



## D When to Perform Zero Voltage Verification (ZVV)

### ZVV is Mode 1 with a Contact Tester and ALL PPE:

- ZVV when establishing Electrically Safe Work Condition. Tests must be performed Phase-to-Phase and Phase-to-Ground, and Phase-to-Neutral and Neutral-to-Ground where applicable.
- ZVV upon first exposure of any new circuit part
- ZVV when circuit conditions change
- ZVV whenever LOTO integrity is compromised.

### Supplementary Voltage Checks:

- Includes any other check **after ZVV** was performed.
- **Test Before Touch** after returning from offsite or after leaving job for more than 2 hours.
- *Prox tester may be used **instead of** contact tester.*

### Test Before Touch:

- **EVERY CIRCUIT**
- **EVERY CONDUCTOR**
- **EVERY TIME**



**Live – Dead – Live is ALWAYS required!**

## C Shock Risk Assessment (SRA)

- 1 Is there a shock hazard exposure?**
  - What energized conductors or parts will be exposed?
  - Exposed means anything that is not suitably enclosed, guarded or insulated.
  - **Note:** *finger-safe only applies to fingers, not tools or wires.*
- 2 What is the voltage?**
  - Determine the phase to phase nominal voltage for all possible exposures.
- 3 What are the Shock Protection Boundaries? (H)**  
**Limited Approach Boundary (LAB)**
  - Non-QEWs stay out unless escorted by a QEW
  - LOTO required.

**Restricted Approach Boundary (RAB)**

  - QEW only
  - Shock PPE required for all parts of body
  - Insulated tools required
  - Remove conductive articles.
- 4 What shock protection PPE is necessary? (G)**
  - Voltage gloves: what class?
  - Insulating sheeting, sleeves, blankets and/or barriers?

Establish a work zone at the Arc Flash Boundary or Limited Approach Boundary, whichever is greater.

## B Arc Flash Risk Assessment (AFRA)

- 1 Is there an arc flash hazard exposure?**
  - Am I interacting with equipment in a way that could cause an arc flash?
  - Includes switching ( $> 4\text{cal/cm}^2$  (J) (K)), opening covers, metering, etc.
- 2 What is the incident energy at the working distance?\***
  - Indicated on the arc flash label in  $\text{cal/cm}^2$
  - Working distance is normally 18 or 24 inches.
- 3 What is the Arc Flash Boundary (AFB)?**
  - Distance at which arc flash energy is  $1.2\text{ cal/cm}^2$
  - Onset of second degree burn
  - Arc flash PPE required.
- 4 What Arc Flash protection PPE is necessary?**  
Refer to the “Arc Flash PPE Levels” table on reverse side. (L)

*\*If the arc flash label is missing, contact the Electrical Safety Group or Facilities Engineering for assistance.*

See reverse side for barricade guidance. (F)

## A Follow ISM for EVERY JOB Remember your daily PPE inspections!

- 1 Define scope of work:**
  - Identify any switching needed. (J) (K)
  - Identify all equipment that will be entered.
  - Identify all modes of work. (F)
- 2 Analyze the hazards (SRA & AFRA):** (B) (C)
  - Perform Shock Risk Assessment. (C)
  - Perform Arc Flash Risk Assessment. (B)
  - Determine necessary PPE. (G) (L)
- 3 Define controls:**
  - Type of LOTO
  - 2-person rule and emergency plan (E)
  - Barricades, signage and attendants (F)
  - Consider all error precursors.



*PIC verifies all elements of JSP and performs a job briefing for all participants.*

- 4 Execute the work:**
  - Perform ZVV (Mode 1/0). (D)
  - Stay within the LOTO SAFE ZONE.
  - Watch for look-alike equipment.
  - Maintain all controls in place.
  - Redo ISM for any scope change.
- 5 Collect feedback and improve!**

## (E) 50/60Hz AC Hazard Classification & 2-Person Rule

Class	Mode	Two-Person
1.0 <15 V	All	Alone
1.1 15–50 V	All	Alone
1.2a 50–120 V Single Phase	0	Alone
	1	Alone
	2	Standby Person <sup>1</sup>
	3	Safety Watch
1.2b 208–300 V 3-Phase w/o AF hazard	0	Alone
	1	Alone
	2	Standby Person <sup>1</sup>
	3	Safety Watch

Class	Mode	Two-Person
1.3a 208–300 V w/ AF hazard	0	Alone
	1	Standby Person <sup>2</sup>
	2	Safety Watch
1.3b 300–750 V	3	Safety Watch
	0	Alone
	1	Standby Person <sup>2</sup>
	2	Safety Watch
1.4 >750 V	3	Safety Watch
	0	Alone
	1	Standby Person
	2	Safety Watch

- Note: Mode 2 in Class 1.2 may be performed alone, if proper voltage rated gloves and leather protectors are worn.
- Note: Non-hazardous switching may be performed alone. However, the standby person is required for ZVV.

## (F) Modes of Work and Barricades

Barricade Signal Word/Color	Mode	Description
<b>NOTICE</b>	<b>Mode 0</b>	Electrically Safe Work Condition
<b>WARNING</b>	<b>Mode 1</b>	LOTO & Zero Voltage Verification (ZVV)
<b>DANGER</b>	<b>Mode 2</b>	Energized Diagnostics (Testing & Troubleshooting)
<b>DANGER</b>	<b>Mode 3</b>	Energized Repair Work (EEWP)

• Barricades are mandatory for Mode 2/3 work. For Mode 0/1 work, consider whether barricades and/or attendants are necessary to control work area access.

• Place Barricades outside of LAB or AFB, whichever is greater.

### (G) Voltage Glove Class

Class	Tested at	Max Use
00	2500 VAC	500 VAC / 750 VDC
0	5000 VAC	1000 VAC / 1500 VDC

### (H) Shock Approach Boundaries

Voltage	LAB	RAB
50-150	42"	3"
151-750	42"	12"

### (I) Minimum PPE for Electrical Work:

- Safety glasses, and
- Non-melting clothing to include long pants and long sleeves, and
- Non-melting safety footwear that fully covers the feet.

### (J) Conditions for Normal Operation:

- Properly installed
- Properly maintained
- Used per listing/labeling
- All covers/doors on and bolted/latched
- No signs of impending failure.

## (K) Switching Rules

YES

Panel meets Conditions for Normal Operation, and labeled arc flash incident energy is 4 cal/cm<sup>2</sup> or less:

NO

### Non-Hazardous Switching (no shock or arc flash hazard):

- Can be performed by a Non-QEW (EHS0536 training required if ≥15A).
- Leather glove and safety glasses required.
- Stand to side, look away, close eyes, breathe in and hold, then switch in a complete full manner.

### Hazardous Switching:

- Do not switch if there are any signs of impending failure.
- QEW 2 is required 250V and higher (QEW 1 OK if no arc flash hazard and ≤300V).
- Perform a SRA and AFRA to select the appropriate PPE for shock and arc flash. (B) (C)
- Stand to side, close eyes, breathe in and hold, then switch in a complete full manner.

## (L) Arc Flash PPE Levels

Level	Incident Energy	Arc-Rated Gear	Other PPE
2	Exposure no higher than 8.0 cal/cm <sup>2</sup>	Rated at least <b>8 ATPV</b>	<ul style="list-style-type: none"> <li>Hard hat (Class E)</li> <li>Safety glasses (Z 87.1)</li> <li>Hearing protection</li> <li>Heavy-duty leather footwear</li> <li>Heavy-duty leather gloves</li> </ul>
		<ul style="list-style-type: none"> <li>Arc-rated long-sleeve shirt and pants (or arc-rated coveralls)</li> <li>Arc-rated faceshield</li> <li>Arc-rated balaclava</li> </ul>	
4	Exposure no higher than 40 cal/cm <sup>2</sup>	Rated at least <b>40 ATPV</b>	<ul style="list-style-type: none"> <li>Hard hat (Class E)</li> <li>Safety glasses (Z 87.1)</li> <li>Hearing protection</li> <li>Heavy-duty leather footwear</li> <li>Arc-rated gloves, or rubber insulating gloves with leather protectors</li> </ul>
		<ul style="list-style-type: none"> <li>Arc-rated flash suit (pants and jacket)</li> <li>Arc-rated flash suit hood</li> </ul>	

Other Arc Flash PPE Levels are described in the ESM, Table 8.10.1.