

Safe Work Practices



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1.0 GENERAL

This SWP will capture and summarize excerpts from the Versant Power Safety Manual. This section covers the workplace practices and use of “AR” (Arc Rated) protective clothing and equipment when employees are exposed to the hazards associated with flames and electrical arc flash. The intent is to have all related material one document.

2.0 RESPONSIBILITIES (Versant Power Safety Manual 5.3.2)

2.1 APPLICATION

- a. All persons performing work that exposes them to an arc flash hazard within an arc flash boundary shall wear approved AR (Arc Rated) clothing or clothing system and use other protective equipment with an arc rating greater than or equal to the heat energy they are exposed to as described in Section 5.3.4. All persons performing work that exposes them to an open flame hazard shall wear approved FR (Flame Resistant) clothing and other protective equipment.
 - i. Examples requiring AR protective clothing and equipment include:
 1. entry into an arc flash boundary of exposed energized parts
 2. performing any function outside of normal operating conditions that constitutes interaction with energized equipment that may result in an arc flash hazard
 3. exposure to contact with energized parts
 4. the use of rubber gloves, insulated sticks, or switching activity
 - ii. The use of welders, grinders, torches, or open flames require the wearing of FR protective clothing and equipment.
- b. Employees shall report to work wearing base AR clothing for rating of ARC 2 – see 5.3.2 3 below. AR clothing must be worn during red tag work (de-energized and grounded) if you are inside the potential Arc Flash Boundary.

2.2 Proper Wearing of AR clothing when inside the Arc Flash Boundary:

- a. Shirts may be worn tucked in or over pants
- b. Shirt Sleeves rolled down and buttoned unless tucked into rubber gloves or sleeves
- c. Shirt buttoned to but not including the top collar button.
- d. Pockets do not need to be fastened closed.
- e. Excluding a-d above - All zippers zipped, buttons buttoned, Velcro fastened, etc, that are providing 2 layers of protection.
- f. AR Clothing needs to be clean, free from contaminants
- g. Must fit well with some looseness to provide air gap which improves performance in reducing exposure to heat.

2.3 AR clothing and undergarments worn under AR clothing

- a. Base AR clothing for standard daily wear shall be a minimum rating of ARC 2 (Minimum 8 calorie/cm²) and consist of long pants and long sleeve shirt.
- b. Undergarments (if non AR) shall be light in color and 100% natural fiber, such as 100% cotton, wool or silk or AR rated in any available color and be worn underneath AR clothing. Non AR shirts cannot have labels or decals that compromise the 100% natural requirements. AR shirts cannot be modified from original manufacturer design.
- c. ARC 2 or greater shirts, or similar items, require the wearing of undergarments as outlined in 5.3.2.b above.
- d. Clothing made from acetate, nylon, polyester, or polypropylene shall not be worn either alone or in blends.

2.4 Outermost layers

- a. Traffic safety vests, rain suits and any other wear that makes up the outermost protective layer shall be AR.

2.5 Contractors

- a. Contractors shall wear AR protective clothing and equipment as specified in this section of the Company’s Safety Manual.

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3.0 REQUIREMENTS

- 3.1 Minimum AR pants and shirts (8 Cal Shirt, 8 & 20 Cal pants)
- 3.2 20 Cal Face Shield
- 3.3 20 Cal Balaclava
- 3.4 Minimum 20 Cal Clothing system to meet ARC-3
- 3.5 40 calorie suit, as specified for metal clad switchgear
- 3.6 Protective Rubber Goods
- 3.7 Insulated Stick
- 3.8 PPE including: Hard Hat, Safety Glasses, AR Hearing Protection, Rubber Gloves with Leather Protectors, Heavy-Duty Leather Gloves (min weight 12 oz/yd²), Heavy-Duty over the Ankle Work Boots
- 3.9 Undergarments as described in section 5.3.2.3.b & c of the Safety Manual or 2.3 b&c above.

4.0 RISK IDENTIFICATION

- 4.1 General – Risk
 - a. AR clothing and AR equipment used as PPE:
 - i. Arc flash hazards should be eliminated whenever it is practical to do so.
 - ii. Ratings of AR protective wear are intended to minimize an arc flash burn to a 50% probability of the onset of a second degree burn.
 - b. Required PPE by ARC Levels:
 - i. The required PPE for Arc Flash Protection will fall under 1 of 4 ARC categories defined by the level of Incident Energy Exposure, (also refer to Appendix A).
 - ii. The following table outlines those requirements:

Versant Power Arc Rating PPE levels

AR Category	Cal/Cm ² Range	Required PPE
ARC1 (Base PPE)	0.0 - 5.0	AR8 Cal Long Sleeve Shirt and Pants,T-Shirt or other Non AR Undergarments (must be light in color and 100% natural Fiber Cotton, wool,silk) or AR rated in any available color, Hard Hat, Safety Glasses, Rubber Gloves with Leather Protectors when needed or Heavy Duty (=> 12 oz/yd ²) or AR Leather Gloves. Heavy duty over the ankle footwear. Additional outer layers (Jacket, Parka, Rainwear or Hard Hat Liners must be AR).
ARC2	5.0 - 8.0	Same as ARC1
ARC3	8.0 - 20.0	AR20 Cal Clothing System or Lab Coat, all else the same.
ARC4	20.0 - 40.0	AR40 Cal Suit Including 40 Cal Hood, all else same.
Head and face Protection		Suffix F = AR20 Cal Faceshield Suffix B = AR20 Cal Balaclava
<i>Examples</i>	ARC2 - F ARC3 - FB	ARC2 PPE required + Faceshield ARC3 PPE required + Faceshield + Balaclava

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4.2 T&D Substations (2.4kv – 345 kV)

- a. Arc Flash Boundary:
 - i. The arc flash boundary for all substations is 6 feet from any exposed energized equipment.
- b. ARC PPE Level:
 - i. ARC-2 for all energized stick work.
 - ii. For any work requiring direct contact with rubber gloves, engineering shall be consulted to determine the specific IE (Incident Energy) at a distance of 15 inches.
- c. Exceptions:
 - i. Orrington, Bar Harbor and Eastern Ave. Arc Flash Boundary = 9 feet.
 - ii. Grant Street 2.4 Kv Substation Arc Flash Boundary = 14 feet.

4.3 T&D Overhead Lines (2.4kv – 345 kV)

- a. Arc Flash Boundary:
 - i. The arc flash boundary for all T&D Lines will be equal to the applicable MAD (Minimum Approach Distance) for the nominal voltage of the Line.
- b. ARC PPE Level:
 - i. ARC-2 for all stick and rubber glove work.
- c. Exceptions:
 - i. None.

4.4 Metal Clad Breakers – (Arc In A Box)

- a. Arc Flash Boundary:
 - i. The arc flash boundary for all metal clads is anywhere within the metal clad unit. For open rooms (Park Street and etc.), anywhere in the room, for outdoor units 40 feet.
- b. ARC PPE Level:
 - i. ARC-4
- c. Exceptions:
 - i. Eastport T1L - Scada operate remotely, de-energize for anything beyond until engineered out.
 - ii. ARC-2 PPE level is acceptable inside metal clad unit if no switching is occurring and no equipment is exposed (doors closed) for brief inspections, meter reading.

4.5 Meters - (Arc In A Box)

- a. Arc Flash Boundary:
 - i. The arc flash boundary for all meters is 6 feet.
- b. ARC PPE Level:
 - i. ARC-2F
- c. Exceptions:
 - i. 480 Volt Series Connected ARC-3FB
 - ii. Transformer Rated Meters (any voltage) ARC-2

4.6 Padmount Transformers including secondary cabinets and pedestals - (Arc In A Box)

- a. Arc Flash Boundary:
 - i. The arc flash boundary for all Pad Mount Transformers including secondary cabinets and pedestals is 6 feet.
- b. ARC PPE Level:
 - i. ARC-2F
- c. Exceptions:
 - i. Distribution and Substation 480 Volt ARC-3FB
 - ii. AMR XFMR Secondary Cabinets Arc Flash Boundary = 13 Feet, ARC-4 or De-energize.

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- 4.7 OMU Cabinets – 480 Volt
 - a. Arc Flash Boundary:
 - i. The arc flash boundary for OMU cabinets is 6 feet.
 - b. ARC PPE Level:
 - i. ARC-2F
 - c. Exceptions:
 - i. None.

- 4.8 Underground Systems - (Arc In A Box) Manhole Underground Systems: examples: City of Bangor and Loring
 - a. Arc Flash Boundary:
 - i. The arc flash boundary for all underground in this category is within any enclosed area with energized equipment including vaults, manholes and etc. and 6 feet when in open space (above grade switch enclosures, etc.).
 - b. ARC PPE Level:
 - i. ARC-2
 - c. Exceptions:
 - i. Any activity involving work with exposed energized conductors or equipment or the operation or switching of equipment ARC – 3FB.

- 4.9 URD - Underground Residential Distribution
 - a. Arc Flash Boundary:
 - i. The arc flash boundary for all underground in this category is within any enclosed area including vaults, manholes and etc. and 6 feet when in open space (above grade switch enclosures and etc.).
 - b. ARC PPE Level:
 - i. ARC-2
 - c. Exceptions:
 - i. Any activity involving work with exposed energized conductor or equipment. ARC – 3FB

- 4.10 Distribution Panels - (Arc In A Box)
 - a. For the purpose of this section, electrical panel boards that are not locked out and tested as being de-energized shall be considered energized.
 - i. All work in “AC” panel boards should be performed with the panel board de-energized unless the company can demonstrate that de-energizing introduces additional or increased hazards or that performing de-energized work is not feasible due to equipment design or operational limitations.
 - b. Persons performing work in energized panel boards shall be protected as follows:
 - i. Arc Flash Boundary:
 - 1. The arc flash boundary for panel boards is 7 feet.
 - ii. ARC PPE Level:
 - 1. ARC-2F
 - iii. Exceptions:
 - 1. \geq 480 volts ARC–3FB
 - 2. Arc flash boundary for 480 volts panels is 10 feet.

5.0 SAFETY PROCEDURES

5.1 AR Clothing Care and Maintenance

- a. Inspection: AR clothing and equipment shall be inspected prior to use.
 - i. Inspection Criteria:

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1. AR clothing and equipment shall be inspected to verify all buttons, zippers, velcro or other attachment devices are properly attached and are functional.
 2. AR clothing shall be removed from service when the fabric is frayed on cuffs, collars, hoods, elbows and etc. is identified.
 - a. The wearing of altered AR clothing, such as AR shirts with the sleeves cut off is prohibited.
 3. AR clothing shall not contain rips or tears unless properly repaired by the clothing vendor using approved methods.
 - a. Employees shall not repair AR clothing for rips, tears, missing buttons or similar defects.
 - b.
 4. AR equipment shall be removed from service if cracks, gouges or other signs of damage are identified.
- ii. Self-Washing Criteria:
1. Employees are to follow the guidance provided by the manufacturer for the type of AR fabric that their clothing is made from.
 2. Do not:
 - a. use water over 140 degrees F.
 - b. launder with non-AR clothing.
 - c. use tallow soap, bleach, fabric softener, or hydrogen peroxide to launder AR clothing.
 3. Leased clothing should be washed by the leasing vendor.
- iii. Insect Repellent use on AR protective clothing or equipment:
1. Only Rainbow 4507 or 4509 Tick & Mosquito Repellent is approved for use on AR protective clothing and equipment.
 - a. Other repellents shall require the Safety Department's approval and shall be issued as an addendum to this section once approved.
 2. Insect repellents containing DEET are permitted for use on the skin only and shall NOT be used on AR protective clothing.

6.0 CLOTHING AND FOOTWEAR (EMSM 2.4.5.2.a-e)

- 6.1 All employees working in or visiting field locations are required to wear the proper PPE. Refer to Section 2.8 Personal Protective Equipment.
- 6.2 Employees shall not wear jewelry of any kind while working on electrical equipment of any voltage (energized or de-energized). Exceptions to this safe work practice are as follows:
 - i Electrically or thermally nonconductive jewelry shall be approved on a case by case basis by the Safety Department.
 - ii Company approved medical bracelets.
- 6.3 While working on rotating machinery or equipment such as paper shredders or electric motors, employees shall ensure that all loose clothing or jewelry are out of the line of fire and proper PPE is worn.
- 6.4 Clothing suitable for work conditions shall be worn at all times.
- 6.5 Refer to the Company's appearance policy for more information. http://grid.emera.com/pp/Pages/hr_policies.aspx

7.0 DEFINITIONS

ARC: Versant Power's Arc Rating Categories.

ARC-1 0 – 5.0 Calories/CM²

ARC-2 5.001-8.0 Calories/CM²

ARC-3 8.001-20.0 Calories/CM²

ARC-4 20.001-40.0 Calories/CM²

Suffix – F Requires 20 Calorie Face shield

Suffix – B Requires 20 Calorie Balaclava

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Arc Flash: a rapid, explosive discharge of electrical energy that usually results from a short circuit. Short circuits are caused by flashover of electric current through air between live parts or from live parts to ground. Dielectric of air: (1 inch = 10 Kv).

Arc Flash Boundary: if an arc flash occurred, this boundary is where an employee would be exposed to a curable second degree burn (IE of 1.2 calories/cm²). Note: The Arc Flash Boundary that will be used for T&D Lines will be equivalent to the applicable MAD (Minimum Approach Distance) as calculated by Engineering for the nominal voltage of the specific Line. At the MAD for T&D Lines, the IE will be no greater than 2 calories/cm².

Arc Flash Hazard: the danger of excessive heat exposure and serious burn injury due to arcing faults in electrical power systems. Note: An arc flash hazard may exist when energized electrical conductors or circuit parts are exposed or when they are within equipment in a guarded or enclosed condition, provided a person is interacting with the equipment in such a manner that could cause an electric arc. Under normal operating conditions, enclosed energized equipment that has been properly installed and maintained is not likely to pose an arc flash hazard.

Arc Flash Hazard Assessment: a study investigating a worker's potential exposure to arc-flash energy, conducted for the purpose of injury prevention and the determination of safe work practices and the appropriate levels of PPE.

Arc Rating (AR): the value attributed to materials that describe their performance to exposure to an electric arc discharge. The arc rating is expressed in cal/cm² and is derived from the determined value of the arc thermal performance value (ATPV) or break open threshold (EBT) in the event the material exhibits a break open response at a value below the ATPV value.

Arc Thermal Performance Value (ATPV): the incident energy on a material or multilayer system of material that results in a 50% probability that sufficient heat transfer through the material is predicted to cause the onset of a second degree skin burn injury. Used in conjunction with break open threshold (EBT) to derive Arc Rating (AR) Cal/Cm² of material.

Energy Break Open Threshold (EBT): the highest incident energy exposure value on a fabric where the garments do not exhibit break-open which is the formation of holes in the fabric that would allow heat or flames to pass through.

Calorie: the amount of heat it takes to raise one gram of water one degree centigrade at one atmosphere of pressure. If you hold a lighter under your skin for one second, you will experience 1 calorie of heat.

Incident Energy: the total amount of heat energy (per unit area) impressed (Incident) on a surface, a certain distance from the source. Measured in Calories/Square Centimeter. Cal/CM². Level varies inversely with the square of the distance between the employee and the source of the Arc (double distance = quarter energy, visa versa)

Exposed: capable of being inadvertently touched or approached nearer than a safe distance by a person.

Electrical Panel Boards: the electrical AC panels located at the Company's facilities and in substation control houses or any other junction box or enclosure that we own that houses one.

Flame Resistant: the characteristic of a fabric to resist ignition and to self- extinguish if ignited

Minimum Approach Distance: the closest distance a qualified employee is permitted to approach either an energized or grounded object (the grounded object applies to live line work), as applicable for the work method being used.

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7.0 SAFETY MANUAL REFERENCES

- 7.1 **Section 2.8.5.1.d (Safe Work Practices For All Employees – PPE)** Refer to Section 5.3 Arc Flash for information on Arc flash clothing.
- 7.2 **Section 2.8.5.3.d (Safe Work Practices for All Employees – Eye and Face Protection)** Refer to Section 5.3 Arc Flash for information on arc flash clothing and face shield requirements.
- 7.3 **Section 2.8.5.8.c (Safe Work Practices for All Employees – Hearing)** Ear muffs shall not be worn when an employee is exposed to an arc flash hazard. Inside ear protection is required in these circumstances.
- 7.4 **Section 3.5.5.5.g (Operation of Motor Vehicles and Equipment – Testing and Maintenance)** Lift equipment shall be reported to the Fleet Department for inspection if any of the following occurs: i. Contact with energized conductors causing an arc flash.
- 7.5 **Section 5.3 Arc Flash**
- 7.6 **Section 5.5.5.8.b (URD Grounding)** Refer to Section 5.3 Arc Flash for information on arc flash PPE.
- 7.7 **Section 5.7.4.1 (Transmission and Distribution Risk Identification)** Electrical contact or arc flash burns resulting in injury or death.
- 7.8 **Section 5.9.3.1 (URD Installations Requirements)** PPE (including FR and AR clothing)
- 7.9 **Section 5.9.5.1.k (URD Installations Safe Work Practices)** Refer to Section 5.3 Arc Flash for information on arc flash PPE.
- 7.10 **Section 5.9.5.4.a (URD Work on Energized Equipment)** Before a transformer enclosure is opened, all unauthorized persons shall leave and remain clear of the arc boundary. Refer to Section 5.3 Arc Flash for more information.
- 7.11 **Section 5.10.4.2 (Meter Operations Risk Identification)** Serious injury cause by an arcflash.
- 7.12 **Section 5.10.5.1.h (Meter Operations Safe Work Practices)** Refer to Section 5.3 Arc Flash for required arc rated PPE, including face shields and balaclava.
- 7.13 **Section 5.10.5.3.a (Meter Operations Self-Contained Meters)** Eye protection, low voltage rubber gloves and FR/AR clothes shall be worn when installing or removing meters.
- 7.14 **Section 5.11.5.1.g.iv (Substations Safe Work Practices)** Apparel as required by Section 5.3 Arc Flash
- 7.15 **Section 8.2.5.1.a.iii (Welding, Cutting and Brazing Safe Work Practices PPE)** FR clothing

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Minimum Approach Distances (MADs)

Minimum Approach Distances (MADs)					
Nominal Voltage (kV)-					
Phase - Phase	Distance		Distance		
	(ph - gr exposure)		(ph - ph exposure)		
	ft	inches	ft	inches	
0.050 - 0.300	Avoid contact		Avoid contact		
0.301 - 0.750	1.09	14	1.09	14	
0.751 - 5.0	2.07	25	2.07	25	
5.1 - 15.0	2.14	26	2.24	27	
15.1 - 36.0	2.53	31	2.92	36	
36.1 - 46.0	2.76	34	3.22	39	
46.1 - 72.5	3.29	40	3.94	48	

Nominal Voltage (kV)-					
Phase - Phase	Distance		Distance		
	(ph - gr exposure)		(ph - ph exposure*)		
	ft	inches	ft	inches	
72.5 - 121.0	3.71	45	4.66	56	
121.1 - 145.0	4.27	52	5.38	65	
145.1 - 169.0	4.79	58	6.36	77	
169.1 - 242.0	6.59	80	10.1	122	
242.1 - 362.0	11.19	135	18.11	218	
362.1 - 420.0	13.94	168	22.34	269	
420.1 - 550.0	16.63	200	27.03	325	
550.1 - 800.0	22.57	271	37.34	449	

*-Provided no insulated tool spans the gap and no large conductive object is in gap

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Minimum Approach Distances (MADs)

Distance Distance

Nominal Voltage (kV) Phase - Phase	(ph - gr exposure)		(ph - ph exposure)	
	ft	inches	ft	inches
0.050 - 0.300	Avoid contact		Avoid contact	
0.301 - 0.750	1.09	14	1.09	14
0.751 - 5.0	2.07	25	2.07	25
5.1 - 15.0	2.14	26	2.24	27
15.1 - 36.0	2.53	31	2.92	36
36.1 - 46.0	2.76	34	3.22	39
46.1 - 72.5	3.29	40	3.94	48
72.5 - 121.0	3.71	45	4.66	56
121.1 - 145.0	4.27	52	5.38	65
145.1 - 169.0	4.79	58	6.36	77
169.1 - 242.0	6.59	80	10.1	122
242.1 - 362.0	11.19	135	18.11	218
362.1 - 420.0	13.94	168	22.34	269
420.1 - 550.0	16.63	200	27.03	325
550.1 - 800.0	22.57	271	37.34	449

ASTM D120 Class Specifications for Insulating Rubber Gloves

Class	Proof Test Voltage	Max Use Voltage	Label Color
Class 00	2,500 AC/10,000 DC	500 AC/750 DC	Beige
Class 0	5,000 AC/20,000 DC	1,000 AC/1,500 DC	Red
Class 1	10,000 AC/40,000 DC	7,500 AC/11,250 DC	White
Class 2	20,000 AC/50,000 DC	17,000 AC/25,500 DC	Yellow
Class 3	30,000 AC/60,000 DC	26,500 AC/39,750 DC	Green
Class 4	40,000 AC/70,000 DC	36,000 AC/ 54,000 DC	Orange

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ARC Flash Requirements PPE Requirements by System Category

Section 5 - 5.3 AF Cheat Sheet
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AF System Category	PPE Level	Boundary	Exceptions/Notes
T&D Substations (2.4 kV - 345 kV)	ARC-2	6 feet	ARC-2 for stick work, consult engineering for Incident Energy levels for Glove work at 15 inches. Grant Street Boundary = 14 feet, Orrington, Eastern Ave and Bar Harbor Boundary = 9 feet
T&D Lines (2.4 kV - 345 kV)	ARC-2	See Note	The arc flash boundary for all T&D Lines will be equal to the applicable MAD (Minimum Approach Distance) for the nominal voltage of the Line.
Metal Clad Switchgear	ARC-4	See Note	The arc flash boundary for all Metal Clads is anywhere within the metal clad unit. For open rooms (Park Street, etc.), anywhere in the room, for outdoor units 40 feet. Eastport T1L – Scada operate remotely, de-energize for anything beyond until engineered out. <i>If no switching or exposed live parts then ARC-2 is sufficient for brief inspections or meter readings</i>
Padmount XFRM'S 120/240/208 Volt	ARC-2F	6 Feet	
Padmount XFMR'S 480 Volt	ARC-3FB	6 Feet	AMR Padmount XFMR'S (Secondary Cabinet) Arc Flash Boundary = 13 Feet, ARC-4 or De-energize
OMU Cabinets 480 Volt	ARC-2F	6 Feet	
Meters 120/240/208 Volt	ARC-2F	6 Feet	<i>Transformer rated meters of any voltage - ARC-2 PPE</i>
Meters 480 Volt	ARC-3FB	6 Feet	480 Volt XFMR Rated = ARC-2 PPE
Panels 120/240/208 Volt	ARC-2F	7 Feet	
Panels 480 Volt	ARC-3FB	10 Feet	
Primary Underground (City of Bangor, Loring)	ARC-2	see note	The arc flash boundary for all Underground in this category is within any enclosed area with energized equipment including vaults, manholes, etc. and 6 feet when in open space (above grade switch enclosures, etc.) Any activity involving work with exposed energized conductors or equipment or the operation or switching of equipment requires level ARC – 3FB PPE
URD Underground	ARC-2	see note	Same as above Underground note

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