



**DEPARTMENT OF VETERANS AFFAIRS
VA MEDICAL CENTER – ERIE, PA**

Contract No. V244-P-1779
TWN Project No. 2113994

August 2011

Fault Current Study and Arc Flash Analysis

SECTION 4

ARC FLASH HAZARD ANALYSIS

4.0 ARC FLASH HAZARD ANALYSIS

4.1 Introduction

TEAMWORKnet, Inc. has carefully reviewed the potentially Arc Flash hazardous working areas at the Project Site. The Modeled Arc Flash Study is designed to insure compliance with NFPA, NEC and OSHA safety standards and to better protect field personnel. Arc Flash provides the latest calculation procedures for determining potentially hazardous working areas and for applying proper flame resistant clothing requirements.

4.2 General Arc Flash Procedure

Model Arc Flash calculations are based on the IEEE 1584 "Standard for Electrical Safety Requirements for Employee Workplaces". These calculations provide specific incident energies and arc flash boundaries for each protective equipment area at the studied facility. IEEE 1584 is used as a basis for evaluating and providing electrical safety in the workplace and is compatible with Occupational Safety and Health Administration (OSHA), Code 29 and the National Electrical Code requirements.

The Arc Flash Study determines the Limited, Prohibited and Restricted Approach Boundaries (distance from live parts). These minimum approach boundaries safeguard workers from the dangers of fire, shock, arc flash and arc blast. Additionally, this study states the necessary Personal Protective Equipment (PPE) qualified and unqualified personnel must wear when working within the approach boundaries.

4.3 Specific Arc Flash Procedures (See Appendix IX)

4.4 Arc Flash Hazard Analysis Results and Recommendations

4.4.1 Arc Flash Hazard Table Headings Guide and PPE Table

The arc flash hazard analysis table summarizes the results of the arc flash hazard analysis. The calculations are based on the settings developed in previous sections (see Section 3). On the following pages is a brief description of the report headings for the Arc Flash Hazard Analysis report include in Section 4.4.2.

Report Headings for the Arc Flash Hazard Analysis (1 of 2)

Protective Device Name: The designation for the overcurrent protective device that clears the arcing fault. In cases where several sources are connected to a single bus (e.g., multiple mains, motor contribution to an MCC, etc.), the main device to operate is reported.

Bus Bolted Fault (kA): The calculated three-phase bolted fault current, RMS symmetrical amperes.

Prot. Dev. Bolted Fault (kA): The portion of the bolted fault current through the protective device.

Prot. Dev. Arcing Fault (kA): The calculated arcing fault current associated with the bolted fault current.

Trip/Delay Time (sec.): This is the time for the main protective device to react to the arcing current. For fuses, it is the total clearing time. For circuit breakers, it is the relay or trip unit time delay. The time is taken from a time-current curve using the arcing current or the reduced (85%) arcing current, unless the maximum tripping time of 2.0 seconds is used.

Breaker Opening Time (sec.): This is the time for the circuit breaker mechanism to open the contacts and interrupt the current. The time is in addition to the trip or delay time. For low voltage breakers, the opening time is included in the trip/delay time.

Ground: This indicates whether the system is grounded or ungrounded (including ungrounded or impedance grounded).

Equip. Type: This indicates the type of equipment in which the arc is assumed to occur: switchgear, panelboard, cable, or open air.

Gap: This is the gap between conductors and defines the length of the arc. Standard bus gap distances are defined in IEEE 1584.

Arc Flash Hazard Boundary: This is the working distance at which incident energy equals 1.2 cal/cm², considered to be the level which can produce second-degree burns on exposed skin. Any approach closer than the arc flash boundary requires use of personal protective equipment.

Working Distance: The assumed distance from the arc point to the head and body of the worker positioned in place to perform the assigned task.

Incident Energy: The thermal energy density to which a person at the working distance is exposed.

Report Headings for the Arc Flash Hazard Analysis (2 of 2)

Required Protective FR Clothing Class: The hazard class associated with the incident energy and the corresponding personal protective clothing required. If the incident energy is higher than 40 cal/cm² (Category 4), work should not be performed on or near the equipment unless the equipment has been placed in an electrically safe condition. For such hazard levels, the description “Dangerous” is used. The required FR clothing classes reported in the table are based on Table 130.7(C)(11) of NFPA 70E-2009, as shown in the Table 2 below. The descriptions in the arc flash summary table are typical—consult NFPA 70E and manufacturers’ Arc Rating information for further information and additional requirements on other required protective clothing, including hearing, face, and eye protection. NFPA 70E (Latest Revision) should also be reviewed regarding limitations and requirements for working on energized equipment. Requirements related to energized work in the Latest version of the standard, including mandatory energized work permits, are much more restrictive than in previous versions of NFPA 70E.

Hazard/Risk Category	Clothing Description	Total Weight (oz/yd ²)	Minimum Required ATPV
0	Untreated Cotton	4.5-7	N/A*
1	FR Shirt/Pants	4.5-8	4
2	Cotton Underwear plus FR Shirt and FR Pants	9-12	8
3	Cotton underwear plus FR Shirt and FR Pants plus FR Coverall	16-20	25
4	Cotton Underwear plus FR shirt and FR pants plus double-layer switching coat and pants	24-30	40

Table 2: Typical Protective Clothing Characteristics.

4.4.2 Arc Flash Evaluation Report

The Following Pages represent the Arc Flash Evaluation Report as produced from the Model based on the assumptions, input data and analysis methods outlined in this report.

ARC FLASH EVALUATION REPORT

CD File: **Arc Flash Evaluation Report**

4.5 Arc Flash Labels (Available on Disk)

TEAMWORKnet arc flash labeling practice will be used for this job. Labels for each piece of equipment, or for each section of multi-section equipment, will consist of a Arc Flash Information label. The Arc Flash Information label is printed with values produced by the arc flash hazard analysis and is field installed.

The Arc Flash Information is printed on a two color vinyl label that is resistant to chemicals, water and UV light. Each label is approximately 4 inches in height and 6 inches in width. Each label works appropriately on surfaces up to 200 degree F. Each label will have an orange strip approximately 1 3/16 inch in height.

The following information is included on each label:

- a) "Arc Flash Information" banner on the top of the label
 - a. Flash Protection Boundary in inches
 - b. Incident Energy in cal/cm²
- b) Working Distance in inches
- c) PPE Category per NFPA 70E
- d) Protection
 - a. Head
 - b. Glove
 - c. Clothing
- e) Shock hazard when cover is open
- f) Limited Approach in inches
- g) Restricted Approach in inches
- h) Prohibited Approach in inches

The standard Arc Flash Information label will report the maximum incident energy and flash protection boundary for each PPE category number and equipment type, unless voltage is greater than 15kV, or if incident energy is above 40 cal/cm². Generally no equipment name is printed on the label, unless the voltage is greater than 15kV, or if incident energy is greater than 40 cal/cm². This type of Arc Flash information label may reduce the need to replace arc flash labels due to changes in the electrical system that change the incident energy and flash protection boundary values but do not affect the PPE category at a given piece of equipment.

4.6 Work Permit Example

ENERGIZED ELECTRICAL WORK PERMIT																																			
PART I: TO BE COMPLETED BY THE REQUESTER:				Job/Work Order Number: _____																															
(1) Description of circuit/equipment/job location: 007 SWBD-1A _____																																			
(2) Description of work to be done: _____ _____																																			
(3) Justification of why the circuit/equipment cannot be de-energized or the work deferred until the next scheduled outage: _____ _____ _____																																			
Requester/Title _____				Date _____																															
PART II: TO BE COMPLETED BY THE ELECTRICALLY QUALIFIED PERSONS DOING THE WORK:																																			
(1) Detailed job description procedure to be used in performing the above detailed work: _____																																			
(2) Description of the Safe Work Practices to be employed: _____																																			
<table border="1" style="width: 100%; border-collapse: collapse;"><tr><td style="width: 15%;">Flash Boundary</td><td style="width: 15%;">78"</td><td style="width: 15%;">Flash Hazard</td><td style="width: 15%;">13 cal/cm²</td><td style="width: 15%;">Working Distance</td><td style="width: 15%;">18"</td></tr><tr><td>Shock Hazard</td><td>480 VAC</td><td>Limited Approach</td><td>42"</td><td>Glove Class</td><td>00</td></tr><tr><td></td><td></td><td>Restricted Approach</td><td>12"</td><td></td><td></td></tr><tr><td></td><td></td><td>Prohibited Approach</td><td>1"</td><td></td><td></td></tr><tr><td>Required PPE</td><td>Category 3</td><td colspan="4">Cotton Underwear + FR Shirt & Pant + FR Coverall</td></tr></table>						Flash Boundary	78"	Flash Hazard	13 cal/cm ²	Working Distance	18"	Shock Hazard	480 VAC	Limited Approach	42"	Glove Class	00			Restricted Approach	12"					Prohibited Approach	1"			Required PPE	Category 3	Cotton Underwear + FR Shirt & Pant + FR Coverall			
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Required PPE	Category 3	Cotton Underwear + FR Shirt & Pant + FR Coverall																																	
(3) Means employed to restrict the access of unqualified persons from the work area: _____																																			
(4) Evidence of completion of a Job Briefing including discussion of any job-related hazards: _____																																			
(5) Do you agree the above described work can be done safely? 0 0 (If no, return to requester)																																			
Electrically Qualified Person(s) _____				Date _____																															
Electrically Qualified Person(s) _____				Date _____																															
PART III: APPROVAL(S) TO PERFORM THE WORK WHILE ELECTRICALLY ENERGIZED:																																			
Maintenance/Engineering Manager _____				Manufacturing Manager _____																															
Safety Manager _____				Electrically Knowledgeable Person _____																															
General Manager _____				Date _____																															

4.7 Arc Flash Hazard Model Analysis Results (See Appendix IV)