubber is a fantastic insulator. It is not big and bulky and can virtually ensure nothing bad will happen if you are careful and cover your hands and feed with rubber (Gloves and shoe soles)

Influencing Factors – Human Response

TABLE 1.4 Nominal Human Response to Current Magnitudes

Current (60 Hz)	Physiological phenomena	Feeling or lethal incidence
<1 mA	None	Imperceptible
1 mA	Perception threshold	Mild sensation
1–3 mA		Painful sensation
3–10 mA		
10 mA	Paralysis threshold of arms	Cannot release hand grip; if no grip, victim may be thrown clear (may progress to higher current and be fatal)
30 mA	Respiratory paralysis	Stoppage of breathing (frequently fatal)
75 mA	Fibrillation threshold 0.5%	Heart action discoordinated (probably fatal)
250 mA	Fibrillation threshold 99.5% (≥5-s exposure)	
4 A	Heart paralysis threshold (no fibrillation)	Heart stops for duration of current passage. For short shocks, may restart on interruption of current (usually not fatal from heart dysfunction)
≥5 A	Tissue burning	Not fatal unless vital organs are burned

- Shown above are approximate human responses to various electrical currents

Influencing Factors – Human Response

- A current flow of approximately **20mA** is sufficient to cause a person to be in a state of 'electrical hold'.

- **Electrical hold** is a condition where the muscles are contracted by the passage of electrical current and the individual is unable to overcome this response.

- Like any injury, certain body parts respond very poorly to the flow of electricity and at much lower thresholds.
  - Current through major organs, such as the heart, can be catastrophic with 70mA of current
  - The cardiovascular system is an easier target, with as little current as 30mA can cause the lungs to be paralyzed.

Electrical Arcs

- ANSI/IEEE Std 100-1988 defines an electrical arc as:
  - A discharge of electricity through a gas, normally characterized by a voltage drop in the immediate vicinity of the cathode approximately equal to the ionization potential of the gas"
- Arcing occurs when a substantial amount of electric current flows through what previous had been air. Since air is a poor conductor, most of the current flow occurs through the vapor of the arc terminal material and the ionized particles of air.
- This mixture of superheated, ionized material through which the arc current flows is called a plasma.

Electrical Arcs

- Arcs can be occur from several scenarios
  - When the voltage between two points exceeds the dielectric strength of the air.
  - When air becomes superheated with the passage of current through a conductor.
    - EX: A very fine wire experiences excessive current, this melts the wire, superheats the air and causes an arc to start
  - When two contacts part while carrying a very high current. The last point of contact is superheated and an arc is created due to the inductive flywheel effect

Electrical Arcs

TABLE 1.5 Ignition Temperatures and Characteristics of Clothing Fibers

Fiber	Melt temperature	Decomposition temperature	Ignition temperature	Burning temperatures
Cotton/Rayon*	N/A	554/581	752/788	1562
Polyester	482	734	1040	1337
Wool	N/A	446	1112	Unknown
Nylon 6,6	490	653	990	1607
PBI	N/A	860	N/A	N/A
NOMEX	N/A	900	N/A	N/A

- Shown in table 1.5 are ignition temperatures and characteristics of clothing fibers.
- What do you think is the best choice to wear in the lab? The worst choice? Why ?

Electrical Arcs – Incident Energy

- The most important of all arc energy equations is the one that determines the energy transfer from the arc to the nearby body. This is called the Incident Energy.

- This information can be used to determine the necessary level of protective clothing required, and can also be used in the performance of a risk analysis

The Lee Method. Ralph Lee has predicted that the heat energy received by an object (or worker) can be calculated using Eq. 1.10.

$$Q_o = \frac{Q_s \times A_s}{4\pi \times r^2} \times t \qquad (1.10)$$

where Q_o = heat flux received by the object (cal/cm^2)
Q_s = heat flux generated by source (cal/s/cm^2)
A_s = surface area of arc sphere
r = distance from center of source to object (cm)
t = length of arc exposure

Electrical Arcs – Arc Burns

- **First Degree Burns-** Cause painful trauma to the outer layers of the skin. Little permanent damage results from a first-degree burn because all the grown areas survive. Healing is usually prompt and leaves no scarring

- **Second Degree Burns-** Result in relatively severe tissue damage and blistering. If the burn is to the skin, the entire outer layer will be destroyed. Healing occurs from the sweat glands

- **Third Degree Burns-** Result in complete destruction of the growth centers. If the burn is small, healing may occur from the edges of the damaged area. Extensive third degree burns usually require skin grafts.

Electrical Blast

- When an electrical arc occurs, it superheats the air instantaneously. This causes a rapid expansion of the air with a wavefront that can reach pressures of 100 to 200 lb per square foot (4.79 to 9.58kPa).

- Such pressure is sufficient to explode switchgear, turn sheet metal into shrapnel, turn hardware into bullets, and push over concrete walls.

Skin Damage

- Skin is the outer layer that completely encloses the body. Each persons skin weights about 4 lbs, protects against bacterial infection, physical injury of underlying cells, and prevents water loss.

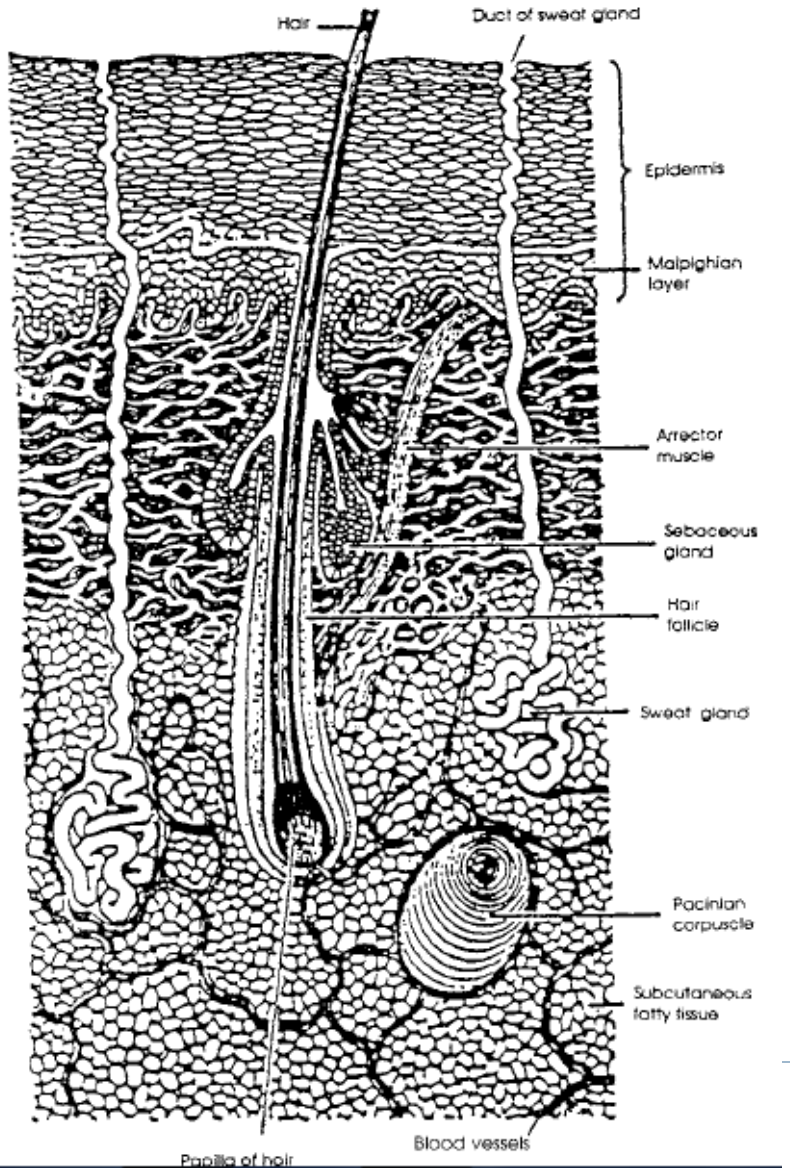
- The main regions of importance for electrical purpose are the epidermis, the sweat glands, and the blood vessels.

- The epidermis, the top layer of the skin, is 0.1 to 1.5mm thick (4 – 60 mils thick) and is made up of five layers, with the outermost layer called the stratum corneum or 'horny layer'

Skin Damage

- The horny layer is composed to 10 to 30 thin layers of dead cells which have been pushed to the surface from lower layers in the normal growth process.

- It is called the horny layer because its cells are toughened like an animals horns.



Skin Damage

- The horny layer is composed primarily of a protein called keratin. Of all the skin layers, keratin exhibits the highest resistance to the flow of electricity.

- As the horny layer becomes tougher by repeated, physical exertion, callouses form and the skin becomes even more resistant to the flow of electricity.

- This layer is by FAR the greatest protection against serious electrical damage we have (High Kilo-Megaohms). If this layer is compromised, or removed, the bodies internal resistance to electricity is almost none (typically 200 ohms)

Electrical Burns

- Electrical burns usually come from at least four different sources:

1. Physical contact with conductors, tools, or other equipment that have been heated by the passage of electrical flow.
2. Current flow through the skin causes burns by I^2R energy. Since these burns occur from the inside out, these are almost always third degree burns.
3. Thermal or Radiation burns are caused by the radiant energy of the electrical arc
4. Contact with superheated plasma caused by the vaporization of solid materials in the vicinity of an electrical arc

The Nervous System

- The nervous system contains the electrical pathways that are used to communicate information from one part of the body to another.
- To communicate, electric impulses are passed from one nerve to another.
- The heart beats when an electric impulse is applied to the muscles that control it. If some external electrical impulse is applied, the nervous system can become confused.
- If the current is high enough, the damage can be permanent or fatal

The Muscular System

- The muscular system provides motor control for the human body.
- When the nervous system stimulates the muscles with electric impulses, the muscles contract to move the body and perform the physical activity.
- Skeletal muscles are either flexor muscles (contracts, closes a joint), or extensor muscles (unbends, or opens a joint)

The Muscular System

- Electrical shock can affect muscles in at least three significant ways:

1. Reflex Action. Muscle contractions are caused by electric impulses. Normally these impulses come from the nervous system. But when an externally induced current flows through a muscle, it can cause the muscle to contract, sometimes violently

2. Electrical Paralysis. Current magnitudes over 10mA may be sufficient to block the nervous system signals to the muscular system. When an external current is flowing through the body, the victim may be unable to let go. This is called an electrical hold.

The Muscular System

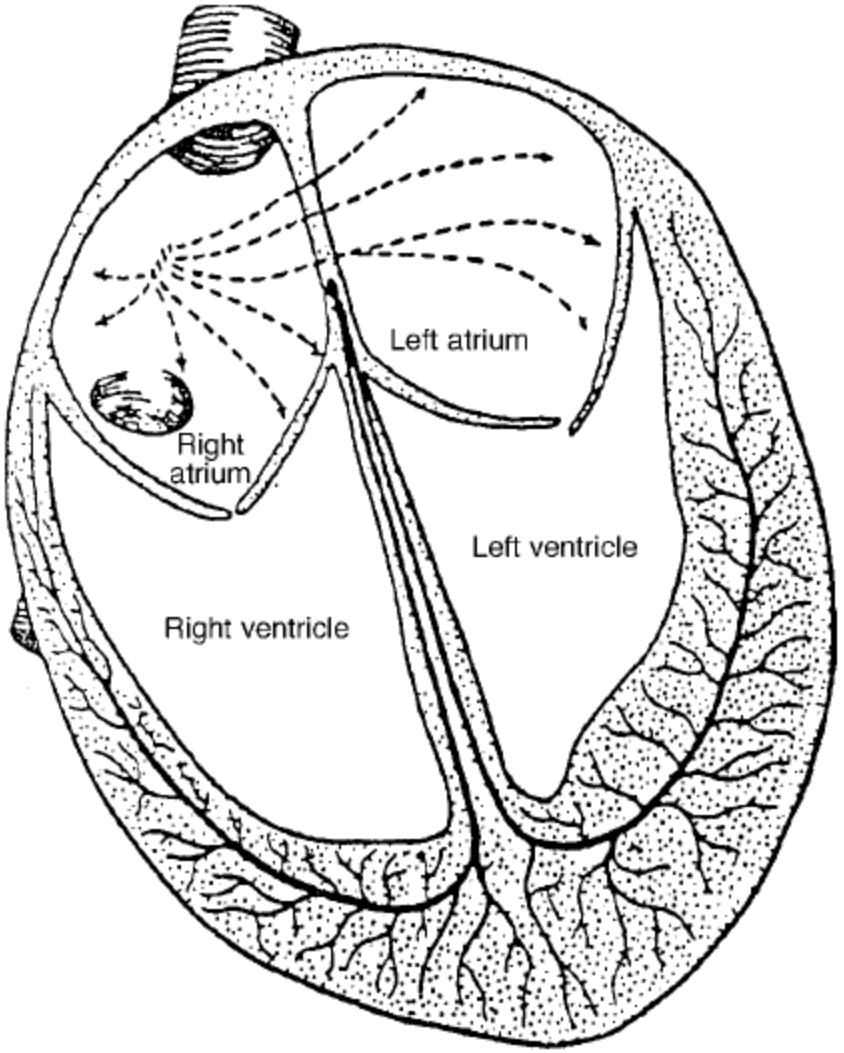
- Permanent Damage. If the current is high enough, the muscle tissue can be destroyed by burning. Currents of less than 5A will cause tissue destruction if it lasts long enough.

- Because this burning destroys growth areas in tissue, the damage can be extremely slow to heal (if at all).

The Heart

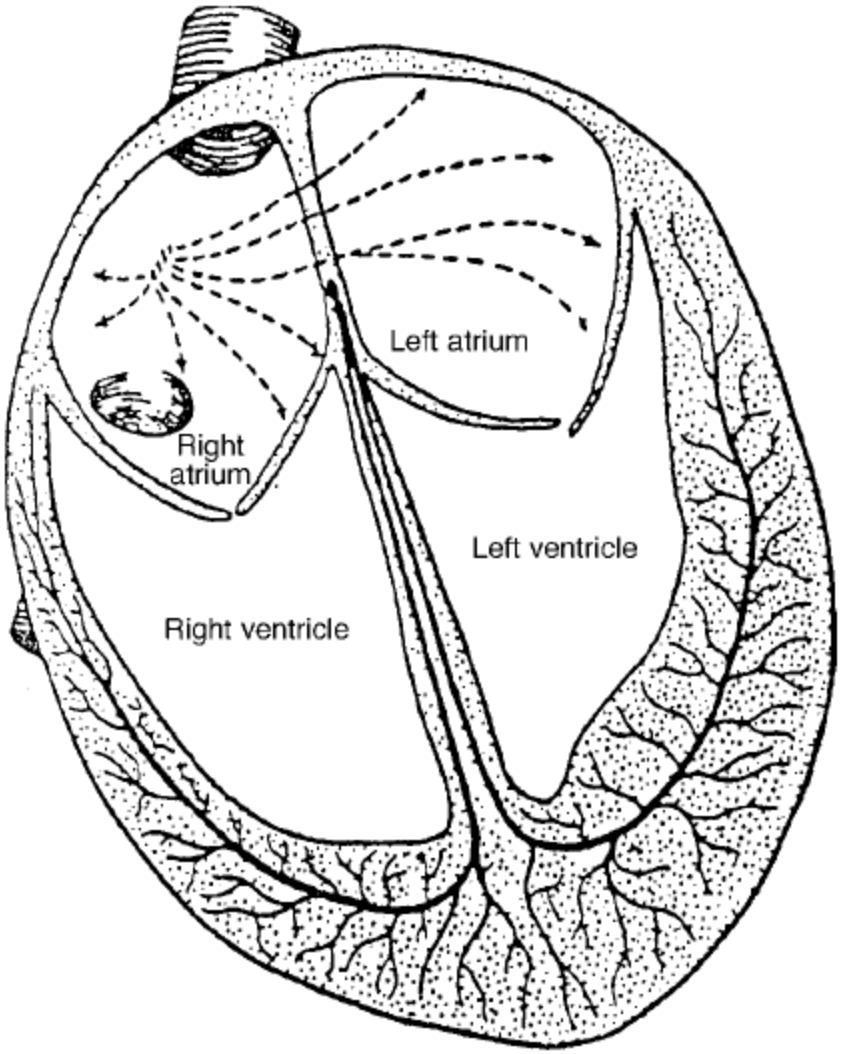
- The heart is a fist-sized pump that beats more than 2.5 billion times in an average 75 year lifetime.

- The atria and ventricles work together, alternately contracting and relaxing to pump blood through your heart



The Heart

- The electrical system of your heart is the source that makes this possible.
- Normally a heart beat starts in the sinus node, travels at approximately 7 ft/s through the AV node, and right and left bundle branches. The resulting contraction sends blood flowing from the heart
- This sequence occurs with every beat. If the path is interrupted for any reason, even for a minute or two, changes in the heart rate and rhythm occur that can be fatal



The Pulmonary System

- With the exception of the heart, the pulmonary system is most critical to human life.
- If breathing stops, which can happen with as little as 30mA, all other functions will cease shortly after.
- When the lower diaphragm moves down, it creates a partial vacuum in the chest chamber. This in turn draws air into the sacs in the lungs. The oxygen is then passed to the bloodstream through tiny capillaries.
- At the same time, carbon dioxide is returned to the air in the lungs.
- When the lower diaphragm moves up, the air is forced out of the lungs completing the breathing cycle

The Pulmonary System

- Current flow through the midsection of the body can disrupt the nervous system impulses which regulate the breathing function.

- This disruption can take the form of irregular, sporadic breathing, or (if the current is great enough) the pulmonary system may be paralyzed. When a stoppage occurs, immediate first aid is usually required.

Typical Clothing Materials- Cotton

- Cotton: Work clothing made from cotton (such as denim and flannel) are a better choice than materials made from synthetic materials.

- Cotton does not melt into the skin when heated, but rather burns and disintegrates, falling away from the skin

- Thick, heavy cotton material provides a minimal barrier from arc temperatures and ignites quickly. At best, cotton provides only minimal thermal protection

Typical Clothing Materials- Synthetic

- Untreated synthetic clothing, such as polyester and nylon, provide extremely poor thermal protection and should never be used when working in areas where an electric arc may occur.

- Synthetic materials have a tendency to melt into the skin when exposed to high temperatures
  - The melted material forms a thermal seal which retains head and increases the severity of the burn
  - Circulation is severely limited or cut off completely under the melted material. This slows healing and the flow of infection-fighting white blood cells and antibodies
  - The removal of melted material is extremely painful and may increase the trauma already experienced by the burn victim

Typical Clothing Materials- Synthetic-Cotton Blends

- Synthetic-cotton blends such as polyester-cotton are used to make clothing that is easier to care for.
- Although slightly less vulnerable to melting than pure polyester, the blends are still extremely vulnerable to the heat of an electric arc.
- Such blends provide poor thermal protection and should not be used in areas where the hazard of electric arc exists

Typical Clothing Materials- Chemically Treated Materials

- Both natural and synthetic fibers can be chemically treated to render them flame resistant.

- While some chemical treatments, such as borax and boric acid-salt combinations, may be temporary in nature, others are very satisfactory

Typical Clothing Materials- Chemically Treated Materials

- Brand name materials offer the best protection for industrial applications such as:

1. NOMEX* IIIA- Made by DuPont
2. Polybenzimidazole (PBI)- Made by Hoechst Celanese Corporation
3. KERMEL- Made in France by Rhone-Poulenc

- These materials are beyond the budget, range, and time available for this class and should be researched further by those interested in industrial protection clothing

Legal Safety Requirements and Standards

- The modern trend in electrical safety is toward more and more individual responsibility as employees are being held increasingly responsible for their actions.
- At the same time, OSHA has become increasingly severe in its enforcement of safety standards.
- Electrical safety standards and/or requirements are produced by a variety of organizations. Some standards are voluntary, while others are local or federal law
- Whether voluntary or mandatory, these standards provide guidance for the proper way to work on or around electric energy.

The Occupational Safety and Health Act of 1970

- In 1970, the United States was faced with the following statistics:
  - Job related accidents accounted for more than 14,000 worker deaths per year
  - Nearly 2.5 million workers were disabled
  - Ten times as many person-days were lost from job-related disabilities than from strikes
  - Estimated new cases of occupational diseases totaled 300,000
- To address these problems, Congress passed the Occupational Safety and Health Act of 1970 (the Act). The Act created the OSHA to continually create, review, and redefine specific standards and practices

The Occupational Safety and Health Act of 1970

- The Act exempts three important categories:
  - Self Employed People
  - Farms at which only immediate members of the farm employer's family are employed
  - Working conditions regulated by other federal agencies under other federal statues

Responsibilities and Rights of Employees

- The Act was designed to establish workplace rules and regulations. Employees, therefore, are not cited for violations.

- Employees must:
  - Read the OSHA poster at the job site
  - Comply with all applicable OSHA standards
  - Follow all employer safety and health rules & regulations
  - Report hazardous conditions to a supervisor
  - Report any job-related injury or illness to the employer
  - Promptly seek treatment from job-related injuries or illness

Responsibilities and Rights of Employees

- Employees must (Continued):
  - Cooperate with OSHA compliance officer conducting an inspection if he/she inquires about safety and health conditions in your workplace
  - Exercise their rights under the Act in a responsible manner
  - Seek safety and health on the job without fear of punishment
  - Complain to an employer, union, the OSHA, or any other government agency about job safety and health hazards
  - File safety or health grievances
  - Participate on a workplace safety and health committee or in union activities concerning job safety and health
  - Participate in OSHA inspections, conferences, hearings, or other OSHA-related activities

TABLE 7.1 Employee Safety Behavior

- Determine the nature and extent of hazards before starting a job.
- Each employee should be satisfied that conditions are safe before beginning work on any job or any part of a job.
- All employees should be thoroughly familiar with and should consistently use the work procedures and the safety equipment required for the performance of the job at hand.
- While working, each employee should consider the effects of each step and do nothing that might endanger themselves or others.
- Each employee should be thoroughly familiar with emergency procedures.

- Shown above is an employee safety behavior list as given in the Electrical Safety Handbook.

- NEVER administer first aid that you are not qualified to administer. Injuries can be aggravated by improperly administered first aid.
- Get qualified medical help quickly.

TABLE 7.5 General First Aid Procedure

- Act quickly.
- Survey the situation.
- Develop a plan.
- Assess the victim's condition.
- Summon help if needed.
- Move the victim only if danger is imminent.
- Administer required first aid:
  - Shock
  - Electrical burns

- When assessing the victims condition, learn the ABC's of first aid:
- A- check the victims Airway
- B- Check the victims Breathing
- C- Check the victims Circulation
- D- Summon a Doctor or medical help;

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- Assess the victim's condition.
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- Move the victim only if danger is imminent.
- Administer required first aid:
  - Shock
  - Electrical burns

- NEVER move the victim, unless danger is imminent and the person is in mortal danger.
- Accident victims should be moved only by trained personnel and only when necessary
- Moving a victim who is injured could cause increased problems such as paralysis or even death.

Accident Prevention, Investigation, Rescue, and First Air

TABLE 7.9 How to Handle Unresponsive Victims

Breathing—pulse normal	Make victim comfortable. If help has not been summoned, do so and stand by until it arrives.
No breathing—pulse normal	Perform mouth-to-mouth resuscitation until breathing is restored or until help arrives and takes over.
Breathing normal—no pulse	Perform heart-lung resuscitation (CPR) until pulse is restored or until help arrives and takes over.
No breathing—no pulse	Perform heart-lung resuscitation (CPR) until pulse is restored or until help arrives and takes over.

Table 7.0 shows a quick list on how to handle unresponsive victims.

** Even if a person appears normal and states he/she is OK, wait for trained medical help to arrive at the situation.

TABLE 7.10 Typical Symptoms of Electric Shock

- Victim may lose consciousness. This may occur at the moment of contact; however, it can also occur later.
- Victim has a weak or irregular pulse.
- Victim has trouble breathing or has stopped breathing.
- Small burns may appear at the entry and exit points of the electric current.

TABLE 7.11 Precautions for Performing First Aid on an Electric Shock Victim

- Do not touch any energized wires with any part of your body or with any conductive tools or equipment.
- Do not touch a victim who is still in contact with an energized wire with any part of your body or with conductive tools or equipment.
- Do not try to move any energized wires unless you are qualified to do so. Qualified in this instance means that you are trained in the performance of such a procedure and are able to avoid electrical hazards.

After the situation has been dealt with, a report must be filed providing truthful information on the following:

- An overview of the conditions that caused the accident
- Step by step description on what actions were taken to help the accident victim
- A conclusion with eyewitness reports

Accident Prevention, Investigation, Rescue, and First Air

- NOTE: NEVER UNDER ANY CIRCUMSTANCES LIE OR WITHHOLD ANY INFORMATION ABOUT AN ACCIDENT, REGARDLESS OF REPERCUSSIONS.

- Covering up an accident or covering up improper handling of an accident is a serious rule infraction that could result in the failure of the class and possibly have legal disciplinary consequences. WE DO NOT COVER THINGS UP

- Our goal is to learn from accidents both in prevention and in treatment. Hopefully you will take these safety concepts with you in your future employment

LAB SAFETY EXAM- NEXT WEEK

- There will be a written lab safety examination at the beginning of next weeks lab.
- You are only responsible for memorizing the material in **RED TEXT**. The other material is more of a reference
- If you do not receive at least 90% on this exam, you will not be able to work on the laboratories.
- The lab safety exam will be retaken each week until the student has passed the exam. Any previous labs must be made up under my supervision.