



Northeast
Utilities System

Transmission



Administrative Procedure

Transmission Arc Flash Protection Program

M8-MT-2018, Rev. 2

Approval Signature: *Dwayne M. Basler*

Process Dwayne M. Basler
Director-Transmission
Owner: Maintenance & Work Mgmt

Effective
Date: 12/07/2009

Copyright 2009 Northeast Utilities Service Company
Proprietary and Confidential • All Rights Reserved
107 Selden Street • Berlin, CT
Phone 860-665-5000 • Fax 860-665-5225

Table of Contents

1. Purpose	2
2. Scope	2
3. Roles and Responsibilities	2
4. Process Steps	4
4.1. Instructions	5
4.2. Work Sequences That May Cause Arc Flash Events	5
5. CL&P & WMECO Requirements	6
6. PSNH & Contractor Requirements	7
7. Standard Clothing System	8
7.1. Standard Clothing System Requirements	8
7.1.1. SCS Level A	9
7.1.2. SCS Level B	10
7.1.3. SCS Level C	11
7.2. Substations Requiring SCS Level 3 Clothing	12
7.3. NESC Chart (Arc Flash Current)	13
8. Administrative Information	15
8.1. Definitions	15
8.2. References	15
9. Summary of Changes	16

1. Purpose

This procedure establishes the specifications for wearing flame retardant (FR) clothing and clothing systems when working near energized transmission equipment 69kV and greater where there is a potential for an arc flash event. This policy is in addition to any requirements listed in TD-211 When to Wear FR Clothing and other NU Operating Company arc flash guidelines.

NOTE

For working on CL&P, PSNH & WMECO distribution electrical assets, each Operating Company's arc flash program, guidelines or rules shall be followed. Contact your Transmission Safety Representative for guidance.

2. Scope

This procedure applies to all Northeast Utilities (NU) employees and contractors* working on or near energized **transmission voltages** 69kV or greater where there is a potential for an arc flash event. This applies to both Transmission and Distribution maintained assets that are 69kV or greater including new construction and maintenance of existing T&D facilities.

* NOTE

Contractors shall meet the requirements of this NU policy as a minimum but may follow their own internal company arc flash policies where their policy exceeds these requirements.

3. Roles and Responsibilities

Director, Transmission Maintenance and Work Management

- Approves program and ensures management has implemented the requirements of the program.

Supervisor, Safety & Environmental (Transmission)

- Provides updates to the arc flash program as necessary.
- Ensures training updates are communicated to all affected groups as changes to the policy are made.
- Develops Transmission specific safety practices, guidelines and rules for arc flash.
- Provides safety advice and assistance to all organizational units of the Transmission Group. Serves as an advisor and consultant to functional management.

- Represents the Transmission Group on root cause evaluations of any arc flash events.

Managers, Transmission Group

- Ensures that all Transmission Group and NU safety guidelines and rules in the arc flash policy are well understood and followed by employees within their sections.
- Ensures that all electrical work where arc flashes can occur is performed by qualified employees.

Transmission Protection and Controls Engineering

- Performs fault current calculations and breaker clearing times as updates or changes are made to the grid in NU service territories that affect clearing times or fault magnitude.

Construction Representatives

- Ensures that when qualified electrical contractors working on a job managed by a Construction Representative for NU meets the terms of this policy when they perform operations where an arc flash may occur.

Supervisors, Transmission Group

- Responsible for implementation of the requirements of the arc flash program within their units.
- Follows and enforces all Transmission and NU arc flash safety guidelines and rules.
- Instructs employees to report hazards immediately.
- Ensures contractors working under their authority meet the requirements of this policy where there is a possibility for an arc flash to occur.

Employees, Transmission Group & Operating Company Supporting Transmission

- Reports arc flash events immediately.
- Follows all requirements of the arc flash policy.

4. Process Steps

NESC 410 requires that by January 2009 that the “employer shall ensure that an assessment is performed to determine potential exposure to an electric arc for employees who work on or near energized parts or equipment. If the assessment determines a potential employee exposure greater than 2 cal/cm² exists, the employer shall require employees to wear clothing or a clothing system that has an effective arc rating not less than the anticipated level of arc energy.” (NESC 410 – 2007).

Transmission performed an assessment and has developed a Standard Clothing System (SCS) for work tasks on or around energized transmission lines and equipment that may cause an arc flash event. To make compliance with the NESC recommended clothing levels less complicated, Transmission created the SCS which is a required minimum clothing level for listed activities that ensures compliance with the NESC recommendations. The SCS has three levels: A, B, and C.

Level C is only for substations and lines that are rated at a 12 cal/cm² level. NU has provided tables T1 – T3 within this policy that indicate which substations and lines that have a 12 cal/cm² level. These higher levels of clothing are **only required when performing the listed within section 4.2.**

The clothing levels are determined by calculations performed by arc flash computer software (ARCPRO). The calculations are completed by utilizing the following data:

1. Single phase to ground faults at the substation bus
2. The primary protection system cycle trip time
3. NESC minimum approach distance for qualified employees*
4. Maximum anticipated per unit overvoltage factor (T) of 3.0

The distance to the arc flash is assumed to be the qualified employees phase to ground exposure distance. The “body” is defined as the chest region, not including the arms, legs, or head distance to the arc event.

In substations with a multiple bus set up, the arc flash calculations assume the bus with the highest available fault current as the primary feeder for the voltage to be worked on.

NOTE

OSHA minimum approach distances for qualified employees calculated for PSNH and Contractors. CL&P and WMECO minimum approach distances (as specified in the NU Employee Safety & Health Handbook) for qualified employees calculated for CL&P and WMECO.

4.1. Instructions

These instructions are guidelines to meet compliance with the NESC 410 standard. Employees or contractors who would like to increase the minimum protections detailed in this procedure may do so as long as they do not pose additional hazards to the worker.

4.2. Work Sequences That May Cause Arc Flash Events

Work tasks that have the ability to cause an arc flash event are defined as:

- Testing for potential of circuits or parts of an energized or de-energized transmission electrical system.
- Application of worker protective grounds to lines, bus structures, or taps to transmission lines.
- Switching where the configuration of the equipment is such that the operator must stand directly below or at the qualified employee distance of the switch or breaker during the act of switching (manual crank or MOD).
- During scheduled switching that requires personnel to stand at the OSHA qualified employees distance to a breaker that will be operated to break electrical load, including SF6, GIS, and OCB.

Work tasks where arc flashes are likely to occur also require a minimum level of FR protection for lower voltages, follow TD-211 requirements for:

- Entry into substations
- Work in energized electrical cabinets 480-1000 volts

NOTE

This policy is not intended to cover Transmission live line work practices for arc flash events. Employees who are qualified for Transmission live line work shall follow M8-MT-3010 for arc flash guidance.

5. CL&P & WMECO Requirements

Employees working at the CL&P and WMECO minimum approach distances for qualified employees shall follow the SCS Level A for all work tasks described in Section 4.2. Level A requirements are established in Section 7.1.1. DO NOT REFER to the charts located in Section 7.2, those charts are calculated using the OSHA qualified employee distances not the NU qualified employee distances (except WMECO's French King Substation).

NOTE

Any employee performing work (as described in Section 4.2) at the French King Substation or on the French King feeder shall be required to wear SCS Level B clothing requirements

6. PSNH & Contractor Requirements

PSNH employees and contractors working at the OSHA minimum approach distances for qualified employees shall follow the **SCS Levels** for work tasks as described in Section 7.

- **SCS Level A** follow Section 7.1.1
 - Electrical panel/cabinet work 480 - 1000 volts energized
 - Climbing on energized structures for maintenance activities (poles, towers)
 - Entry into a transmission substation

- **SCS Level B** follow Section 7.1.2
 - Transmission voltage switching, testing potential & grounding

- **SCS Level C** follow Section 7.1.3
 - Transmission voltage switching, testing potential & grounding (**only for stations listed in Section 7.2**)

7. Standard Clothing System

7.1. Standard Clothing System Requirements

Clothing systems are designed to provide personnel protection under the various work tasks that may cause an arc event. The garments worn **must either be labeled with an ATPV or cal/cm² rated value** meeting or exceeding the defined energy value for the specific equipment they are exposed to during their work tasks.

Layering of FR clothing provides additional layers of protection during work tasks that may cause an arc flash event. For the purposes of this procedure the following clothing may be layered to meet arc flash levels:

- Shirts:
 - 5 cal/cm² = a long sleeve shirt with a 5 cal/cm² minimum rating.
 - 8 cal/cm² = a long sleeve shirt with a 8 cal/cm² minimum rating.
 - 8 cal/cm² = a t-shirt with a 5 cal/cm² minimum rating and a long sleeve shirt with a 5 cal/cm² minimum rating.
 - 12 cal/cm² = a long sleeve shirt with a 12 cal/cm² rating or higher.
 - 12 cal/cm² = a t-shirt with a 5 cal/cm² minimum rating and a long sleeve shirt with a 8 cal/cm² minimum rating.

- Pants:
 - 5 cal/cm² = pants with a 5 cal/cm² minimum rating
 - 8 cal/cm² = pants with a 8 cal/cm² minimum rating
 - 8 cal/cm² = pants with a 5 cal/cm² minimum rating and coveralls with a 5 cal/cm² minimum rating
 - 12 cal/cm² = pants with a 5 cal/cm² minimum rating and coveralls with a 8 cal/cm² minimum rating
 - 12 cal/cm² = pants with a 12 cal/cm² minimum rating

7.1.1. SCS Level A

All Work Groups –

1. Electrical panel/cabinet work 480 - 1000 volts energized
2. Climbing on energized structures for maintenance activities (poles, towers)
3. Entry into a transmission substation

CL&P and WMECO –

1. Transmission voltage switching, testing potential & grounding

Electrical work in energized electrical cabinets requires the following:

- Arc rated balaclava 12 cal/cm² or higher (as required in TD-211)
- Safety glasses (as required in NU Safety & Health Handbook Section 1.26)
- Class 0 electrical gloves (as required in NU Safety & Health Handbook section 3.5)
- Class E (ANSI Z89.1) rated hard hat (as required in NU Safety H& Health Handbook 1.26.8)
- FR shirt / pants or coveralls with a 5 cal/cm² minimum rating



+



+



+



+



or



7.1.2. SCS Level B

PSNH and Contractors –

1. Transmission voltage switching, testing potential & grounding

- Arc rated balaclava 12 cal/cm² minimum rating
- Safety glasses
- Class II electrically insulated gloves
- Class E hard hat
- FR shirt / pants or coveralls with a 8 cal/cm² minimum rating



NOTE

For transmission line crews not working inside a substation, the crew shall reference all substations the line they perform work on terminates. Depending on configuration this could be two or more substations. The substation with the highest available fault current shall be selected as the governing station for PPE protection. This will provide the work crew on the line the most conservative estimate of an arc flash event.

NOTE

For Live Line hot stick work completed from a climbing position, not from a bucket truck, follow the SCS Level B requirements.

7.1.3. SCS Level C

SCS Level C – Refer to Charts T1-T3 (Section 7.2) for covered substations

PSNH and Contractors –

1. Transmission voltage switching, testing potential & grounding
 - Arc rated balaclava 12 cal/cm² minimum rating
 - 12 cal/cm² arc rated face shield and safety glasses
 - Class II electrically insulated gloves
 - Class E hard hat
 - FR shirt / pants with an 8 cal/cm² minimum rating and an additional layer coveralls, lab coat* or switching jacket* with a 5 cal/cm² minimum rating



*** NOTE**

Length of FR lab jacket or switching jacket must cover to the knee.

7.2. Substations Requiring SCS Level 3 Clothing

NOTE

The tables below are for PSNH and Contractor crews only, and for any employee performing work at the WMECO French King Substation or the French King feeder

Substations listed below require additional protective clothing and clothing systems due to the higher fault currents or breaker fault clearing times. The lists are separated by State.

T1 – New Hampshire

State	Substation name	Substation ID	Voltage	Phase to ground fault	Cycle clearing time	Clothing System Cal/cm ²
NH	None					

T-2 Massachusetts

State	Substation name	Substation ID	Voltage	Phase to ground fault	Cycle clearing time	Clothing System Cal/cm ²
MA	* FRENCH KING	21B	115	4,001 amps	683	37.7

*** NOTE: Must meet clothing system requirement (37.7 cal/cm²) and/or perform a detailed Job Hazard Assessment (JHA) as specified in the Northeast Utilities Safety & Health Handbook.**

T-3 Connecticut

State	Substation name	Substation ID	Voltage	Phase to ground fault	Cycle clearing time	Clothing System Cal/cm ²
CT	FLANDERS	11Y	115	8,002 amps	65	12
CT	BLACK ROCK	11H	115	11,693 amps	46	12

7.3. NESC Chart (Arc Flash Current)



5 September 2008 (Revision)

Table 410-2—Live-line tool work clothing and clothing systems—voltage, fault current, and maximum clearing time for voltages 46.1 to 800 kV ¹

(See Rule 410A3.)

Phase-to-phase voltage (kV)	Fault current (kA)	4-cal system	8-cal system	12-cal system
		Maximum clearing time (cycles)	Maximum clearing time (cycles)	Maximum clearing time (cycles)
46.1 to 72.5	20	<u>18.2</u>	<u>36.4</u>	<u>54.5</u>
	30	<u>10.2</u>	<u>20.4</u>	<u>30.6</u>
	40	<u>6.6</u>	<u>13.2</u>	<u>19.7</u>
	50	<u>4.6</u>	<u>9.2</u>	<u>13.9</u>
72.6 to 121	20	<u>9.9</u>	<u>19.8</u>	<u>29.8</u>
	30	<u>5.7</u>	<u>11.4</u>	<u>17.1</u>
	40	<u>3.8</u>	<u>7.5</u>	<u>11.3</u>
	50	<u>2.7</u>	<u>5.4</u>	<u>8.1</u>
138 to 145	20	<u>12.1</u>	<u>24.1</u>	<u>36.2</u>
	30	<u>7.4</u>	<u>14.9</u>	<u>22.3</u>
	40	<u>5.2</u>	<u>10.4</u>	<u>15.6</u>
	50	<u>3.9</u>	<u>7.8</u>	<u>11.7</u>
345 to 362	20	<u>26.4</u>	<u>52.7</u>	<u>79.1</u>
	30	<u>16.2</u>	<u>32.4</u>	<u>48.6</u>
	40	<u>11.3</u>	<u>22.6</u>	<u>34.0</u>
	50	<u>8.5</u>	<u>17.0</u>	<u>25.5</u>

¹Arc gap—calculated by using the phase-to-ground voltage of the circuit and dividing by 10. The dielectric strength of air is taken at 10 kV per inch. See IEEE Std 4-1995

Distance from arc—calculated by using the minimum approach distance from Table 441-2 and subtracting two times the assumed arc gap length.

These calculations were derived using a commercially available computer software program. Other methods are available to estimate arc exposure values and may yield slightly different, but equally acceptable results.

The use of the table in the selection of clothing is intended to reduce the amount or degree of injury but may not prevent all burns.



Table 441-2

	72.5 to 121.0	121.1 to 145.0	145.1 to 169.0	169.1 to 242.0	242.1 to 362.0	362.1 to 550.0	550.1 to 800.0
1.5	2 ft 2 in	2 ft 5 in	2 ft 8 in	3 ft 4 in	4 ft 6 in	6 ft 6 in	10 ft 5 in
1.6	2 ft 3 in	2 ft 6 in	2 ft 9 in	3 ft 6 in	4 ft 9 in	7 ft	11 ft 5 in
1.7	2 ft 4 in	2 ft 7 in	2 ft 10 in	3 ft 8 in	4 ft 11 in	7 ft 6 in	12 ft 5 in
1.8	2 ft 5 in	2 ft 8 in	3 ft	3 ft 10 in	5 ft 2 in	8 ft 1 in	13 ft 6 in
1.9	2 ft 6 in	2 ft 9 in	3 ft 1 in	4 ft	5 ft 5 in	8 ft 8 in	14 ft 8 in
2.0	2 ft 7 in	2 ft 11 in	3 ft 2 in	4 ft 1 in	5 ft 8 in	9 ft 4 in	15 ft 11 in ³
2.1	2 ft 8 in	3 ft	3 ft 4 in	4 ft 3 in	5 ft 10 in	9 ft 11 in	17 ft 2 in
2.2	2 ft 9 in	3 ft 1 in	3 ft 5 in	4 ft 5 in	6 ft 2 in	10 ft 7 in	18 ft 5 in
2.3	2 ft 10 in	3 ft 2 in	3 ft 6 in	4 ft 7 in	6 ft 6 in	11 ft 2 in	19 ft 9 in
2.4	2 ft 11 in	3 ft 3 in	3 ft 7 in	4 ft 9 in	6 ft 10 in	11 ft 10 in ³	21 ft 3 in
2.5	3 ft	3 ft 4 in	3 ft 9 in	4 ft 11 in	7 ft 3 in	12 ft 8 in	22 ft 8 in
2.6	3 ft	3 ft 5 in	3 ft 10 in	5 ft	7 ft 7 in	13 ft 4 in	
2.7	3 ft 1 in	3 ft 6 in	3 ft 11 in	5 ft 2 in	7 ft 11 in	14 ft 2 in	
2.8	3 ft 2 in	3 ft 7 in	4 ft 1 in	5 ft 4 in	8 ft 4 in	15 ft	
2.9	3 ft 3 in	3 ft 9 in	4 ft 2 in	5 ft 6 in	8 ft 9 in	15 ft 9 in	
3.0	3 ft 4 in	3 ft 10 in	4 ft 3 in	5 ft 8 in	9 ft 2 in	16 ft 8 in	
3.1	3 ft 5 in	3 ft 11 in	4 ft 4 in	5 ft 10 in	9 ft 6 in		
3.2	3 ft 6 in	4 ft	4 ft 6 in	6 ft	9 ft 11 in		
3.3	3 ft 7 in	4 ft 1 in	4 ft 7 in	6 ft 3 in	10 ft 4 in		
3.4	3 ft 8 in	4 ft 2 in	4 ft 8 in	6 ft 5 in	10 ft 9 in		
3.5	3 ft 9 in	4 ft 3 in	4 ft 10 in	6 ft 8 in	11 ft 3 in		

8. Administrative Information

8.1. Definitions

Acronym or Word	Definition
<u>OSHA</u>	Occupational Safety and Health Administration
<u>Arc flash</u>	is a voltage breakdown of the resistance of air resulting in an arc which can occur where there is sufficient voltage in an electrical system and a path to ground or lower voltage
<u>Body</u>	In this policy is defined as the torso, not including the legs, head, or arms
<u>PPE</u>	Personal Protective Equipment
<u>NESC</u>	National Electric Safety Code
<u>Standard Clothing System (SCS)</u>	a clothing system that is the minimum PPE requirement for the work activities listed in the policy

8.2. References

- NESC 2007 Edition 410 A (3) General Requirements
- OSHA 1910.132 Personal Protective Equipment
- OSHA 1910.269 (g)
- TD 211: When to Wear FR Clothing
- NU Employee Safety & Health Handbook
- CL&P, WMECO & PSNH Operating Company Arc Flash Rules

9. Summary of Changes

Revision 0

- None – This procedure is the original issue.

Revision 1

- Added Black Rock 11H Substation to Section 4.4 - Table T3 (Substations Requiring SCS Level 3 Clothing)

Revision 2

- Created two separate arc flash requirements sections (Sections 5 & 6) based on the OSHA minimum approach distances for qualified employees and the CL&P and WMECO minimum approach distances for qualified employees.