



ARC-FLASH OVERVIEW

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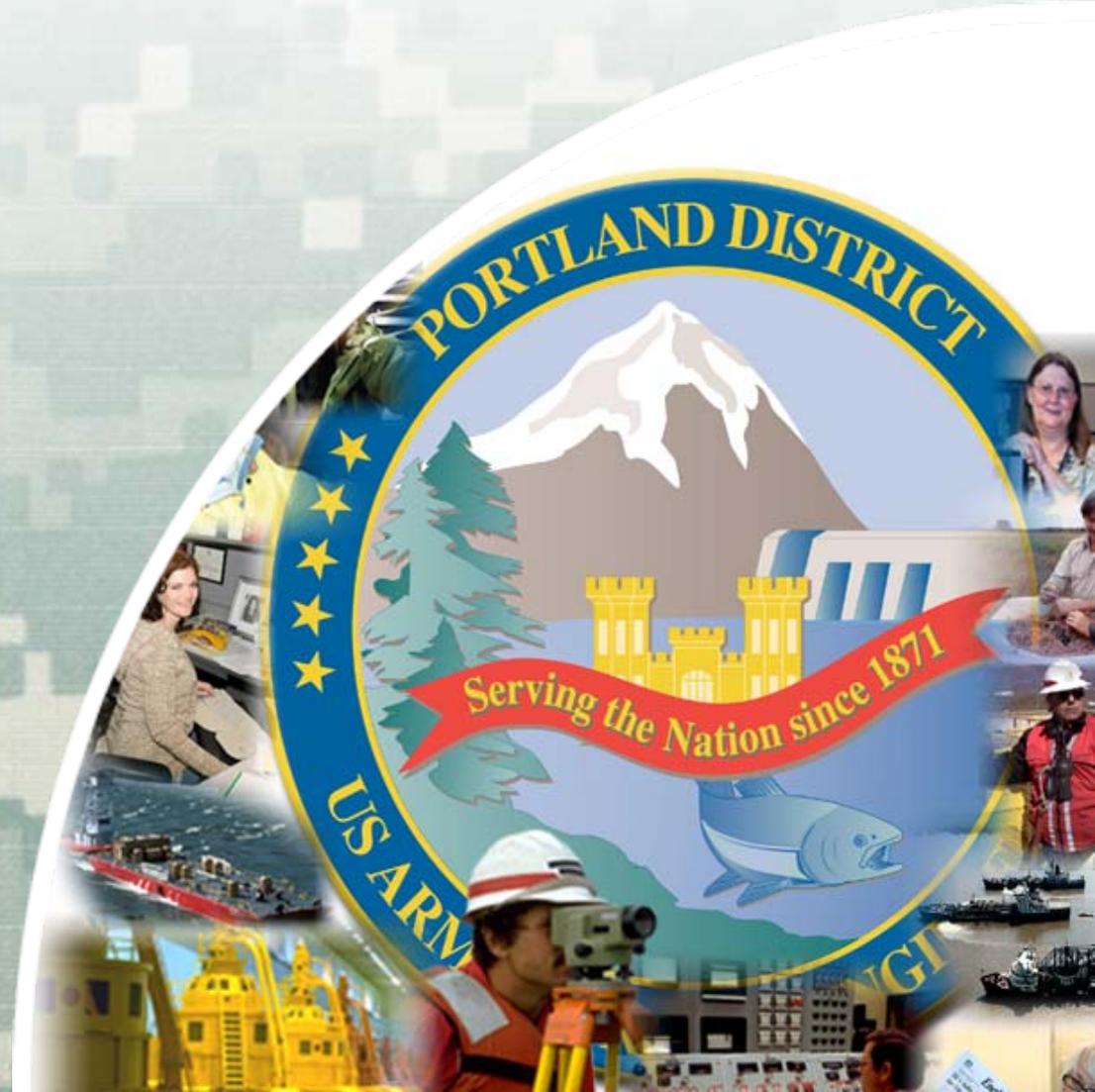
Robert Duncan Plaza

27 January 2011



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US Army Corps of Engineers
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Annual Industrial Electrical Accidents

- 30,000 non-fatal electrical shock incidents
- 600-1000 people die due to electrocution
- Arc burns make up over 80% of the electrical injury cases
- More than 2000 people are treated for severe electrical burns
- 5-10 arc explosions occur in electrical equipment each day in the U.S.





Three Types of Electrical Hazards

- Shock/Electrocution
 - ▶ Current passes through your body



Electrical Shock

Current Range and Effect on 150 lb Man

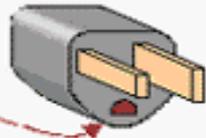
1-3 mA 3-10 mA	Perception Threshold	Mild Sensation Painful Sensation
10 mA	Paralysis threshold of arms	Cannot release hand grip
30 mA	Respiratory paralysis	Stoppage of breathing
75 mA	Fibrillation threshold	Heart action becomes uncoordinated
4A	Heart Paralysis	Heart stops for duration of current passage
>5A	Tissue Burning	Not fatal unless vital organs are burned

Electrical Shock

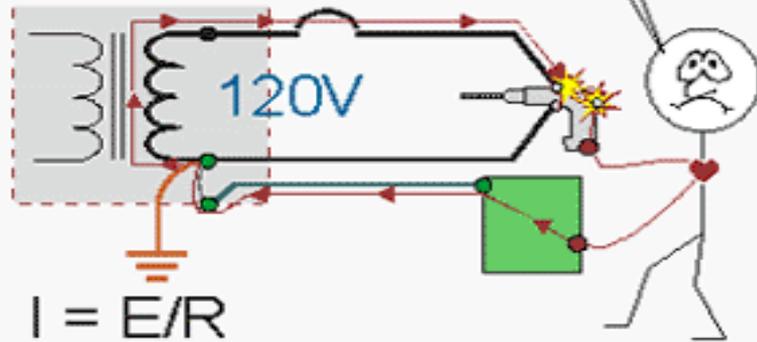
The body becomes part of an electrical path.

Line-to-ground fault energizes metal parts.

Broken Terminal



1000 Ohms



$$I = E/R$$
$$120V/1000\Omega = 120 \text{ mA}$$

Grounded Object or Surface

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*"This will teach you to not use your computer
in the tub. You can search for cars online
after you get out."*





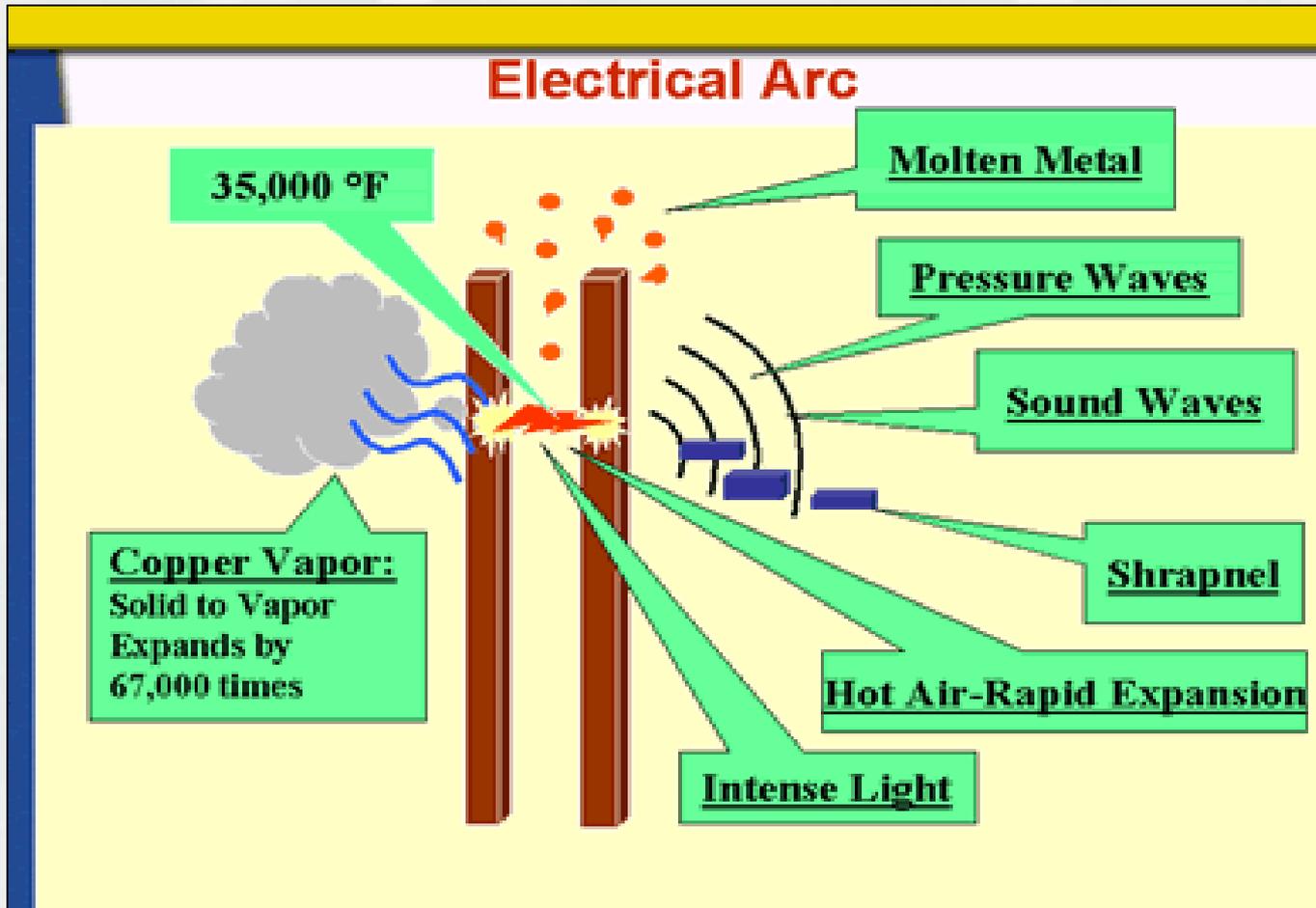
WWW.RESCUEMIAAOK.COM



Three Types of Electrical Hazards

- Shock
 - ▶ Current passes through your body
- Arc
 - ▶ Current passing between two conducting metals (or conducting metal to ground) through ionized gas or vapor, usually air
- Blast
 - ▶ Pressure developed by the near instantaneous heating of the air surrounding the arc and from the expansion of metal as it is vaporized







Arc Flash Hazard Categories

Hazard Category	Incident Energy
Category 0	<1.2 cal/cm ²
Category 1	1.2 to 4 cal/cm ²
Category 2	4 to 8 cal/cm ²
Category 3	8 to 25 cal/cm ²
Category 4	25 to 40 cal/cm ²



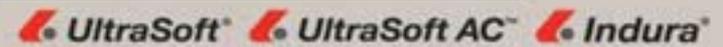


Clothing on Manikin:

*Incident Energy: 4.0 Cal/cm²
Disconnect: 480V, 30AMP*



Electric Arc Flashes Created by 70E Solutions



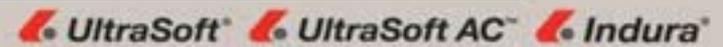


Clothing on Manikin:

*Incident Energy: 7.1 Cal/cm²
Disconnect: 480V, 30AMP*



Electric Arc Flashes Created by 70E Solutions







What's Being Done Nationally?

- Standards

- ▶ OSHA 29 CFR Part 1910, Subpart S
- ▶ USACE EM 385-1-1-2008
- ▶ NFPA 70-2011 (NEC) Section 110.16
- ▶ NFPA 70E-2009
- ▶ IEEE Standard 1584 – 2002
- ▶ USACE ER 385-1-100 & EP 385-1-100
(to be finalized in the near future)





What Can We Do Locally?

- Job Hazard Analysis – Plan Ahead
- Lockout Procedures – De-energize if at all possible
- Arc Flash Study – Identify magnitude of hazard



Arc Flash Labels

 WARNING	
Arc Flash & Shock Hazard - PPE Required	
43 inch	Flash Hazard Boundary
18 inch	Working Distance
5	cal/cm ² Flash Hazard at 18 inches
Category 2	FR Shirt & Pants
480 VAC	Shock Hazard when cover is removed
0	Glove Class
42 inch	Limited Approach (Fixed Circuit)
12 inch	Restricted Approach
1 inch	Prohibited Approach
Bus: LQ2.1 Bus Prot: PD-3	
**** LINE SIDE FAULT****	
Warning: Changes in equipment settings or system configuration may invalidate the calculated results. (Date:Nov 2008 No:002)	

 WARNING	
Arc Flash & Shock Hazard - PPE Required	
48 inch	Flash Hazard Boundary
18 inch	Working Distance
5	cal/cm ² Flash Hazard
Category 2	
Bus: LQ2.1 Bus Prot: PD-3	
**** LINE SIDE FAULT****	
Warning: Changes in equipment settings or system configuration may invalidate the calculated results. (Date:Nov 2008 No:002)	



Arc Flash Labels

 CAUTION	
Arc Flash & Shock Hazard - PPE Required	
14 inch	Flash Hazard Boundary
18 inch	Working Distance
0.76	cal/cm ² Flash Hazard at 18 inches
Category 0	Untreated Cotton
480 VAC	Shock Hazard when cover is removed
00	Glove Class
42 inch	Limited Approach (Fixed Circuit)
12 inch	Restricted Approach
1 inch	Prohibited Approach
Bus: LQ1.1 Bus Prot: PD-1	
****BUS SIDE FAULT****	
Warning: Changes in equipment settings or system configuration may invalidate the calculated results. (Date:Nov 2008 No:001)	

 WARNING	
Arc Flash & Shock Hazard - PPE Required	
43 inch	Flash Hazard Boundary
18 inch	Working Distance
5	cal/cm ² Flash Hazard at 18 inches
Category 2	FR Shirt & Pants
480 VAC	Shock Hazard when cover is removed
0	Glove Class
42 inch	Limited Approach (Fixed Circuit)
12 inch	Restricted Approach
1 inch	Prohibited Approach
Bus: LQ2.1 Bus Prot: PD-3	
****LINE SIDE FAULT****	
Warning: Changes in equipment settings or system configuration may invalidate the calculated results. (Date:Nov 2008 No:002)	



What Can We Do Locally?

- Job Hazard Analysis – Plan Ahead
- Lockout Procedures – De-energize if at all possible
- Arc Flash Study – Identify magnitude of hazard
- Wear proper PPE – Minimize potential injuries





Hazard/Risk Category	Clothing Description (typical clothing layers)	Minimum Arc Rating of PPE (cal/cm²)
0	Non-melting, flammable materials with a fabric weight at least 4.5 oz/yd ² (1)	N/A
1	Arc-rated FR Shirt & FR Pants or FR coverall (1)	4
2	Arc-rated FR shirt and FR pants (1 or 2)	8
3	Arc-rated FR shirt, FR pants or FR coverall and arc flash suit selected so that the system arc rating meets the required minimum	25
4	Arc-rated FR shirt, FR pants or FR coverall and arc flash suit selected so that the system arc rating meets the required minimum	40



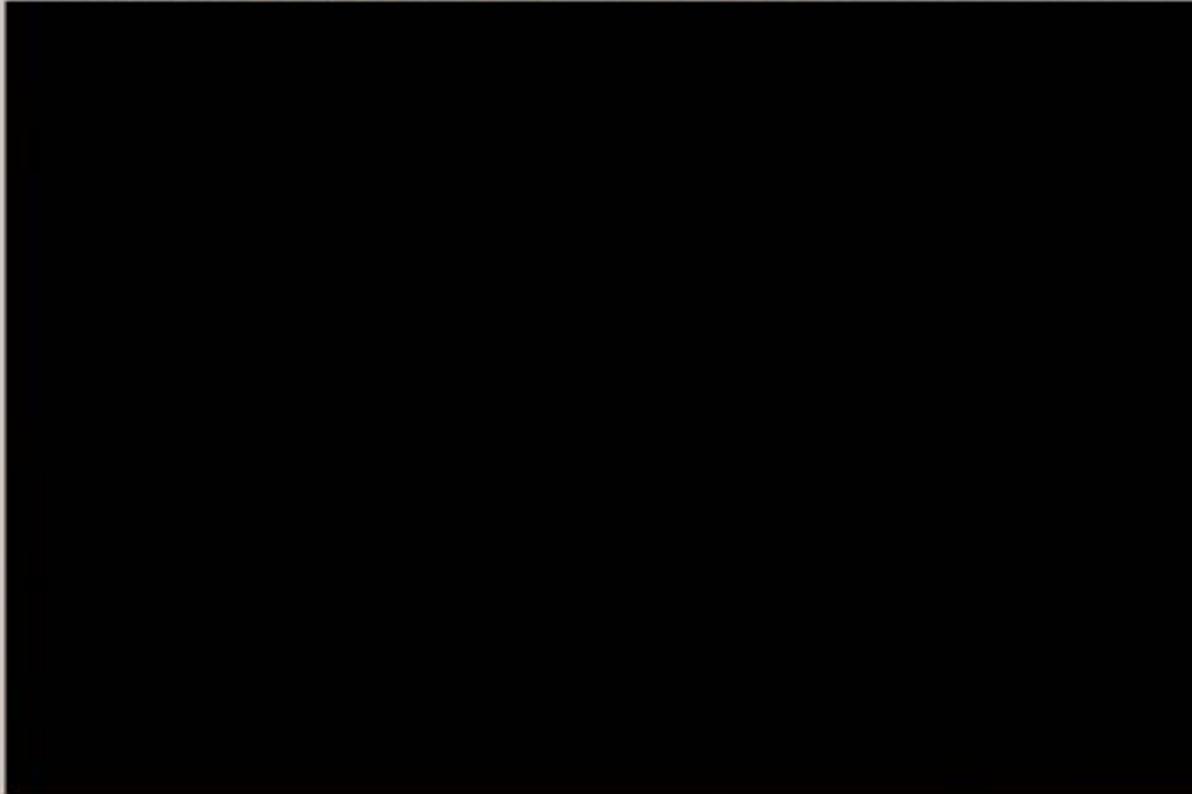


Clothing on Manikin:

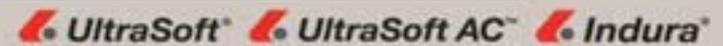
Poly/Cotton Shirt & Pants

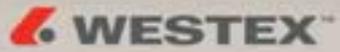
Incident Energy: 7.6 Cal/cm²

Disconnect: 480V, 100AMP



Electric Arc Flashes Created by 70E Solutions





Clothing on Manikin:

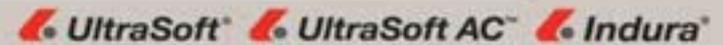
UltraSoft® 7 oz. Shirt & 9 oz. Pants

Incident Energy: 7.4 Cal/cm²

Disconnect: 480V, 200AMP



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What Can We Do Locally?

- Job Hazard Analysis – Plan Ahead
- Lockout Procedures – De-energize if at possible
- Arc Flash Study – Identify magnitude of hazard
- Wear proper PPE – Minimize potential injuries
- Staying outside of the Flash Approach Boundary
- Beware of your surroundings – Stay Alert
- Proper maintenance – Equipment performs as expected





Final Thoughts

- You can't see electricity, hear it coming, feel it, smell it, or taste it.
- Don't need to fear it, but need to respect it.
- Financial impacts – loss of equipment/time/people
- Emotional impacts – individual/co-workers
- Impacts to family/friends
- **PROTECT YOURSELF** – Ultimately we are responsible for our own safety



Questions?

Did you
do your
safety

