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Since 2008

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Can-Technologies Inc.

An Engineering Company

Safety Solutions

“Electrical Arc Flash Hazards & What it Means to You”

CANEW 2011 - Montreal
22nd September 2011

Electrical Arc Flash Safety

Agenda

Hazards of Arc Flash

- What is an Arc Flash, What are the Causes, What are the Potential Hazards , Where do they Occur and What are the Impacts?
- Why is an Arc Flash Analysis Needed?
- What is the Law and Who does it Effect?

Existing Codes and the New CSA Standard (CSA-Z462)

- What are your Responsibilities

Arc Flash Protection – The Process to Compliance

- Arc Flash Hazard Analysis and Report (Step Process and Detail)
- Personal Protective Equipment (PPE)
- Other Elements - Training, Mitigating Issues, etc

Electrical Arc Flash Safety

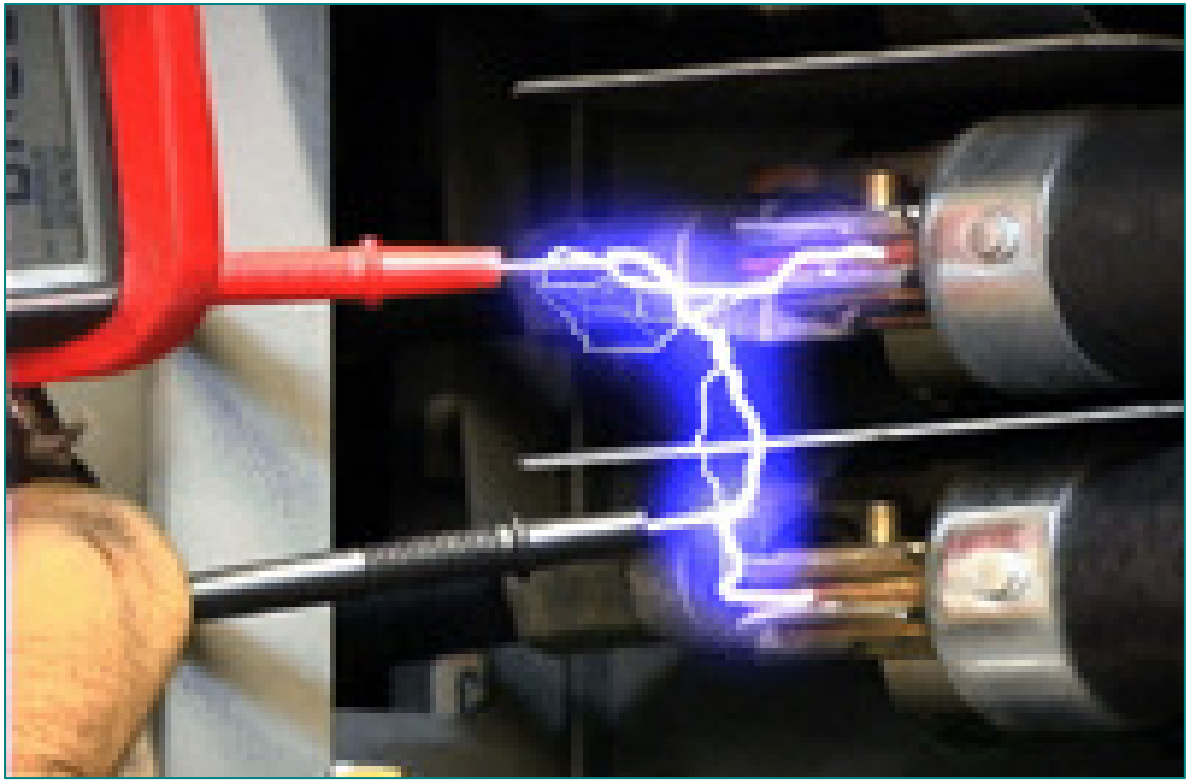
What is an Arc Flash?

". . . a dangerous condition associated with the release of energy caused by an electric arc."

Electrical Arc Flash Safety

What is an Electric Arc?

An electric arc is a short circuit current passing through the air



Electrical Arc Flash Safety

What is an Arc Flash?

Electrical Arc Flash Safety

What are the Causes of Electric Arcs?

Arcs can be initiated by:

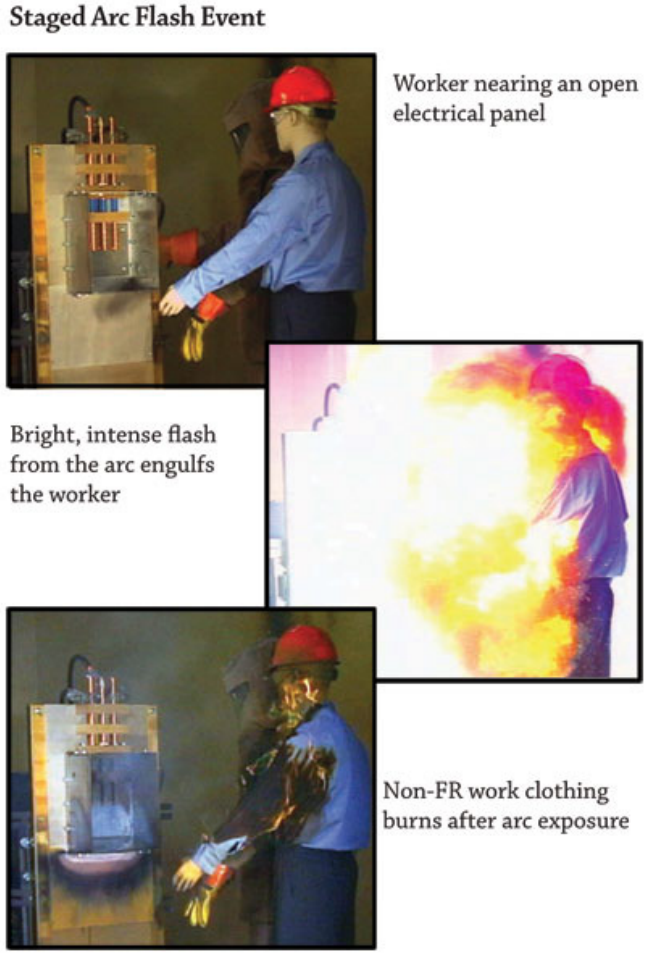
- Glow to Arc Discharge
  - Dust and Impurities
  - Corrosion
  - Condensation of Vapour and Water
- Spark Discharge
  - Accidental Touching
  - Dropping or Leaving Tools/Parts
  - Rodents and other Animals
- Over Voltages across Narrow Gaps
- Equipment/Insulating Material Failure
- Improper Work Procedures

Electrical Arc Flash Safety

What are the Potential Hazards?

PRIMARY – Heat and Light

- Intense UV Light – Blindness
- Intense Heat – Severe Burns
  - *Superheated Ball of Gas >20,000 Deg C*
- Intense Heat – Severe Lung Damage
  - *Inhalation of Extremely Hot Air, Molten Metal, Vapourized Metal and Toxic Fumes*

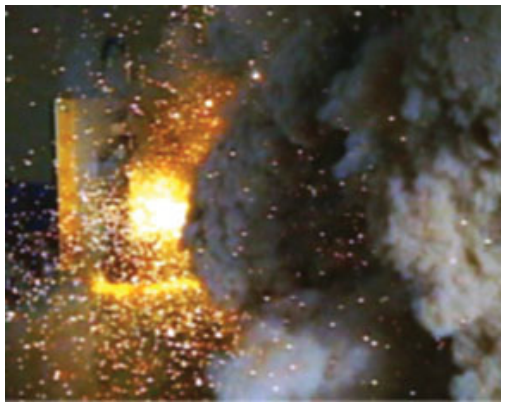


Electrical Arc Flash Safety

What are the Potential Hazards?

SECONDARY - Pressure, Auditory and Projectile

- Intense Pressure (2000lb/ft2)
  - *Throws Workers across the Room – Bruising, Broken Bones Concussion, Collapsed Lungs or other Organ Trauma*
- Intense Sound Blast (160 dB)
  - *Deafness, Memory Loss and Brain Damage*
- High Velocity Projectiles (700mph)(Molten Metal and Objects)
  - Blast Shrapnel can Penetrate the Body



Electrical Arc Flash Safety

Where do they Occur?

A hazardous arc flash can occur in any electrical device in which energy is high enough to sustain an arc.

Examples:

- Panel Boards
- Switchboards
- MCC's
- Switchgear
- Motor Starters
- Drive Cabinets
- Fused Disconnects
- Busway/Plugs








Electrical Arc Flash Safety

What are Risk Exposure Activities?

Examples of activities which involve Arc Flash Risks:

- Racking in and out of draw-out circuit breakers
- Removing or installing circuit breakers or fuses
- Applying Safety Grounds
- Removing Panel Covers for Inspections or other activities
- Low Voltage Testing and Diagnostics

Electrical Arc Flash Safety

What are the Impacts of an Arc Flash Incident?

Treatment can require years of skin grafting and lengthy rehabilitation. The victim may never return to work or retain the same quality of life.

The above is simply not quantifiable but other direct costs are:

- Intense Treatment Costs
- Litigation Fees, Fines and Imprisonment
  - Company/Corporate/Personal
- Asset Replacement Cost
- Production Loss
- Insurance Fees

Electrical Arc Flash Safety

What are the Chances of it Happening?

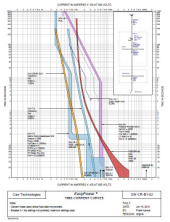
- In North America (Canada/USA)
  - 5-10 Arc Flash incidents occur each day that require hospitalization
  - 1-2 Deaths occur each day from electrical events (Shock, Flash and Blast)
  - More than 2,000 workers are treated in burn centres per year with severe arc flash injuries (This does not include injuries in hospitals and clinics which go unreported)

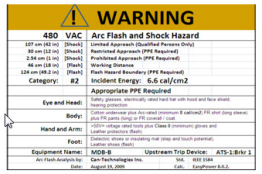
Electrical Arc Flash Safety

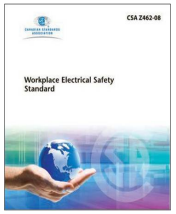
What is the 'Law' and Who does it Effect?

- Arc Flash Analysis legislatively addressed Provincially and Federally
- Any and all Workers exposed to energized equipment must be trained and equipped to be protected against Arc Flash Hazards.
- An Arc Flash Analysis must be conducted on Applicable Power Distribution equipment to determine PPE.
- Arc Flash Hazards affects all Workers, Supervisors, Managers and Owners.
- The CSA Z462-08 and NFPA 70E–2009 are now harmonized and in effect.
- MOL expect Full Arc Flash Compliance.

Ontario Canada







NFPA 70E STANDARD for Electrical Safety in the Workplace 2009 EDITION

Ontario
MINISTRY OF LABOUR

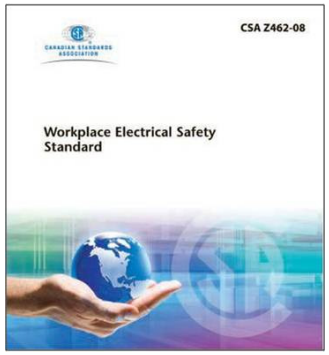
Review of Codes & Standards

Existing Codes

Occupational Health & Safety Act
- Applicable regulations

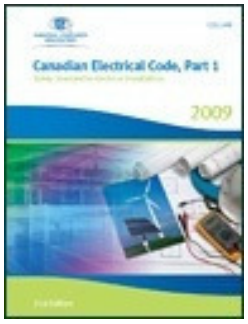
US National Fire Protection Association
- Standard NFPA 70E

Canadian Standards Association
- Standard Z462



Institute of Electrical & Electronics Engineers
- Standard 1584

Canadian Electrical Code
- Rule 2-306



Review of Codes & Standards

What is the Ontario Occupational Health & Safety Act?

"General Principles of Health and Safety in the Workplace"

OHSA
- Section 25.(2)

- Duties of an Employer
  - (a) Provide information, instruction and supervision to a worker to protect the health or safety of the worker;
  - (h) Take every precaution reasonable in the circumstances for the protection of the worker.

    Known as the ***"Due Diligence Clause"***
- Similar statements for the Duties of a Constructor article 23 and Duties of a Supervisor article 27

Review of Codes & Standards

What is NFPA 70E?

National **F**ire **P**rotection **A**ssociation
-Standard NFPA 70E

"….. Standard for Electrical Safety in the Workplace"

"Specify requirements for a practical safe working area for workers relative to hazards arising from the use of electricity"

- 8th Edition released September 2008
- Was De Facto Standard and adopted by Canadian Companies

Should be used in conjunction with other Codes and Standards i.e. Canadian Electrical Code C22.1/2/3

Review of Codes & Standards

What is CSA Standard Z462?

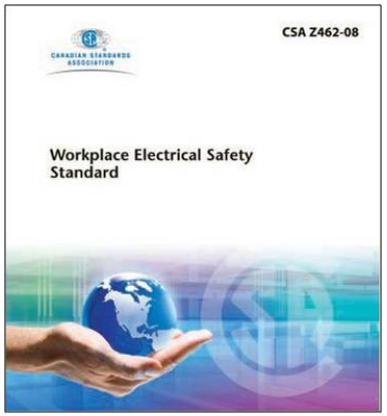
Canadian Standards Association
- Standard Z462-08

"….. Standard for Electrical Safety in <u>Canadian</u> Workplaces"

"Specify requirements for a practical safe working area for workers relative to hazards arising from the use of electricity"

- "Harmonized" with NFPA 70E-2009 edition
- Released 28th December2008

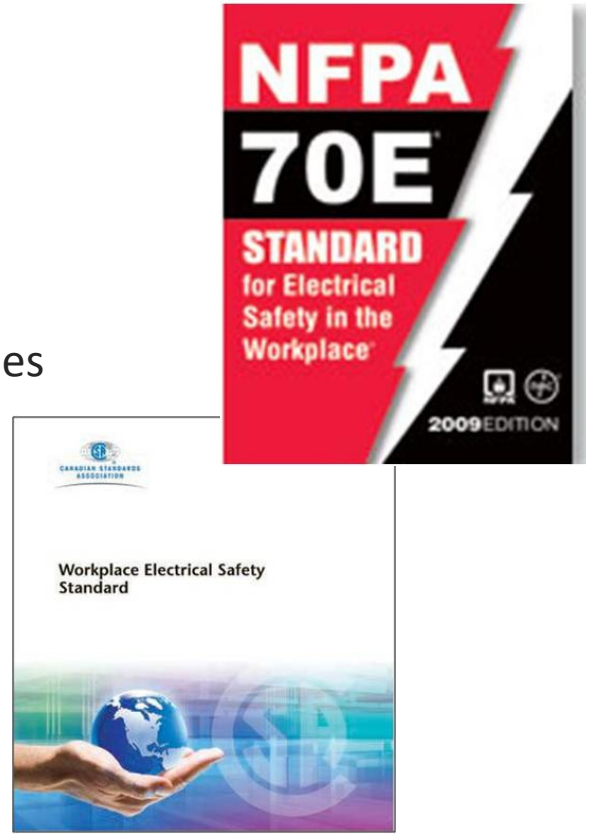
Should be used in conjunction with other Codes and Standards i.e. Canadian Electrical Code C22.1/2/3



Review of Codes & Standards

What are the elements of the CSA/NFPA Standard?

- Electrical Safety Program
  - Qualified Worker
  - Establishment of Electrically Safe Working Conditions (Lock Out Tag Out)
  - Hazard/Risk Evaluation Procedures
  - Job Briefing and Planning
  - Energized Electrical Work Permits
- Arc Flash Study & Analysis
  - Incident Energy Levels
  - Limits of Approach and Flash Protection Boundaries
  - Personal Protective Equipment (PPE)
  - Hazard Risk Categories
  - Hazard Analysis
  - Labels
  - Training



Review of Codes & Standards

What is IEEE Standard 1584?

Institute of Electrical & Electronics Engineers -Standard 1584

"A guide for performing Arc Flash Hazard Calculations"

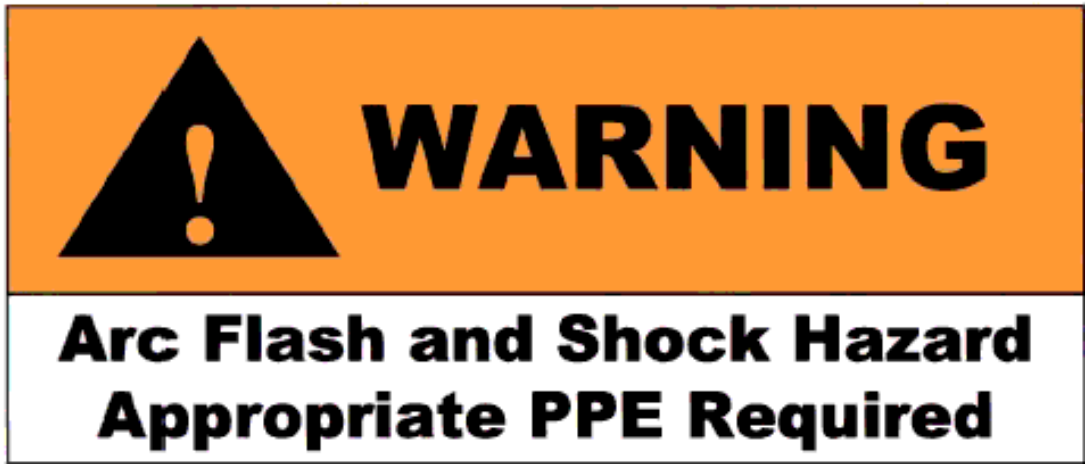
Review of Codes & Standards

What is CEC Rule 2-306?

Canadian **E**lectrical **C**ode
- Rule 2-306

Electrical Safety Authority

"A requirement for field-marking electrical equipment to warn persons of potential electric shock and arc flash hazards "



Arc Flash Protection – "The Nuts and Bolts"

What are the Operating Companies Responsibilities under the New Codes?

1. Implement Qualified and General Worker Training
2. Provide Necessary Personal Protective Equipment (PPE)
3. Conduct an Arc Flash Analysis of the Power System
4. Establish Shock and Flash Protection Boundaries along with Incident Energy Levels at Working Distances
5. Affix the Appropriate Warning Labels on Equipment

Arc Flash Protection – "The Nuts and Bolts"

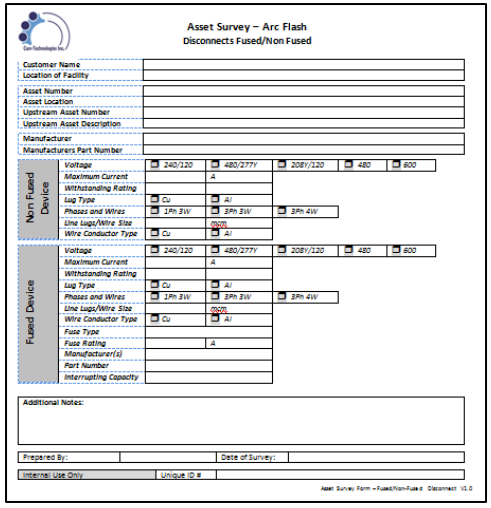
Methodology (Process)

Arc Flash Protection – "The Nuts and Bolts"

What are the Steps to Compliance – Step 1

Pre-Start

- Obtain Asset Data (Number and Type)



Asset Survey – Arc Flash
Disconnects Fused/Non Fused

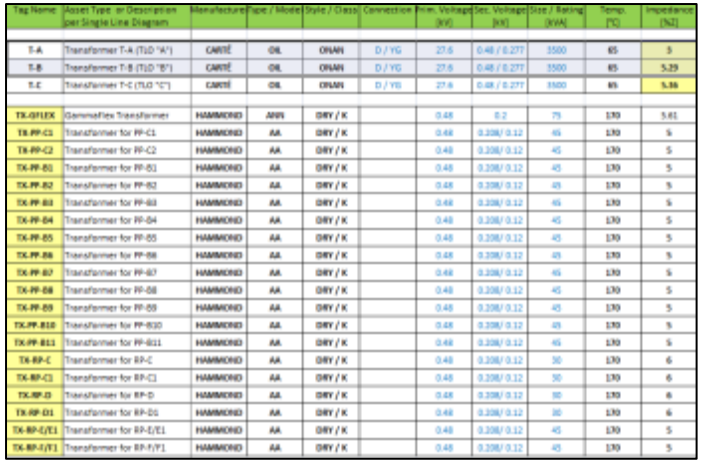
Customer Name						
Location of Facility						
Asset Number						
Asset Location						
Upstream Asset Number						
Upstream Asset Description						
Manufacturer						
Manufacturers Part Number						
Non Fused Device – Voltage	☐ 240/120	☐ 480/277Y	☐ 208Y/120	☐ 480	☐ 600	
Maximum Current		A				
Withstanding Rating						
Lug Type	☐ Cu	☐ Al				
Phases and Wires	☐ 1Ph 3W	☐ 3Ph 3W	☐ 3Ph 4W			
Line Lugs/Wire Size		AWG				
Wire Conductor Type	☐ Cu	☐ Al				
Fused Device – Voltage	☐ 240/120	☐ 480/277Y	☐ 208Y/120	☐ 480	☐ 600	
Maximum Current		A				
Withstanding Rating						
Lug Type	☐ Cu	☐ Al				
Phases and Wires	☐ 1Ph 3W	☐ 3Ph 3W	☐ 3Ph 4W			
Line Lugs/Wire Size		AWG				
Wire Conductor Type	☐ Cu	☐ Al				
Fuse Type						
Fuse Rating		A				
Manufacturer(s)						
Part Number						
Interrupting Capacity						

Additional Notes:

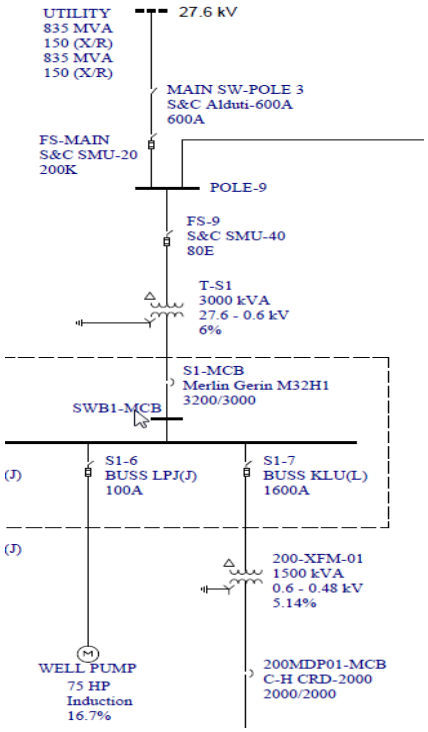
Prepared By: | Date of Survey:

Internal Use Only | Unique ID #

Asset Survey Form – Fused/Non-Fused Disconnect V1.0



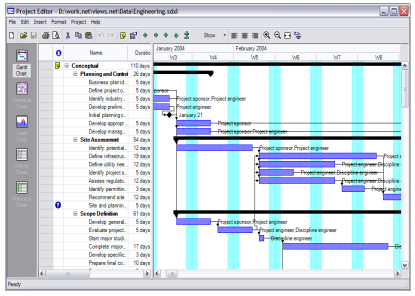
Tag Name	Asset Type or Description per Single Line Diagram	Manufacturer	Type / Model	Style / Class	Connection	Prim. Voltage (kV)	Sec. Voltage (kV)	Size / Rating (kVA)	Temp. (°C)	Impedance (%Z)
T-A	Transformer T-A (TLO "A")	CARTÉ	OIL	ONAN	D / YG	27.6	0.48 / 0.277	3500	65	5
T-B	Transformer T-B (TLO "B")	CARTÉ	OIL	ONAN	D / YG	27.6	0.48 / 0.277	3500	65	5.29
T-C	Transformer T-C (TLO "C")	CARTÉ	OIL	ONAN	D / YG	27.6	0.48 / 0.277	3500	65	5.36
TX-GFLEX	GammaFlex Transformer	HAMMOND	ANN	DRY / K		0.48	0.2	75	130	5.61
TX-PP-C1	Transformer for PP-C1	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-C2	Transformer for PP-C2	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-B1	Transformer for PP-B1	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-B2	Transformer for PP-B2	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-B3	Transformer for PP-B3	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-B4	Transformer for PP-B4	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-B5	Transformer for PP-B5	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-B6	Transformer for PP-B6	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-B7	Transformer for PP-B7	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-B8	Transformer for PP-B8	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-B9	Transformer for PP-B9	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-B10	Transformer for PP-B10	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-B11	Transformer for PP-B11	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-RP-C	Transformer for RP-C	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	30	130	6
TX-RP-C1	Transformer for RP-C1	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	30	130	6
TX-RP-D	Transformer for RP-D	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	30	130	6
TX-RP-D1	Transformer for RP-D1	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	30	130	6
TX-RP-E/E1	Transformer for RP-E/E1	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-RP-F/F1	Transformer for RP-F/F1	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5



Arc Flash Protection – "The Nuts and Bolts"

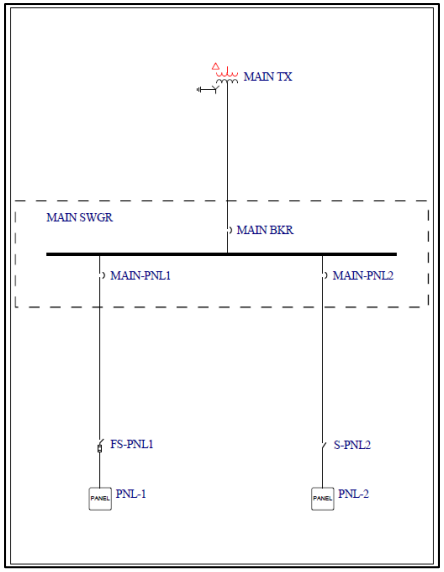
What are the Steps to Compliance – Step 1a

- Kick-Off Meeting
  - Meet & Greet Project Team Players
  - Transfer Electrical Asset Data/Information
  - Determine Conventions
    - Naming
    - Labels
  - Generate Training Program Agenda
  - Confirm Project Schedule/Milestones



Tag Name Sample	
Legend	0553230CB-A4
05	Unit Number
53230	Thermal Subject Index
CB	Circuit Breaker
A	Power Distribution source
4	Breaker No.

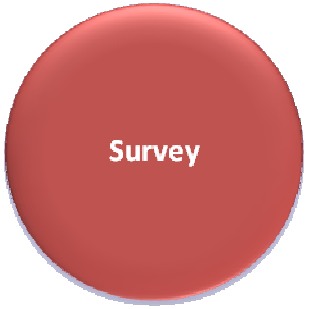
Asset List	
1	Bus
2	MCC
3	Panel
4	Utility
5	Generator
6	Motor
7	Capacitor
8	Filter
9	2W-Xformer
10	3W-Xformer
11	Cable
12	Busway
13	CL-Reactor
14	HV Fused Switch
15	HV Switch
16	LV Switch
17	MV_LV_Breaker
18	UPS
19	ATS
20	CT
21	Protection Relay



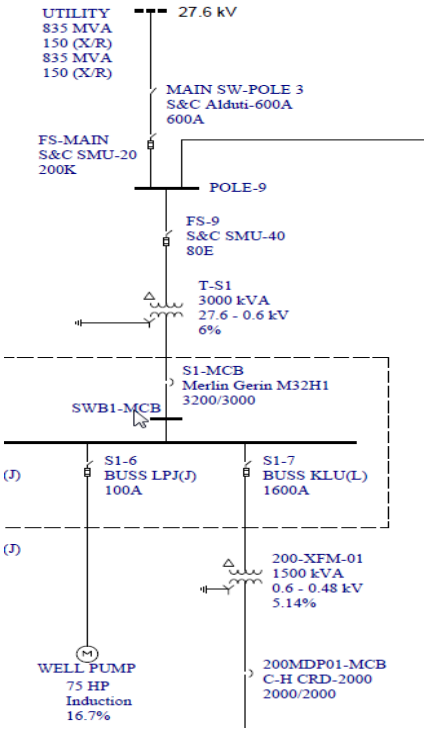
- Introduction and Course Objectives
- Electrical Power System Safety and Arc Flash Hazards
  - What is the Law and Who does it Effect?
  - What is an Arc Flash, What are the Causes,
  - What are the Potential Hazards,
  - Where do they Occur and What are the Impacts?
- Electrical Safety in the Workplace Review
  - Review of Existing and Related Codes
  - Elements of CSA Z462 Related to Arc Flash
  - Electrical Safety Program
  - Establishing an Electrically Safe Working Condition
  - Energized Electrical Work Permits
  - Incident Energy Levels
  - Limits of Approach and Flash Protection Boundaries
  - Hazard Risk Categories
  - Personal Protective Equipment (PPE)
  - Due Diligence
- Practical Solutions to Mitigating Arc Flash Hazards
- Obligations and Process to Full Compliance
- Course Wrap Up

Arc Flash Protection – "The Nuts and Bolts"

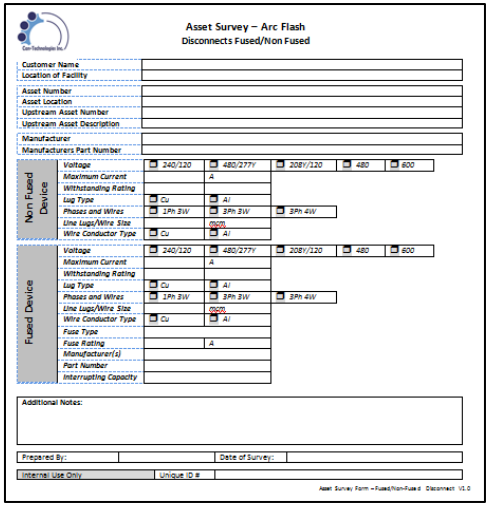
What are the Steps to Compliance – Step 1b



- **Conduct** Detailed Assessment of Asset Data
- **Collect/Verify additional** System/Equipment Data
- **Determine Normal** Modes of Operation
- **Determine** System Voltages **and** Equipment Classes



Tag Name	Asset Type or Description (per Single Line Diagram	Manufacturer	Type / Model	Style / Class	Connection	Prim. Voltage (kV)	Sec. Voltage (kV)	Size / Rating (kVA)	Temp. (°C)	Impedance (%Z)
T-A	Transformer T-A (TLO "A")	CARTÉ	OIL	ONAN	D / YG	27.6	0.48 / 0.277	3500	65	5
T-B	Transformer T-B (TLO "B")	CARTÉ	OIL	ONAN	D / YG	27.6	0.48 / 0.277	3500	65	5.29
T-C	Transformer T-C (TLO "C")	CARTÉ	OIL	ONAN	D / YG	27.6	0.48 / 0.277	3500	65	5.86
TX-GFLEX	GammaFlex TransFormer	HAMMOND	ARN	DRY / K		0.48	0.2	75	130	5.61
TX-PP-C1	Transformer for PP-C1	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-C2	Transformer for PP-C2	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-B1	Transformer for PP-B1	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-B2	Transformer for PP-B2	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-B3	Transformer for PP-B3	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-B4	Transformer for PP-B4	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-B5	Transformer for PP-B5	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-B6	Transformer for PP-B6	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-B7	Transformer for PP-B7	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-B8	Transformer for PP-B8	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-B9	Transformer for PP-B9	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-B10	Transformer for PP-B10	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-PP-B11	Transformer for PP-B11	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-RP-C	Transformer for RP-C	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	30	130	6
TX-RP-C1	Transformer for RP-C1	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	30	130	6
TX-RP-D	Transformer for RP-D	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	30	130	6
TX-RP-D1	Transformer for RP-D1	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	30	130	6
TX-RP-E/E1	Transformer for RP-E/E1	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5
TX-RP-F/F1	Transformer for RP-F/F1	HAMMOND	AA	DRY / K		0.48	0.208/ 0.12	45	130	5



Asset Survey – Arc Flash
Disconnects Fused/Non Fused

Customer Name
Location of Facility
Asset Number
Asset Location
Upstream Asset Number
Upstream Asset Description
Manufacturer
Manufacturers Part Number

Non Fused Device
Fused Device

Voltage: 240/120 | 480/277Y | 208Y/120 | 480 | 600
Maximum Current
Withstanding Rating
Lug Type: Cu | Al
Phases and Wires: 1Ph 3W | 3Ph 3W | 3Ph 4W
Line Lugs/Wire Size
Wire Conductor Type: Cu | Al
Fuse Type
Fuse Rating
Manufacturer(s)
Part Number
Interrupting Capacity

Additional Notes:

Prepared By: | Date of Survey:
Internal Use Only | Unique ID #

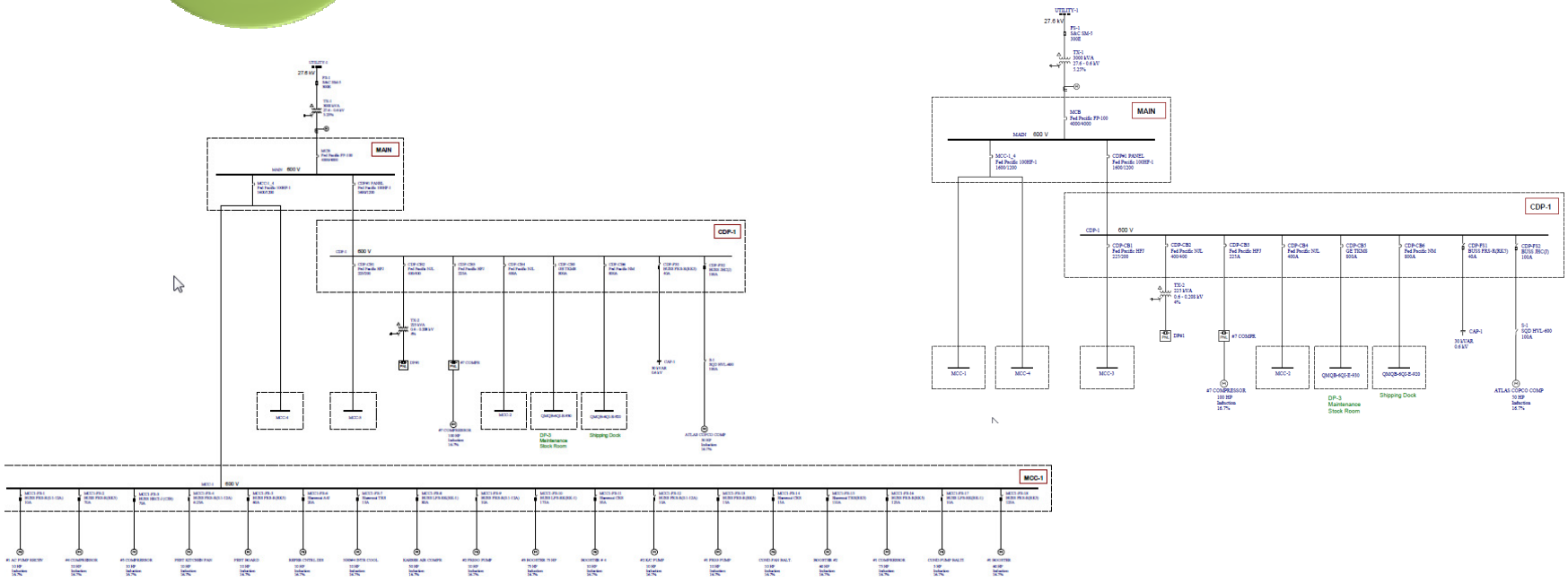
Asset Survey Form – Fused/Non-Fused Disconnect V1.0

Arc Flash Protection – “The Nuts and Bolts”

What are the Steps to Compliance – Step 2

Development

- **Generate** Electrical Single Line Diagram **(Standard)**



Arc Flash Protection – "The Nuts and Bolts"

What are the Steps to Compliance – Step 3a

- Conduct a Short Circuit Study

Arc Fault Bus Name	Arc Fault Bus kV	Upstream Trip Device	Equip Type	Gnd	Arc Gap (mm)	Bolted Fault (kA)
89XFO01-PRI	27.60	89-LBS-01	Open Air	X	254	15.15
89XFO02-PRI	27.60	89-LBS-02	Open Air	X	254	15.15
89XFO03-PRI	27.60	89-LBS-03	Open Air	X	254	15.46
89XFO04-PRI	27.60	89-LBS-04	Open Air	X	254	15.46
89XFO05-PRI	27.60	89-LBS-05	Open Air	X	254	15.46
NEW SWG	27.60	FS-5E	Switchgear	X	254	15.51
POLE 5E	27.60	FS-MAIN	Open Air	X	254	15.60
POLE-7E	27.60	FS-MAIN	Open Air	X	254	15.26
POLE-9	27.60	FS-MAIN	Open Air	X	254	16.49
T-S1-PRI	27.60	FS-9	Open Air	X	254	16.28
108XFM001-PRI	4.16	3-F2A	Open Air		102	8.44
430-CMP-007	4.16	3-F4	Other		102	9.03
96-SWG-03	4.16	89-LBS-03	Switchgear		102	9.18
- A -	0.60	007PDP001-13	Panel	X	25	0.25
200XFM01-PRI	0.60	S1-7	Other	X	32	45.88
AIR CONV	0.60	CMPMC-7	Panel	X	25	7.42
AIR DRYER	0.60	BLM_SPL-7	Panel	X	25	3.32

Arc Flash Protection – "The Nuts and Bolts"

What are the Steps to Compliance – Step 3b

Study & Analysis

-**Conduct an Equipment Duty Study**

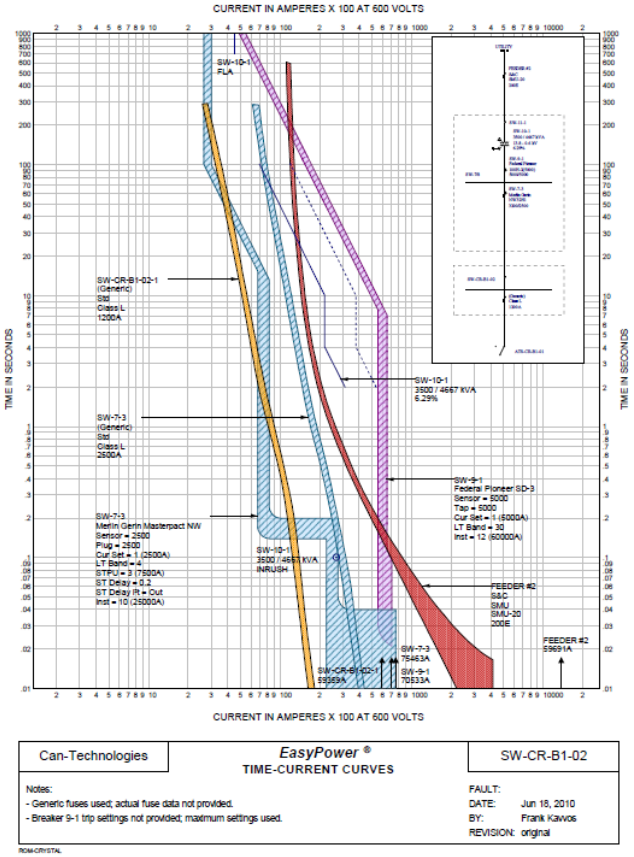
Equipment			Ratings	Duties		Comments	Recommendation		
ID	Manufacturer	Style	1/2 Cycle kA	1/2 Cycle kA	1/2 Cycle Percent		Type	1/2 Cycle Rated kA	1/2 Cycle Duty %
96-MCC-01			42	58.00	38.1%	VIOLATION			
96-MCC-02			42	58.84	40.1%	VIOLATION			
96-MCC-03			42	53.69	27.8%	VIOLATION			
96-MCC-04			42	53.69	27.8%	VIOLATION			
96-MCC-05			42	40.35	-3.9%	Warning			
1-F1	Federal Pioneer	65H-3 (1600)	65	62.23	-4.3%	Warning			
1-F2	Federal Pioneer	65H-3 (1600)	65	62.23	-4.3%	Warning			
1-F6	Federal Pioneer	65H-3 (1600)	65	62.23	-4.3%	Warning			
96-SWG-01			65	62.23	-4.3%	Warning			
4-F1	Cutler Hammer	MDL	50	67.61	35.2%	VIOLATION	C-H HMDL	65	4.0%
4-F3	Cutler Hammer	ND	50	62.57	25.1%	VIOLATION	C-H HND	65	-3.7%
4-F2	Cutler Hammer	MDL	50	67.61	35.2%	VIOLATION	C-H HMDL	65	4.0%
4-F5	Cutler Hammer	MDL	50	67.61	35.2%	VIOLATION	C-H HMDL	65	4.0%
4-F6	Cutler Hammer	MDL	50	66.26	32.5%	VIOLATION	C-H HMDL	65	1.9%
4-F4	Cutler Hammer	MDL	50	67.61	35.2%	VIOLATION	C-H HMDL	65	4.0%
4-F7	Cutler Hammer	MDL	50	67.61	35.2%	VIOLATION	C-H HMDL	65	4.0%
96-SWG-04			65	64.01	-1.5%	Warning			
5-F1	Cutler Hammer	MDL	50	63.59	27.2%	VIOLATION	C-H HMDL	65	-2.2%
5-F2	Cutler Hammer	MDL	50	63.59	27.2%	VIOLATION	C-H HMDL	65	-2.2%
5-F3	Cutler Hammer	MDL	50	61.03	22.1%	VIOLATION	C-H HMDL	65	-6.1%
5-F4	Cutler Hammer	HKD	65	63.59	-2.2%	Warning			
5-F5	Cutler Hammer	MDL	50	63.59	27.2%	VIOLATION	C-H HMDL	65	-2.2%
5-F7	Cutler Hammer	MDL	50	63.59	27.2%	VIOLATION	C-H HMDL	65	-2.2%
008-PDP-001			42	40.31	-4.0%	Warning			
050-PDP-003			42	44.78	6.6%	VIOLATION			

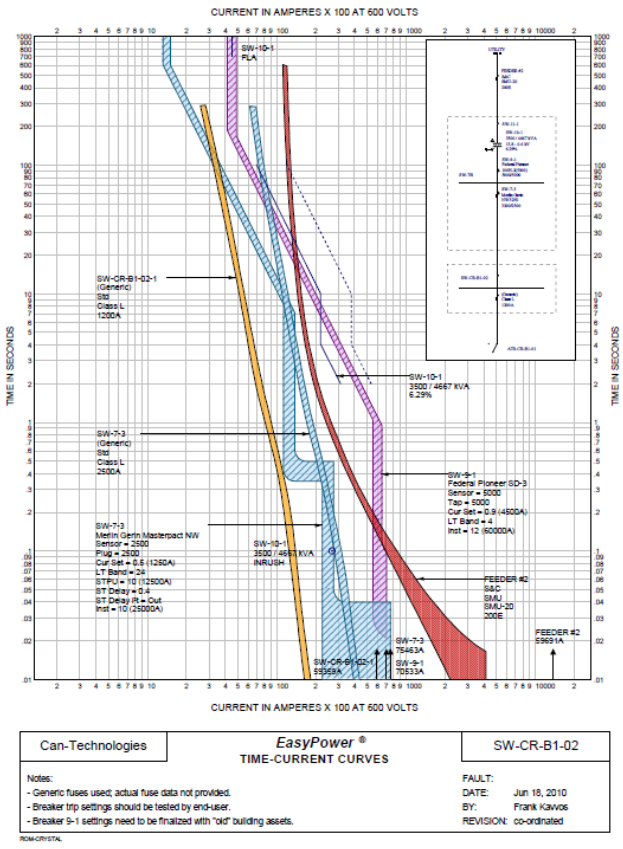
Arc Flash Protection – "The Nuts and Bolts"

What are the Steps to Compliance – Step 3c

Study & Analysis

→ **-Conduct a Protective Device Coordination Study**





Arc Flash Protection – "The Nuts and Bolts"

What are the Steps to Compliance – Step 3d

- **Calculate** Thermal Incident Energy **Exposure Values**
- **Determine Hazard** Risk Categories

Incident Energy From (cal/cm2)	Incident Energy To (cal/cm2)	Hazard Risk Category
0.0	1.2	0
1.2	4.0	1
4.0	8.0	2
8.0	25.0	3
25.0	40.0	4

Arc Fault Bus Name	Arc Fault Bus kV	Upstream Trip Device Name	Equip Type	Gnd	Arc Gap (mm)	Bolted Fault (kA)	Est Arc Fault (kA)	Trip Time (sec)	Opening Time (sec)	Arc Time (sec)	Est Arc Flash Boundary (inches)	Working Distance (inches)	Incident Energy (cal/cm2)	Required Clothing Class
89XFO01-PRI	27.6	89-LBS-01	Open Air	X	254	15.15	15.15	0.022	0	0.022	69.8	31	7.6	#2
89XFO02-PRI	27.6	89-LBS-02	Open Air	X	254	15.15	15.15	0.022	0	0.022	69.8	31	7.6	#2
89XFO03-PRI	27.6	89-LBS-03	Open Air	X	254	15.46	15.46	0.025	0	0.025	74.8	31	8.7	#3
89XFO04-PRI	27.6	89-LBS-04	Open Air	X	254	15.46	15.46	0.025	0	0.025	74.8	31	8.7	#3
89XFO05-PRI	27.6	89-LBS-05	Open Air	X	254	15.46	15.46	0.025	0	0.025	74.8	31	8.7	#3
NEW SWG	27.6	FS-5E	Switchgear	X	254	15.514	15.514	0.029	0	0.029	81.2	31	10.3	#3
POLE 5E	27.6	FS-MAIN	Open Air	X	254	15.595	15.595	0.034	0	0.034	88.5	31	12.2	#3
POLE-7E	27.6	FS-MAIN	Open Air	X	254	15.26	15.26	0.034	0	0.034	87.5	31	12	#3
POLE-9	27.6	FS-MAIN	Open Air	X	254	16.485	16.485	0.034	0	0.034	90.3	31	12.7	#3
T-S1-PRI	27.6	FS-9	Open Air	X	254	16.283	16.283	0.021	0	0.021	71.1	31	7.9	#2
108XFM001-PRI	4.16	3-F2A	Open Air		102	8.44	8.22	0.038	0	0.038	12.2	26	0.3	#0
430-CMP-007	4.16	3-F4	Other		102	9.03	8.78	0.01	0	0.01	3	18	0.3	#0
96-SWG-03	4.16	89-LBS-03	Switchgear		102	9.18	8.92	0.182	0	0.182	72.1	18	4.6	#2
- A -	0.6	007PDP001-13	Panel	X	25	0.25	*0.223	3.203	0	3.203	22.6	18	1.7	#1
200XFM01-PRI	0.6	S1-7	Other	X	32	45.88	*25.271	0.017	0	0.017	19.3	18	1.7	#1
AIR CONV	0.6	CMPMC-7	Panel	X	25	7.42	5.97	0.012	0	0.012	5.6	18	0.2	#0
AIR DRYER	0.6	BLM_SPL-7	Panel	X	25	3.32	2.85	0.012	0	0.012	3.4	18	0.1	#0
ATLASCOPCO 1	0.6	CMPMC-10	Panel	X	25	12.95	9.97	0.012	0	0.012	7.8	18	0.4	#0
ATLASCOPCO 2	0.6	CMPMC-3	Panel	X	25	12.95	9.97	0.012	0	0.012	7.8	18	0.4	#0
BLM SPLITTER	0.6	S2-2	Other	X	32	15.491	*9.512	0.03	0	0.03	13.5	18	1	#0
BLM VENT	0.6	BLM_SPL-5	Panel	X	25	3.23	*2.359	0.022	0	0.022	4.6	18	0.2	#0
CMP 1	0.6	BLM_SPL-10	Panel	X	25	13.229	*8.645	0.037	0	0.037	15	18	1.1	#0
CMP. MCC	0.6	S2-1	MCC	X	25	24.911	*15.488	0.028	0	0.028	19	18	1.6	#1
COMP FAN	0.6	BLM_SPL-6	Panel	X	25	3.322	2.847	0.012	0	0.012	3.4	18	0.1	#0
CONVEYOR	0.6	BLM_SPL-9	Panel	X	25	3.374	2.888	0.012	0	0.012	3.5	18	0.1	#0
COOL. TWR	0.6	BLM_SPL-8	Panel	X	25	3.374	2.888	0.012	0	0.012	3.5	18	0.1	#0
DOOR 20	0.6	BLM_SPL-1	Panel	X	25	3.297	2.828	0.012	0	0.012	3.4	18	0.1	#0
DOOR 21	0.6	BLM_SPL-4	Panel	X	25	3.297	2.828	0.012	0	0.012	3.4	18	0.1	#0

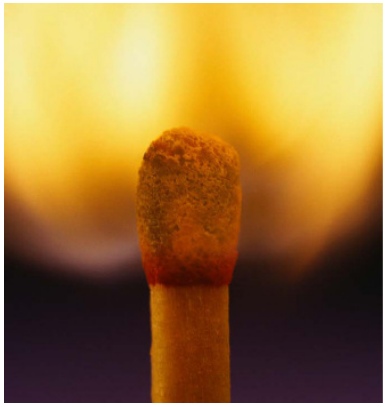
Arc Flash Protection – "The Nuts and Bolts"

What is Thermal Incident Arc Flash Energy?

Thermal Incident Energy is measured in Calories/cm^2 (1.2 Calories/cm^2 is the threshold of a second degree burn)

Arc Flash protection is to limit the injury to no more than the "just curable" 2nd Degree Burn.

Personal Protective Equipment (PPE) is selected based on this Calculated Value

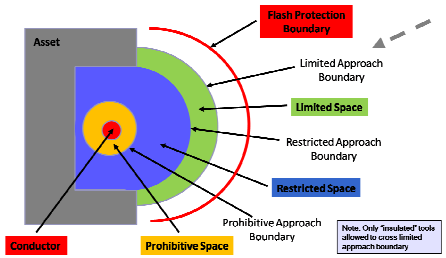


1.2 Calories/cm^2 = Holding your finger in the blue part of the flame for one second

Arc Flash Protection – "The Nuts and Bolts"

What are the Steps to Compliance – Step 3e

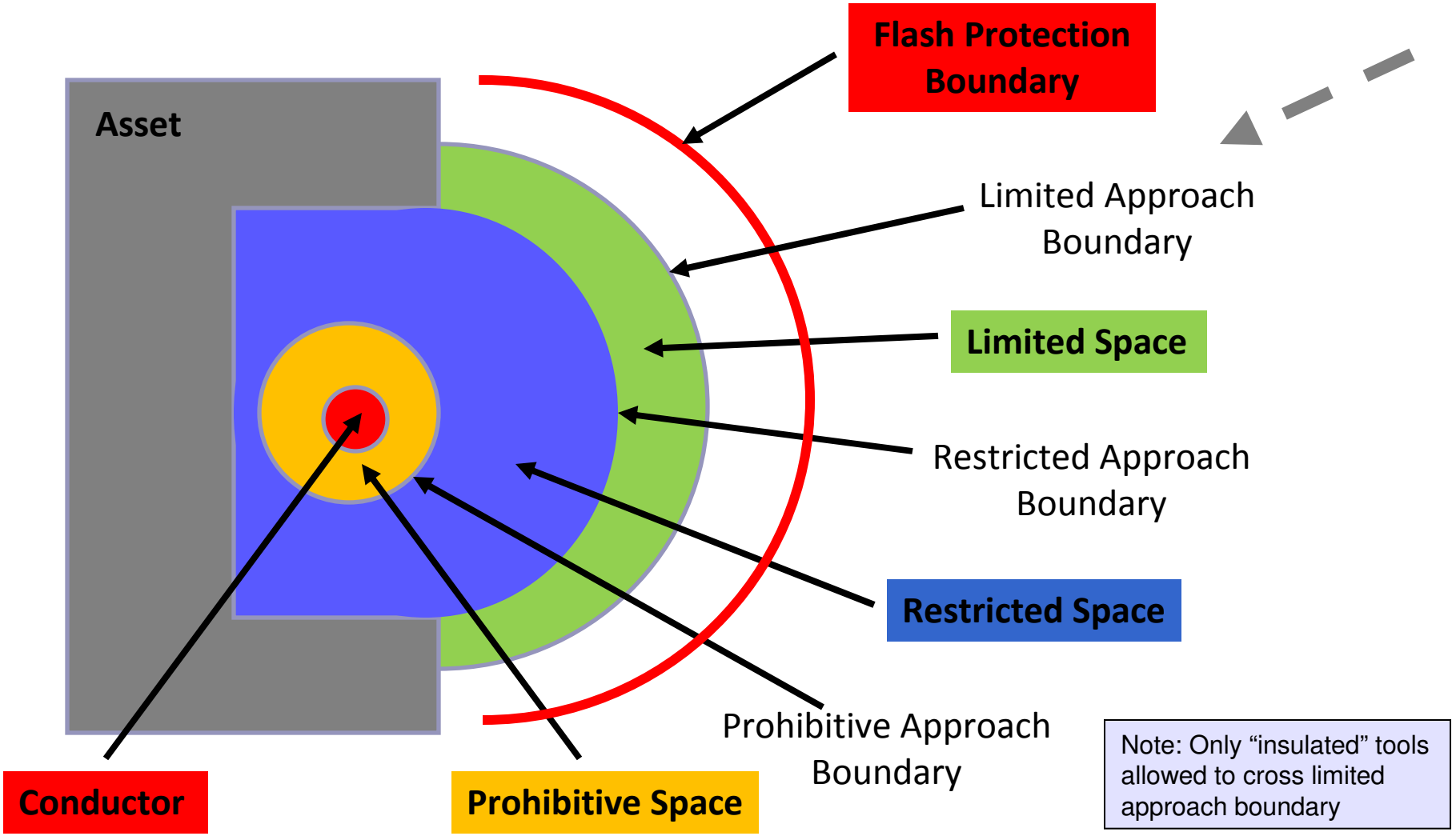
- **Calculate Flash Protection Approach Boundary**
- **Calculate Shock Protection Approach Boundaries**



Arc Fault Bus Name	Arc Fault Bus kV	Upstream Trip Device Name	Equip Type	Gnd	Arc Gap (mm)	Bolted Fault (kA)	Est Arc Fault (kA)	Trip Time (sec)	Opening Time (sec)	Arc Time (sec)	Est Arc Flash Boundary (inches)	Working Distance (inches)	Incident Energy (cal/cm2)	Required Clothing Class
89XFO01-PRI	27.6	89-LBS-01	Open Air	X	254	15.15	15.15	0.022	0	0.022	69.8	31	7.6	#2
89XFO02-PRI	27.6	89-LBS-02	Open Air	X	254	15.15	15.15	0.022	0	0.022	69.8	31	7.6	#2
89XFO03-PRI	27.6	89-LBS-03	Open Air	X	254	15.46	15.46	0.025	0	0.025	74.8	31	8.7	#3
89XFO04-PRI	27.6	89-LBS-04	Open Air	X	254	15.46	15.46	0.025	0	0.025	74.8	31	8.7	#3
89XFO05-PRI	27.6	89-LBS-05	Open Air	X	254	15.46	15.46	0.025	0	0.025	74.8	31	8.7	#3
NEW SWG	27.6	FS-5E	Switchgear	X	254	15.514	15.514	0.029	0	0.029	81.2	31	10.3	#3
POLE 5E	27.6	FS-MAIN	Open Air	X	254	15.595	15.595	0.034	0	0.034	88.5	31	12.2	#3
POLE-7E	27.6	FS-MAIN	Open Air	X	254	15.26	15.26	0.034	0	0.034	87.5	31	12	#3
POLE-9	27.6	FS-MAIN	Open Air	X	254	16.485	16.485	0.034	0	0.034	90.3	31	12.7	#3
T-S1-PRI	27.6	FS-9	Open Air	X	254	16.283	16.283	0.021	0	0.021	71.1	31	7.9	#2
108XFM001-PRI	4.16	3-F2A	Open Air		102	8.44	8.22	0.038	0	0.038	12.2	26	0.3	#0
430-CMP-007	4.16	3-F4	Other		102	9.03	8.78	0.01	0	0.01	3	18	0.3	#0
96-SWG-03	4.16	89-LBS-03	Switchgear		102	9.18	8.92	0.182	0	0.182	72.1	18	4.6	#2
- A -	0.6	007PDP001-13	Panel	X	25	0.25	*0.223	3.203	0	3.203	22.6	18	1.7	#1
200XFM01-PRI	0.6	S1-7	Other	X	32	45.88	*25.271	0.017	0	0.017	19.3	18	1.7	#1
AIR CONV	0.6	CMPMC-7	Panel	X	25	7.42	5.97	0.012	0	0.012	5.6	18	0.2	#0
AIR DRYER	0.6	BLM_SPL-7	Panel	X	25	3.32	2.85	0.012	0	0.012	3.4	18	0.1	#0
ATLASCOPCO 1	0.6	CMPMC-10	Panel	X	25	12.95	9.97	0.012	0	0.012	7.8	18	0.4	#0
ATLASCOPCO 2	0.6	CMPMC-3	Panel	X	25	12.95	9.97	0.012	0	0.012	7.8	18	0.4	#0
BLM SPLITTER	0.6	S2-2	Other	X	32	15.491	*9.512	0.03	0	0.03	13.5	18	1	#0
BLM VENT	0.6	BLM_SPL-5	Panel	X	25	3.23	*2.359	0.022	0	0.022	4.6	18	0.2	#0
CMP 1	0.6	BLM_SPL-10	Panel	X	25	13.229	*8.645	0.037	0	0.037	15	18	1.1	#0
CMP. MCC	0.6	S2-1	MCC	X	25	24.911	*15.488	0.028	0	0.028	19	18	1.6	#1
COMP FAN	0.6	BLM_SPL-6	Panel	X	25	3.322	2.847	0.012	0	0.012	3.4	18	0.1	#0
CONVEYOR	0.6	BLM_SPL-9	Panel	X	25	3.374	2.888	0.012	0	0.012	3.5	18	0.1	#0
COOL. TWR	0.6	BLM_SPL-8	Panel	X	25	3.374	2.888	0.012	0	0.012	3.5	18	0.1	#0
DOOR 20	0.6	BLM_SPL-1	Panel	X	25	3.297	2.828	0.012	0	0.012	3.4	18	0.1	#0
DOOR 21	0.6	BLM_SPL-4	Panel	X	25	3.297	2.828	0.012	0	0.012	3.4	18	0.1	#0

Arc Flash Protection – "The Nuts and Bolts"

What are the Shock and Arc Flash Boundaries ?

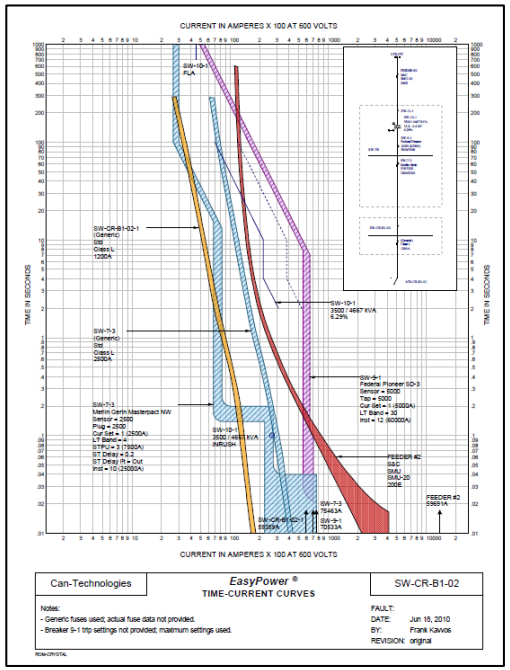


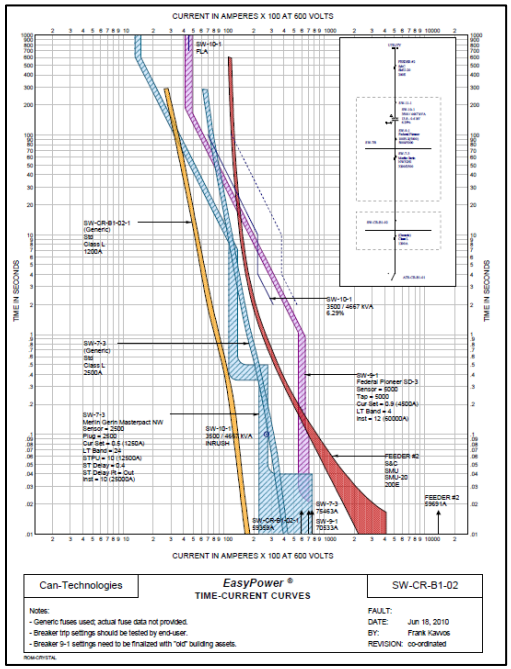
Arc Flash Protection – "The Nuts and Bolts"

What are the Steps to Compliance – Step 4a

Deliverables

- **Generate** Mitigating Analysis – **Report**
- **Conduct** Analysis Review **Meeting**





Arc Flash Hazard Mitigation Report

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Suggested protective devices and/or settings are shown in table below:

AF Fault Bus Name	Existing Trip Device & Setting	Existing IE / HRC	Suggested Trip Device Setting	New IE / HRC
RP-CR-B2-02	PP-CR-B2-01 Inst = **2850**A	21.4 cal/cm2 HRC **#3**	Inst = **2250**A (middle position) or lower	0.2 cal/cm2 HRC **#0**

Arc Flash Protection – "The Nuts and Bolts"

What are the Steps to Compliance – Step 4b

Deliverables

-**Recommend Required PPE**

Incident Energy From (cal/cm2)	Incident Energy To (cal/cm2)	Hazard Risk Category
0.0	1.2	0
1.2	4.0	1
4.0	8.0	2
8.0	25.0	3
25.0	40.0	4

Arc Flash Protection – "The Nuts and Bolts"

PPE Category 0 < 1.2 Cal/cm2

- Non-Melting Untreated Natural Fibers
- Long Sleeve Shirt
- Long Pants
- **OR** Overalls
- Safety Glasses
- Hearing Protection
- Hard Hat
- Safety Shoes (Green Label)
- Gloves (Applicable to Voltage Class)

Arc Flash Protection – "The Nuts and Bolts"

PPE Category 1 <4 Cal/cm2

- Fire Resistant Long Sleeve Shirt
- Fire Resistant Long Pants with Minimum arc rating of 4 Cal/cm2
- **OR** Fire Resistant Coveralls with Minimum arc rating of 4 Cal/cm2 (in place of Shirt and Pants)
- Safety Glasses
- Hearing Protection
- Hard Hat and Face Shield (8 cal/cm2 is standard)
- Safety Shoes (Green Label)
- Gloves (Applicable to Voltage Class)

Arc Flash Protection – "The Nuts and Bolts"

PPE Category 2 < 8 Cal/cm2

- Fire Resistant Long Sleeve Shirt
- Fire Resistant Long Pants with minimum arc flash rating of 8 cal/cm2
- **OR** Fire Resistant Coveralls with minimum arc flash rating of 8 cal/cm2 (in place of Shirt and Pants)
- Cotton Undergarments
- Safety Glasses
- Hearing Protection
- Hard Hat and Face Shield with minimum arc flash rating of 8 cal/cm2
- **AND** wrap around Sock Hood for forehead, ears, neck (Could use a flash suit hood)
- Safety Shoes (Green Label)
- Gloves (Applicable to Voltage Class)

Arc Flash Protection – "The Nuts and Bolts"

PPE Category 3 < 25 Cal/cm2

- Fire Resistant Long Sleeve Shirt and Pants **AND** Fire Resistant Coveralls
- **OR** 2 sets of Fire Resistant Coveralls
- Flash Suit Hood
- Cotton Undergarments
- Safety Glasses
- Hearing Protection
- Safety Shoes
- Gloves (Applicable to Voltage Class)

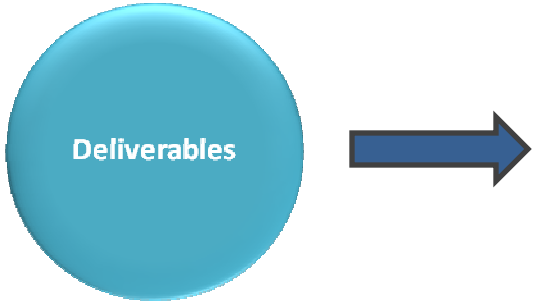
Arc Flash Protection – "The Nuts and Bolts"

PPE Category 4 < 40 Cal/cm2

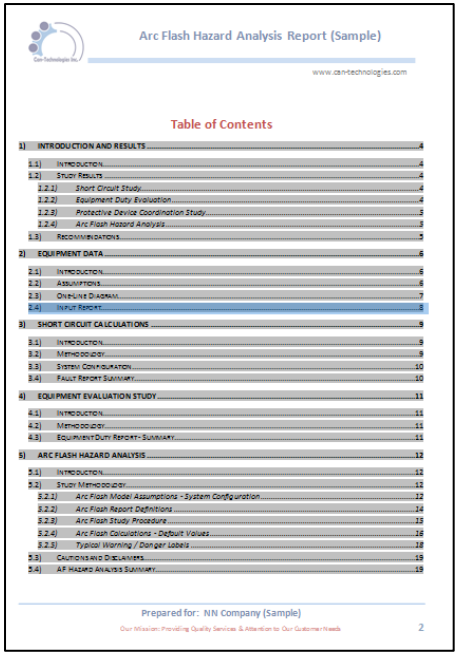
- Fire Resistant Long Sleeve Shirt and Pants **OR** Coveralls (Cat 2)
- **AND** Flash Suit and Hood
- Cotton Undergarments
- Safety Glasses
- Hearing Protection
- Safety Shoes
- Gloves (Applicable to Voltage Class)

Arc Flash Protection – "The Nuts and Bolts"

What are the Steps to Compliance – Step 4c



- **Create Detailed Arc Flash Analysis Report**
  - Asset Details & Single Line Diagrams
  - Short Circuit Study
  - Equipment Duty Study
  - Protective Device Coordination Study
  - Arc Flash Study
  - PPE Recommendations
- **Create Arc Flash Labels**
- **Create Compliance Letter**
- **Training (Awareness/Detailed)**
- **PPE Sizing and Application**



Arc Flash Hazard Analysis Report (Sample)

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Prepared for: NN Company (Sample)

Our Mission: Providing Quality Services & Attention to Our Customer Needs 2

WARNING	
600V AC	Arc Flash and Shock Hazard
1.07 meters / 42" (Shock) 30cm / 12" (Shock) 25mm / 1" (Shock) 46cm /18" (Flash) 1.24 meters / 48.8" (Flash)	Limited Approach Boundary (Qualified Persons Only/PPE Required) Restricted Approach Boundary (PPE Required) Prohibitive Approach Boundary (PPE Required) Working Distance Flash Protection Boundary (PPE Required)
Category 2	PPE Required (6.9cal/cm²)
Eye and Head	Safety Glasses, Electrically Rated Hard Hat, 8cal/cm2 Hood and Face Shield, Hearing Protection
Body	Cotton Underwear, FR Resistant Shirt (Long Sleeve) and Pants (Long) OR Overalls - Min Arc Flash Rating 8cal/cm²
Hand and Arm	>50V – Voltage Related/Insulated Tools, Class 0 (Minimum) Gloves and Leather Outers (Flash)
Foot	Leather Dielectric Rated Safety Shoes (Flash) or Insulating Mat (Step and Touch Potential)

Equipment Name	MDB-B	Upstream Trip Device	ATS-1:Breaker 1
Arc Flash Analysis Conducted By	Can-Technologies Inc	Standard	IEEE 1584
Date	19 August 2009	Calculation	EasyPower V8.0.2

Arc Flash Hazard Analysis Report

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13 July 2011

Glenda Cunningham
Cooper Standard
80 Arthur Street
Mitchell, ON N0K 1N0

Re: Confirmation of Arc Flash Study/Analysis for Cooper Standard – Mitchell ON

Confirmation is hereby given that Can-Technologies Inc. have conducted an Arc Flash Study and Analysis for Cooper Standard at Mitchell, ON, Canada, as it relates to the Canadian Standards Association Code CSA Z462-08.

The Arc Flash Study and Analysis has been based on the Power Distribution Equipment (Assets) installed at the above address combined with the supplementary information provided by Cooper Standard and collected by Can-Technologies. This information is reflected in the one-line diagram contained within the report.

The final analysis and report were issued to Cooper Standard by Can-Technologies Inc. on July 13, 2011 and this report has satisfied the Project Manager and the Professional Engineer that the equipment listed has been studied and analyzed in accordance with the guidelines outlined in the Canadian Standards Association Code CSA Z462-08.

This Analysis forms part of the overall site compliance that also includes Arc Flash Safety Training, Arc Flash Labels, and the procurement of appropriate PPE as identified within the report.

Please do not hesitate to contact me should you have any questions or require further clarification of the information contained within the submitted Arc Flash Study and Analysis report.

Yours sincerely,

Frank Kavvos, P.Eng.
Project Manager – Can-Technologies Inc.
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F. P. KAVVOS
JUL 13 2011

Prepared for: Cooper Standard – Mitchell ON

Our Mission: Providing Quality Services & Attention to Our Customer Needs

Arc Flash Protection – "The Nuts and Bolts"

Labels

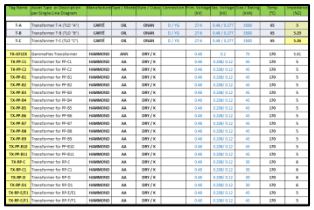
WARNING			
600V AC	**Arc Flash and Shock Hazard**		
1.07 meters / 42" (Shock) **30cm / 12" (Shock)** **25mm / 1" (Shock)** **46cm /18" (Flash)** **1.24 meters / 48.8" (Flash)**	**Limited Approach Boundary (Qualified Persons Only/PPE Required)** **Restricted Approach Boundary (PPE Required)** **Prohibitive Approach Boundary (PPE Required)** **Working Distance** **Flash Protection Boundary (PPE Required)**		
Category 2	**PPE Required (6.9cal/cm^2)**		
Eye and Head	**Safety Glasses, Electrically Rated Hard Hat, 8cal/cm2 Hood and Face Shield, Hearing Protection**		
Body	**Cotton Underwear, FR Resistant Shirt (Long Sleeve) and Pants (Long) OR Overalls - Min Arc Flash Rating 8cal/cm^2**		
Hand and Arm	**>50V = Voltage Related/Insulated Tools, Class 0 (Minimum) Gloves and Leather Outers (Flash)**		
Foot	**Leather Dielectric Rated Safety Shoes (Flash) or Insulating Mat (Step and Touch Potential)**		
Equipment Name	MDB-B	**Upstream Trip Device**	ATS-1:Breaker 1
Arc Flash Analysis Conducted By	Can-Technologies Inc	**Standard**	IEEE 1584
Date	19 August 2011	**Calculation**	EasyPower V9.0.2

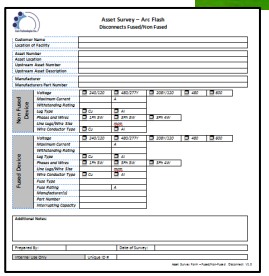
UV and Chemical Resistant ANSI Z535 Compliant Labels

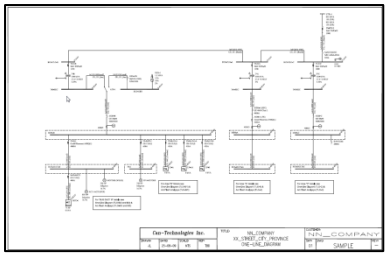
Arc Flash Protection – "The Nuts and Bolts"

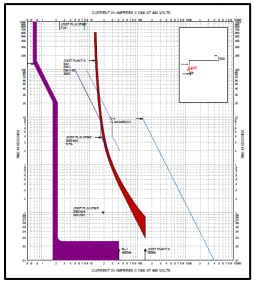
Summary of Deliverables

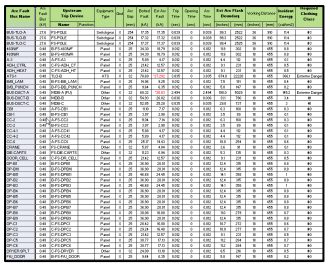
- Standard Electrical Single Line Diagram
- Enhanced Electrical Single Line Diagram
- Initial Study Report (Mitigating Analysis)
- Final Detailed Report
  - Asset Details
  - Short Circuit Study
  - Equipment Duty Study
  - Protective Device Coordination Study
  - Arc Flash Study
  - Recommendation of PPE
- Compliant Arc Flash Labels
- Certificate of Electrical Arc Flash Compliance
- Electrical Arc Flash Hazard Training
- Training Certificates (Individual/Summary)
- Native Format Analysis/Raw Data for Continuous Development

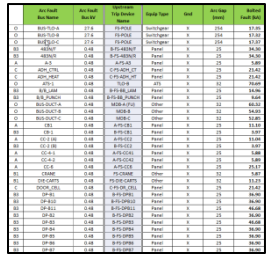


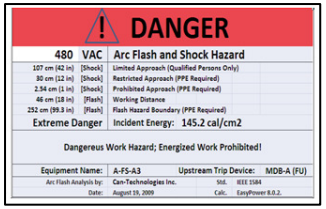


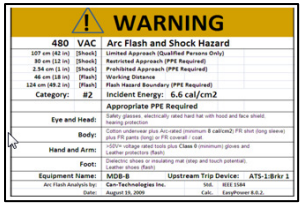


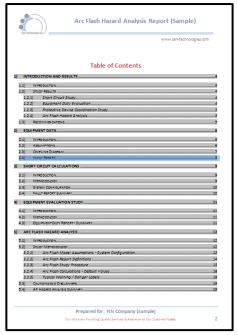


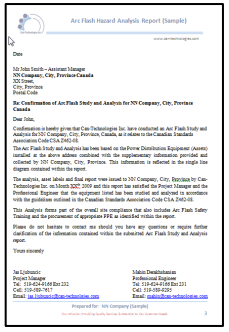










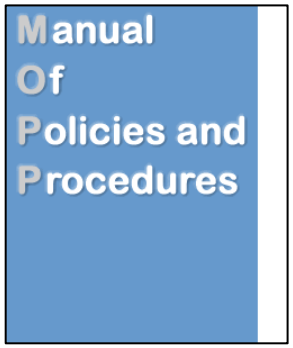


Arc Flash Protection – "The Nuts and Bolts"

Additional Measures/Requirements – Step 5

- **Development of** Electrical Safety Program
  - Hazard/Risk Evaluation
  - Job Briefing and Planning
  - Lock Out Tag Out Procedures*
  - Energized Electrical Work Permits
  - Maintenance/On-Site Policies and Procedures
- **On-Going** Labelling Services
- **Off-Site** Data/Drawing Storage

* Mandatory



Electrical Arc Flash Safety

PPE Category – Keep This in Mind

All of this is to answer ONE Question ……..

What PPE do you wear in case today is a BAD DAY?

Questions?


Thank You

Can-Technologies Inc.
An Engineering Company

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