Arc Flash Hazard

Arc Flash at Wallops

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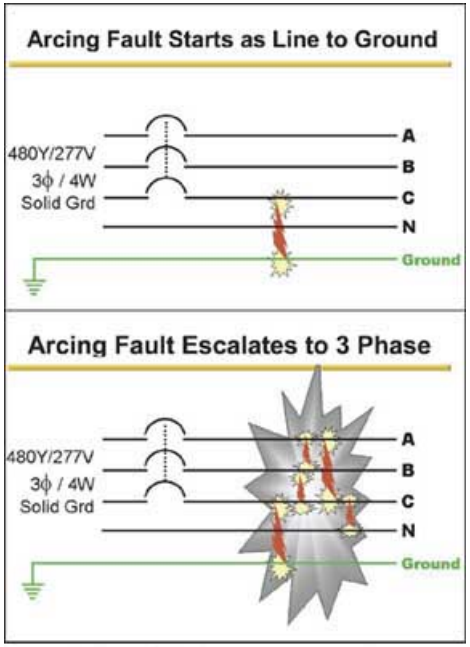
What is Arc Flash Hazard?

- There are two forms of electrical hazard
  - Electric shock, it is an event that occurs when part of the body completes a circuit between conductors of different voltages potentials or between an electrical source and a ground.
  - Arc flash, it is a result from the rapid release of energy due to the flow of electrical current outside of its normal path.

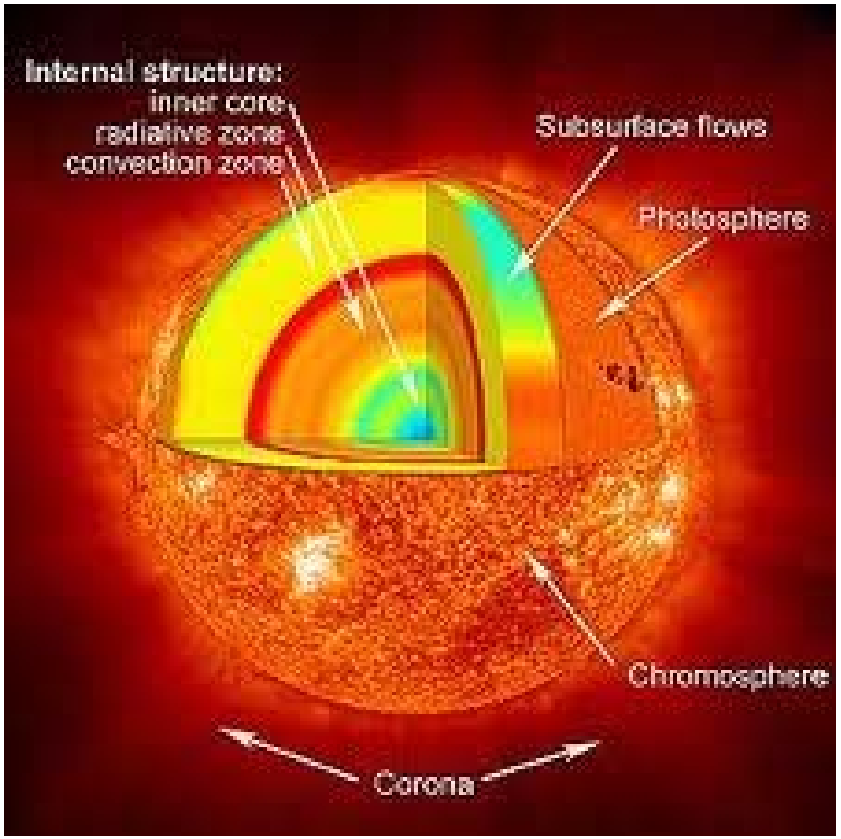


What is Arc Flash Hazard? (cont)

- Causes of Arc Flash
  - A breakdown of the thermal insulation
  - Dust build-up between conductors
  - Loose connections, or
  - By workers dropping a tool onto energized equipment

Characteristics

- Arc Flash > 35,000 °F, Sun (photosphere) ± 11,000 °F



Characteristics (cont)

- Can produce third or fourth degree burns
- Can create a plasma cloud
- Possibility of death or incapacity of worker

Wallops Identified Arc Flash Hazards

1. In January 2004 Star Consultants, Inc conducted a VPP Baseline Survey. They found multiple discrepancies associated with lockout/tagout procedures related to Arc Flash precautions. These discrepancies were related to the process used to disconnect, lock and tag out the circuit in order to work in a electrical circuit.

2. WICC created WOP-03-14.2 in May, 2005 and have been updated in multiple occasions.

Wallops Identified Arc Flash Hazards (cont)

3. In 2009 with studies funded through Facilities, Code 228, TranSystems conducted a study / analysis on few pieces of equipment and developed a schedule for the equipment.

4. In 2009 a VPP Gap Analysis was conducted which included recommendations for additional resources on arc flash calculations, flash boundaries or expert electrical safety support, including the necessity of training for PPE requirement based on arc flash hazard category.

Why Fix it?

Requirements

- The hazard was recognized in 2002 NEC® Section 110.16 Flash Protection
- NASA General Safety Program Requirements NPR 8715.3
- 2014 National Electrical Code NFPA 70 article110 Arc-Flash Hazard Warning
- Institute of Electrical and Electronics Engineers (IEEE) 1584 Guide for performing Arc-Flash hazard calculations
- American National Standard Institute ANSI Z535.4 (NEMA Z535.4)

Why Fix it?

Requirements (cont)

- 2012 Standard for Electrical Safety in the workplace NFPA 70E 130.5 Arc Flash Hazard Analysis
  - An arc flash hazard analysis shall determine the arc flash boundary, the incident energy at the working distance, and the personal protective equipment that people within the arc flash boundary shall use.
    - Exception: The requirements of 130.7(C)(15) and 130.7(C)(16) shall be permitted to be used in lieu of determining the incident energy at the working distance.

- Occupational Safety and Health Administration (OSHA)
  - 29 CFR 1910.137 Electrical Protective Devices
  - 29 CFR 1910.333 Selection and use of work practices
  - 29 CFR 1910.335 Safeguards for personnel protection
  - 29 CFR 1926.431 Safety and Health Regulations for Construction (Maintenance of Equipment)

Why Fix it?
Civic and Moral responsibilities

- Concerns,
  - NASA concern for employees, contractors and visitors are a big chapter in Safety. Lowering the risk of exposure to hazardous, dangerous situations as they close as breaker panels down the hall or a 15kV transformer on the island is a way of taking care of our own. Let's fix it because it is a safety issue, not because it could get us in trouble with the authorities.
- Professionalism,
  - The aeronautical space business is a very delicate and now, very competitive field. With more companies than before in the area of space innovation, as Mid-Atlantic Regional Spaceport (MARS) and ORBITAL Corporations, NASA needs to be known for its progresses and successes more than its failures and mishaps.

How do we fix the problem at Wallops?

- Performing:
- **Analysis**- Perform a full analysis / study with project funding. It is not recommended to complete the analysis sectionalized.
- **Electrical design changes-** On the circuit breaker to minimize the operating cycles.

- **Adapt procedures-** For the electricians to go by when working on equipment that can produce an Arc Flash event.
- **Training**- Train the electricians, maintenance personnel and the public in general. Making a category and training requirements for each one.
- **Acquisition of proper PPE**- By the affected parties and generate procedures to sign it out, perform maintenance and disposal of the task specific PPE.

How do we fix the problem at Wallops?(cont)

- *One option provided in NFPA 70E is based on tables that list common tasks and states the appropriate protective equipment for each task. These tables can be useful, but they can also be misapplied. An approach based on a detailed arc flash assessment is one that can help identify where exposure potential exist; eliminate the hazards completely through engineering design changes or administrative controls; reduce the frequency of potential arc flash events; reduce the magnitude of energy release; and helps to ensure that PPE is appropriately rated for exposures.*

How do we fix the problem at Wallops? Arc Flash Label

Electrical equipment shall be field marked with a label containing all the following information:

(1) At least one of the following:

- Available incident energy and the corresponding working distance
- Minimum arc rating of clothing
- Required level of PPE
- Highest Hazard/Risk Category (HRC) for the equipment

(2) Nominal system voltage

(3) Arc flash boundary

How do we fix the problem at Wallops?
Arc Flash Label

Arc Flash and Shock Hazard

Appropriate PPE Required

FLASH PROTECTION		SHOCK PROTECTION	
Flash Hazard at	**36 inches**	Shock Hazard when cover is removed	**12470 VAC**
Min. Arc Rating:	**0.40 cal/cm^2**		
Flash Protection Boundary:	**9 inches**	Limited Approach	**60 inches**
Glove Class:	**2**	Restricted Approach	**26 inches**
Clothing Category:	**Category 0**	Prohibited Approach	**7 inches**

Non-melting fiber, long sleeve shirt, long pants. Safety Glasses or goggles, hearing protection. Leather Gloves. Leather work shoes.

December 02, 2011 H-100 Load Interrupter Switchboard

How do we fix the problem at Wallops? Personal Protective Equipment

CATEGORY 0

PROTECTIVE CLOTHING, NON-MELTING (ACCORDING TO ASTM F1506-00) OR UNTREATED NATURAL FIBER

- SHIRT (LONG SLEEVE)
- PANTS (LONG)
- SAFETY GLASSES OR SAFETY GOGGLES (SR)
- HEARING PROTECTION (EAR CANAL INSERTS)
- LEATHER GLOVES (AN) (NOTE 2)

CATEGORY 1

FR CLOTHING, MINIMUM ARC RATING OF 4 CAL/CM† (NOTE 1)

- ARC-RATED LONG-SLEEVE SHIRT (NOTE 3)
- ARC-RATED PANTS (NOTE 3)
- ARC-RATED COVERALL (NOTE 4)
- ARC-RATED FACE SHIELD OR ARC FLASH SUIT HOOD (NOTE 7)
- ARC-RATED JACKET, PARKA, OR RAINWEAR (AN)
- HARD HAT
- SAFETY GLASSES OR SAFETY GOGGLES (SR)
- HEARING PROTECTION (EAR CANAL INSERTS)
- LEATHER GLOVES (NOTE 2)
- LEATHER WORK SHOES (AN)

CATEGORY 2

FR CLOTHING, MINIMUM ARC RATING OF 8 CAL/CM† (NOTE 1)

- ARC-RATED LONG-SLEEVE SHIRT (NOTE 5)
- ARC-RATED PANTS (NOTE 5)
- ARC-RATED COVERALL (NOTE 6)
- ARC-RATED FACE SHIELD OR ARC FLASH SUIT HOOD (NOTE 7)
- ARC-RATED JACKET, PARKA, OR RAINWEAR (AN)
- HARD HAT
- SAFETY GLASSES OR SAFETY GOGGLES (SR)
- HEARING PROTECTION (EAR CANAL INSERTS)
- LEATHER GLOVES (NOTE 2)
- LEATHER WORK SHOES

CATEGORY 3

FR CLOTHING, MINIMUM ARC RATING OF 25 CAL/CM† (NOTE 1)

- ARC-RATED LONG-SLEEVE SHIRT (AR) (NOTE 8)
- ARC-RATED PANTS (AR) (NOTE 8)
- ARC-RATED COVERALL (AR) (NOTE 8)
- ARC-RATED ARC FLASH JACKET (AR) (NOTE 8)
- ARC-RATED ARC FLASH PANTS (AR) (NOTE 8)
- ARC-RATED ARC FLASH SUIT HOOD (NOTE 8)
- ARC-RATED JACKET, PARKA, OR RAINWEAR (AN)
- HARD HAT
- FR HARD HAT LINER (AR)
- SAFETY GLASSES OR SAFETY GOGGLES (SR)
- HEARING PROTECTION (EAR CANAL INSERTS)
- ARC-RATED GLOVES (NOTE 2)
- LEATHER WORK SHOES

CATEGORY 4

FR CLOTHING, MINIMUM ARC RATING OF 40 CAL/CM† (NOTE 1)

- ARC-RATED LONG-SLEEVE SHIRT (AR) (NOTE 9)
- ARC-RATED PANTS (AR) (NOTE 9)
- ARC-RATED COVERALL (AR) (NOTE 9)
- ARC-RATED ARC FLASH SUIT PANTS (AR) (NOTE 9)
- ARC-RATED ARC FLASH SUIT JACKET (AR) (NOTE 9)
- ARC-RATED ARC FLASH SUIT HOOD (NOTE 9)
- HARD HAT
- FR HARD HAT LINER (AR)
- SAFETY GLASSES OR SAFETY GOGGLES (SR)
- HEARING PROTECTION (EAR CANAL INSERTS)
- ARC-RATED GLOVES (NOTE 2)
- LEATHER WORK SHOES

NOTES:

SR = Selection required
AN = As needed (optional)
Note 1. See Table 130.7(C)(11). Arc rating for a garment or system of garments is expressed in cal/cm†.
Note 2. If rubber insulating gloves with leather protectors are required by Table 130.7(C)(9), additional leather or arc flash gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc flash protection requirement.
Note 3. The FR shirt and pants used for Hazard/Risk Category 1 shall have a minimum arc rating of 4.
Note 4. Alternate is to use coveralls (minimum arc rating of 4) instead of FR shirt and FR pants.
Note 5. FR shirt and FR pants used for Hazard/Risk Category 2 shall have a minimum arc rating of 8.
Note 6. Alternate is to use coveralls (minimum arc rating of 8) instead of FR shirt and FR pants.
Note 7. A face shield with a minimum arc flash of 4 for Hazard/Risk Category 1 or a minimum arc rating of 8 for Hazard/Risk Category 2, with wraparound guarding to protect not only the face, but also the forehead, ears, and neck (or, alternatively, and arc-rated flash suit hood), is required.
Note 8. Alternate is to use a total FR clothing system and hood, which shall have a minimum arc rating of 25 for a Hazard/Risk Category 3.
Note 9. The total clothing system consisting of FR shirt and FR pants and/or FR coveralls and/or arc flash coat and pants and hood shall have a minimum arc rating of 40 for Hazard/Risk Category 4.

How do we fix the problem at Wallops? Personal Protective Equipment (cont)

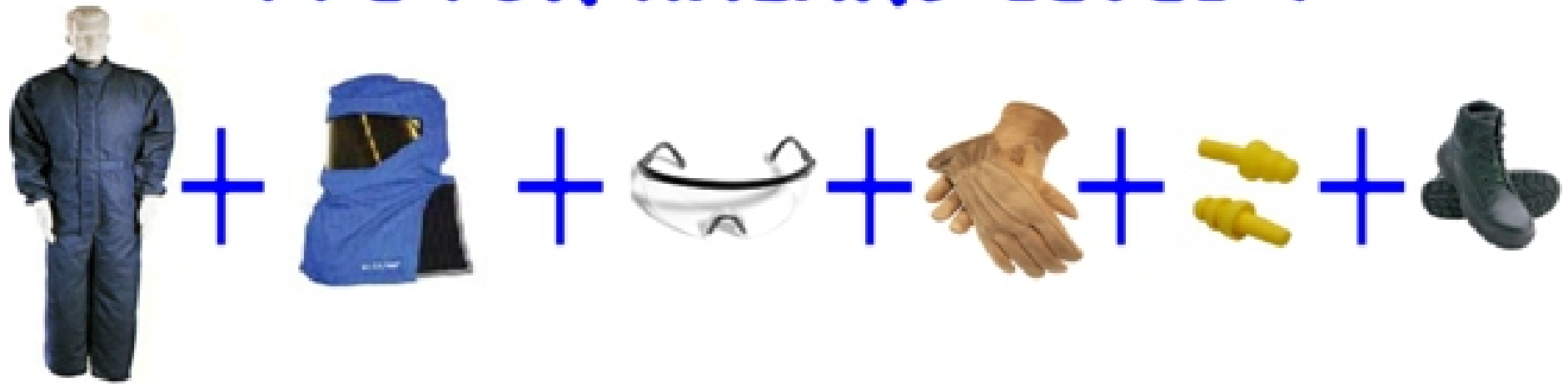
Cat 2 coverall

How do we fix the problem at Wallops?
Personal Protective Equipment (cont)

PPE FOR HAZARD LEVEL 3

How do we fix the problem at Wallops?
Personal Protective Equipment (cont)

PPE FOR HAZARD LEVEL 4



Arc rating **40** suit

Arc rating **40** hood

Safety glasses

Leather gloves*

Hearing protection

Leather work boots

* Plus voltage-rated rubber gloves as needed

How do we fix the problem at Wallops? Personal Protective Equipment (cont)

Cat 4
Arc Flash
Jacket
Leather
gloves
with
rubber
inserts

How do we fix the problem at Wallops? Personal Protective Equipment (cont)

Arc Flash rated 40 cal/cm² hood and pants

How do we fix the problem at Wallops? Personal Protective Equipment (cont)

Rubber Insulating Equipment	When to Test	Governing Standard for Test Voltage*
Blankets	Before first issue; every 12 months thereafter	ASTM F 478
Covers	If insulating value is Suspect	ASTM F 479
Gloves	Before first issue; every 6 months thereafter	ASTM F 496
Line hose	If insulating value is Suspect	ASTM F 478
Sleeves	Before first issue; every 12 months thereafter	ASTM F 496

Table 130.7(C)(7)(c) Rubber Insulating Equipment, Maximum Test Intervals
If the insulating equipment has been electrically tested but not issued for service, it is not permitted to be placed into service unless it has been electrically tested within the previous 12 months.

QUESTIONS