SHOCK HAZARD INFORMATION

The real danger from electricity is an electrical shock therefore dangerous electrical conditions are shock hazards. For a human an electrical shock comes from the body's reaction to electrical amperage flowing through the body, not how great the level of electrical voltage that exists.

An Electrical shock to a human can be as mild as a slight tingling sensation or as severe as instant death. When the human body comes- in- contact with electrical voltage the body actually becomes a parallel current carrying path with the grounding conductor of the electrical device to ground. Electrical current will flow on the grounding conductor as well through the human body. Ohm's Law will determine how much electrical current will flow on the grounding conductor and the human body. This electrical current flowing through the human body will create some type of shock to the human.

To understand how the amount of amperage that will affect the human body and how the body reacts to these amperage levels, we must first review the examples of body resistance of human contact points under different conditions in the table below.

Type of Contact	Dry	Wet
Wire touched by finger	40,000 – 1,000,000 Ω	4,000 - 15,000 Ω
Wire held by hand	15,000 – 50,000 Ω	3,000 – 5,000 Ω
Metal pliers held by hand	5,000 – 10,000 Ω	1,000 – 3000 Ω
Contact with palm of hand	3,000 – 8,000 Ω	1,000 – 2,000 Ω
1.5 inch metal pipe grasped by one hand	1,000 – 3000 Ω	500, 1,500 Ω
1.5 inch metal pipe grasped by two hands	500 – 1,500 Ω	250 – 750 Ω
Hand immersed in conductive liquid		200 – 500 Ω
Foot immersed in conductive liquid		100 – 300 Ω

The conditions necessary to produce 1,000 Ω of body resistance do not have to be as extreme as presented, either (sweaty skin with contact made on a gold ring). Body resistance may decrease with the application of voltage (especially if tetanus causes the victim to maintain a tighter grip on a conductor) so that with constant voltage a shock may increase in severity after initial contact. What begins as a mild shock -- just enough to "freeze" a victim so they cannot let go -- may escalate into something severe enough to kill them as their body resistance decreases and current correspondingly increases.

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Voltage is not a reliable indication of danger because the body's resistance varies so widely it is impossible to predict how much current will flow through the body by a given voltage.

AC is more dangerous than DC, and 60-cycle current is more dangerous than high-frequency current. Skin resistance decreases when the skin is wet or when the skin area in contact with a voltage source increases. It also decreases rapidly with continued exposure to electric current.

Offhand, it would seem that a shock of 10,000 volts would be more deadly than 100 volts. That is not necessarily so! Electrocution of individuals by appliances using ordinary house supplies of 110 volts and by electrical apparatus in industry using as little as 42 volts direct current have happened. The real measure of a shock's intensity lies in the current (amperes) forced through the body, and not the voltage. Any electrical device used on a house wiring circuit, under certain conditions, can transmit a fatal current.

The electrical current is what that does the damage to individuals. Current equals voltage divided by resistance (I = V/R), but the resistance of the human body varies so widely it is impossible to state that one voltage is "dangerous" and another is "safe".

The path through the body has much to do with the shock danger. A current passing from finger to elbow through the arm may produce only a painful shock, but that same current passing from hand to hand or from hand to foot may well be fatal.

Therefore, the practice of using only one hand (keeping one hand behind your back) while working on high-voltage circuits and of standing or sitting on an insulating material is a good safety habit.
Some people are highly sensitive to current, experiencing involuntary muscle contraction with shocks from static electricity. Others can draw large sparks from discharging static electricity and hardly feel it, much less experience a muscle spasm. Despite these differences test were made and approximate guidelines were developed, which indicate very little current being necessary to manifest harmful effects).

Will the 120-volt common household voltage produce a dangerous shock? It depends!
If your body resistance were 100,000 ohms, then the current, which would flow, would be: 120v/100,000Ω=0.0012 amperes which equals 1.2mA. A person may feel a slight tingling sensation. However, if you have just played a couple of sets of tennis, are sweaty and barefoot, and then your resistance to ground might be as low as 1000 ohms. Then the current would be: 120v/1,000Ω=0.12 amperes which equals 120mA. A person will have ventricular fibrillation and death can occur without quick medical attention.

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The severity of shock from a given source will depend upon its path through your body.

THE PHYSIOLOGICAL EFFECT OF ELECTRICAL SHOCK

Electric current damages the body in three different ways: (1) it harms or interferes with proper functioning of the nervous system and heart; (2) it subjects the body to intense heat; and (3) it causes the muscles to contract.

Amperage Below is Given in Milliamps (A Milliamp is Equal to 1/1000 of an Ampere)

AC (60 Hz mA)	DC (mA)	Effect	Body Resistance Required to Create Current at 120V AC	Body Resistance Required to Create Current at 50V DC
0.3 (Women)	0.6	Slight sensation felt at hand(s)	400,000Ω	83,333 Ω
0.4 (Men)	1.0	Slight sensation felt at hand(s)	300,000 Ω	125,000 Ω
0.7 (Women)	3.5	Threshold of perception	171,428 Ω	14,285 Ω
1.1 (Men)	5.2	Threshold of perception	109,090 Ω	9,615 Ω
6 (Women)	42	Painful, but voluntary muscle control maintained	20,000 Ω	1,190 Ω
9 (Men)	62	Painful, but voluntary muscle control maintained	13,333 Ω	806 Ω
10.5 (Women)	51	Painful, to let go of wires	11,428 Ω	980 Ω
16 (Men)	76	Painful, to let go of wires	7,500 Ω	657 Ω
15 (Women)	60	Severe pain difficulty breathing	8,000 Ω	833 Ω
23 (Men)	90	Severe pain difficulty breathing	5,217 Ω	555 Ω
25 (Women)		Painful shock, muscular control is lost	4,800 Ω	
30 (Men)		Painful shock, muscular control is lost	4,000 Ω	
20-75		This shock is more serious. You'll receive a painful jolt and muscle control will be lost resulting in the inability to let go of something you may have grabbed that is shocking you	1,600 Ω	
AC (60 Hz mA)	**DC (mA)**	**Effect**	**Body Resistance Required to Create Current at 120V AC**	**Body Resistance Required to Create Current at 50V DC**
75-100		As the current approaches 100	1,200 Ω	

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		milliamperes, ventricular fibrillation of the heart occurs and damage is done		
100 (Women)	500	Possible heart fibrillation after 3 seconds	1,200 Ω	100 Ω
100 (Men)	500	Possible heart fibrillation after 3 seconds	1,200 Ω	100 Ω
100-200		Ventricular fibrillation occurs and death can occur if medical attention is not administered quickly	600 Ω	
>200		Severe burns and severe muscle contractions occur. Your heart can stop during a shock because the chest muscles put pressure on the heart. Internal organs can be damaged at this stage and in you survive, a painful recovery can be expected. What may surprise you about this level of shock is that through this clamping effect on the heart, ventricular fibrillation is avoided and the chances of a person's survival is good if the victim is removed from the electrical circuit	600 Ω	
1,000-4,300		Ventricular fibrillation: (The rhythmic pumping action of the heart ceases.) Muscular contraction and nerve damage occur. Death is most likely	27.9 Ω	
6A		Sustained ventricular contraction followed by normal heart rhythm. Defibrillation: Temporary respiratory paralysis and possibly burns	20 Ω	
10,000		Cardiac arrest, severe burns and probable death	.012 Ω	

FACTORS INVOLVED IN ELECTRICAL SHOCK

THE QUANTITY OF CURRENT FLOWING THROUGH THE BODY

Current (amperes) is the killing factor in electrical shock, not the voltage. The voltage only determines how much current will flow through a given body resistance. In general, the body's resistance to electrical shock is minimal (150,000 to 600,000 Ohms.) Even contact with standard 110-volt circuits can be lethal under certain conditions.

THE CURRENT PATH THROUGH THE BODY FROM ENTRY TO EXIT

Hand-to-hand, hand- or head-to-foot, and ear-to-ear current paths are the most dangerous because they may cause severe damage to the heart, lungs and brain. This is why it is important not to wear metal jewelry, not to lean against or use both hands on electrical equipment so as not to become part of the circuit.

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THE LENGTH OF TIME THE BODY IS IN THE CIRCUIT

The longer the body is in the circuit, the greater the damage. You may be unable to let go of a 15 to 20 milliampere current. The body temperature may increase possibly damaging tissues, bones, and organs.

Electrical Safety Reminders

Re-route electrical cords or extension cords so they do not run across the aisle/corridor or over pipes or through doors.

Turn off and unplug equipment before removing the protective cover to clear a jam, replace a part, etc.

Do not use an electrical outlet or switch if the protective cover is ajar, cracked, or missing.
Use dry hands and stand on a dry surface when using electrical devices.

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