Electrical Safety Task Group

Risk Assessment for "Normal Operations"

Task Group 5

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EFCOG promotes excellence in all aspects of the operation, management, and integration of DOE facilities in a safe, environmentally sound, efficient and cost-effective manner through the ongoing exchange of information on lessons learned.

2016 PARTICIPANTS

- Earl Myott
- Russ Moder
- Mike Minard
- Glen Mirocha
- Frank Perrotta
- Glenn Anderson
- Greg Christensen
- Robert Fry
- Ray Joggerst
- Rick Ramirez
- Dan Evans
- Omar Al Atassi
- Scot Winningham
- Jennifer Martin
- Jerald Kinz
- Todd Kujawa
- Craig Shaw
- Kevin Gurbisz
- Tommy Martinez
- Jaqueline Mirabal-Martinez
- Matthew Giardina
- Jackie McAlhaney

2017 PARTICIPANTS

- Jack Strait Hanford
- Michael Hicks INL
- Kurt Ririe INL
- William Myers NREL
- Brian Sautter DOE/SRS
- Tommy Martinez LANL
- Lorenzo Martinez LANL
- Roy Gideon SNL
- Robert Spang WTCC
- Greg Retter KCNS
- Kiley Taylor NREL
- Jennifer Martin FE&C/Hanford
- Greg Christensen INL
- Jackie McAlhaney SRS
- Heath Garrison NREL
- Kevin Kennedy Bechtel-WTCC
- Earl Myott WRPS

BACKGROUND

NFPA 70E 2015

Employers are responsible for assessing the risk from the arc hazard for employees that interact with electric equipment

BACKGROUND

NFPA 70E recognizes arc flash hazards may exist even when equipment is in an enclosed condition.

This includes operators whose only interaction is with the equipment in an enclosed condition.

There are situations where opening or closing a switch or breaker has been a contributing factor to an arc flash event.

GOAL

Develop Tools to:

- Verify proper installation
- Verify adequately maintained
- Inspect for Evidence of Impending Failure
- Establish a minimum level of PPE for those who operate OCPD's based on assessment of risk.

VERIFY INSTALLATION

Properly Installed – Task Based Risk Assessment

All electrical installations must have an electrical inspection performed to ensure the installation meets the minimum electrical safety requirements.

The goal is to provide a consistent application of codes and standards.

Inspection documentation must available or labeled for new, modified, refurbished or retrofitted installations.

VERIFY INSTALLATION CRITERIA
(REAL TIME RISK ASSESSMENT)

For the purpose of meeting the criteria for "properly installed"

ALL of the following conditions must be met.

VERIFY INSTALLATION

A Qualified Person's Initial Observation of Equipment Installation – Real Time Risk Assessment

1) Covers in place (screws, fasteners are engaged)
2) All penetrations are closed or sealed (no unused openings)
3) Conduits, Fittings are secured and complete
4) Handle or Switching mechanism is intact (appears functional)
5) Equipment meets field labeling requirements (reviewed in last 5 yrs)
6) No Suspect/Counterfeit/Recalls
7) Field Modifications have been evaluated
8) Clear Working Space

VERIFY INSTALLATION RESOURCES

NFPA 70 2017 Edition

- **Definitions: Approved, Qualified Person, Authority Having Jurisdiction**
- **Article 90.7 & 110.3 Examination, Identification, Installation and Use of Equipment**
- **Article 110.2 Approval of Conductors and Equipment**
- **Article 110.16 Arc Flash Hazard Warning Labels**
- **Article 110.24 (A) Maximum Available Fault Current Labeling & (B) Modifications**

NFPA 70E 2015 Article 130.5 (D) Arc Flash Risk Assessment Equipment Labeling

VERIFY MAINTENANCE OF OCPD'S

Although overcurrent protective devices can be in service for years and may never be called upon to perform their overload– or short-circuit–tripping functions, they are not "maintenance-free" devices.

They require both mechanical and electrical maintenance.

VERIFY MAINTENANCE OF OCPD'S

Mechanical maintenance consists of inspection and adjustment as needed of mechanical mounting, electrical connections, and manual operation to keep the contacts clean and help the lubrication perform properly.

Electrical maintenance verifies functionality and for circuit breakers, verifies it will trip at its desired set point.

Recommend periodic electrical testing of CB's; instantaneous primary current injection and 300% overcurrent

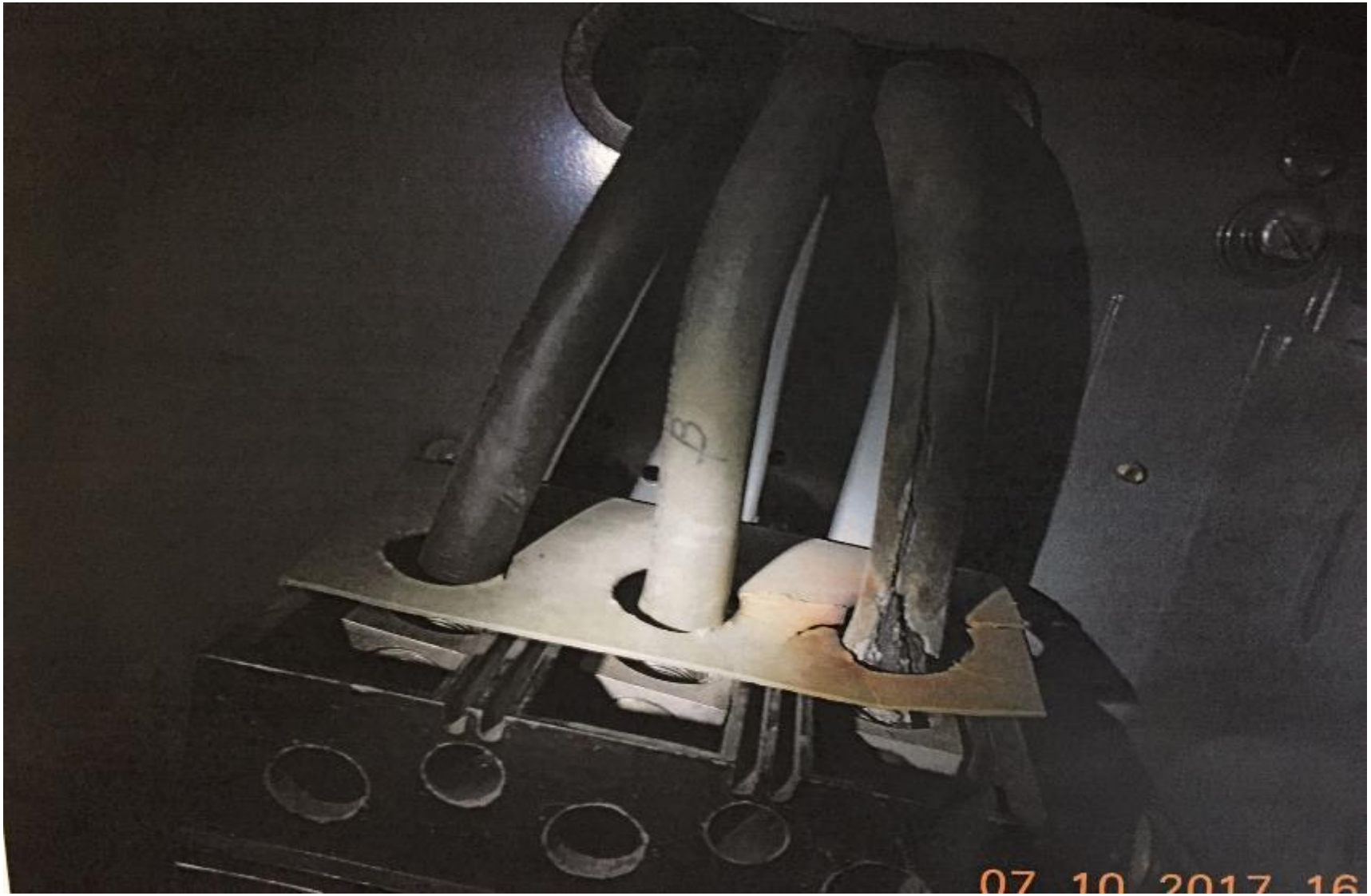
VERIFY MAINTENANCE OF OCPD'S

Circuit breakers should have an initial acceptance test and subsequent maintenance testing at recommended intervals.

Following the maintenance schedule defined by the manufacturer or by a consensus standard reduces the risk of failure and the subsequent exposure of employees to electrical hazards such as shock, arc flash, or arc blast.

NFPA 70B, ANSI/NETA MTS, and ANSI/NEMA AB 4 are documents that can assist a company in understanding the specific tests and testing intervals required to ensure reliability and safety.

VERIFY MAINTENANCE OF OCPD'S



REFERENCES AND RESOURCES

- NFPA 70E “Standard for Electrical Safety in the Workplace” 2015 Edition Chapter 2
- NFPA 70B “Recommended Practice for Electrical Equipment Maintenance” 2016 Edition
- IEEE 1458 “Recommended Practice for the Selection, Field Testing and Life Expectancy of Molded Case Circuit Breakers for Industrial Applications” 2005 Edition
- NEMA AB 4 “Guidelines for Inspection and Preventative Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications” 2009 Edition
- IEEE STD 1015-2006, “The Blue Book IEEE Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems”
- IEEE STD 3007.2 “Recommended Practice for the Maintenance of Industrial and Commercial Power Systems” 2010 Edition
- Emerson - Low Voltage Circuit Breaker Testing Why Test? Series
- ANSI/NETA MTS-2007 “Standard for Maintenance Testing Specifications”
- EPRI “Molded Case Circuit Breaker Application and Maintenance Guide” Rev 2 -2004
- NUREG/CR-5762 Wyle 60101 “Comprehensive Aging Assessment of Circuit Breakers and Relays”
- Schneider Field Testing and Maintenance Guide
- Allen-Bradley Q-Frame Circuit Breaker Instruction Leaflet for Installation of Q Frame Circuit Breakers
- Eaton Cutler Hammer Installation Instructions for DK, KDB, KD, HKD, KDC, KW, HKW,
- KWC, CKD, CHKD Circuit Breakers and Molded Case Switches
- GE Spectra RMS E and F Frame and SG and SK Frame Molded Case Circuit Breakers
- Siemens EM Frame: Types EM6 and EMK Circuit Breakers

Evidence of Impending Failure

Evidence of Impending Failure Table--Real Time Assessment						
Note: Hazard determination does not constitute wether to proceed or not, at any hazard level a re-evaluation and resoultion must be determined prior to operation						
Evidence	**Possible Causes**	**Risk**	**Hazard ID**	**Controls**	**Resolution**	**Resource**
External physical conditions, e.g. fading color (especially if outdoors), blunt trauma, broken handles, evidence of undocumented modifications, visible cracks, un-used openings	Aging, equipment not rated for environment, human error, loose parts or tools, abandonment	Low to High	Arc Flash and Shock	Isolate up-stream	Repair and replace	Facility Engineer, Equipment Owner
Knowledge of manufacturers recall information, and documented previous failures of a certain type or manufacturer of breaker	Inadequate design, manufacturing, history of failure	Low to High	Arc Flash, Shock, Fire	Follow manufacturer recommendations	Follow manufacturer recommendations	Contact manufacturer, Recall websites
Environmental deterioration and contaminates, e.g. snow, rain (rust), dirty, radiation, chemical	Aging, equipment not rated for environment, human error	Low to High	Arc Flash and Shock	Isolate up-stream	Repair and replace	Facility Engineer, Equipment Owner
Trending results from maintenance, e.g. IR scans	Aging equipment, poor design	Low	Arc Flash and Fire	Dependent on trending report	Contact resource	Facility Engineer
Using the breaker according to manufacturers instructions, e.g. applications of breakers	No products designed for application, and misuse of equipment	Medium	Arc Flash	Remote operation, and PPE	Re-design if possible, Engineering controls	Facility Engineer, Equipment Manufacturer, Equipment Owner
Evidence of floating voltages, e.g. equipment not running quite right, loss of phase or ground, meter indicators	Loss of phase, neutral, ground, loose connection	Medium to High	Arc Flash and Shock	Isolate up-stream	Investigate and examine equipment	Utilities, Facility Engineering, Equipment Owner
Failure to trip	Faulty breaker	Medium to High (dependant on incident energy)	Arc Flash	Perform maintenace and testing on breaker to ensure operabilty	Repair or replace	Facility Engineer, Maintenance
Initial operation (energization) after installation or maintenance of equipment	human error, loose parts or tools, abandonment	Low to High	Arc Flash	Wear AR PPE per incident energy analysis	Protect the worker	Facility Engineer, Arc Flash Label

New!

CONCLUSIONS

With respect to arc flash calculations these devices are typically ignored (do not interrupt arcing fault currents).

Breakers downstream of a transformer meeting the criteria in section 4.2 in IEEE 1584-2002

- ***System voltage below 240V and supplied from single transformer (bank) rated less than 125kVA, OR***
- ***<1.2 cal/cm2***

CONCLUSIONS

- Meeting the bounding criteria for “normal operations” is expected to be very difficult
- Conditions can change over time affecting the risk analysis
- A risk is present if an unknown adverse condition exists
- Systems aged or near end of life are a concern

CONCLUSIONS (continued)

- Covers may not stay on in some arc events (high fault current)
- There must be defense in depth
- Establishing a minimum level of PPE is difficult even if criteria is met (IEEE P 1584 change)
- Thresholds for minimum arc flash PPE are not defined

MEETS ALL CRITERIA

1.2 - 40 cal/cm2 Incident Energy

Risk = high consequence/low probability

Consensus: Some level of PPE is recommended.

MEETS ALL CRITERIA

>40 cal/cm2 Incident Energy

Additional Controls are recommended:

Engineering controls, remote racking, switching procedures or additional PPE should be applied to reduce potential exposure to hazards.

RECOMMENDATIONS

<u>All</u> clothing must be non-melting

Some level of daily wear (arc rated) clothing is recommended for qualified workers. (e.g. electricians, HVAC techs, ESOs, other high risk positions)

Workers shall be protected appropriately for the hazard e.g., safety glasses, leather gloves, etc.

FUTURE ESTG TASK SUGGESTIONS

BP for correct application of personal protective ground sets.

- **Tiebreakers, lightning, capacitive charges, induced energy, generators, back-feeds, etc.**

Review Position Paper 2016-01 for Visual Verification of Blade Position [Article 120.1(3)]