

**LESC RESPONSE To
DOE Team Interim Recommendation #2 – ATS Item 2944.5.4**

DOE Recommendation

DOE Team Interim Recommendation #2:

Review the practice of racking circuit breakers with the bus energized or while inserting/removing Motor Control Center (MCC) starter buckets while the MCC is energized

Resulting BNL Action Plan

- Review current procedures to evaluate whether the practice of racking circuit breakers into live bus should be continued and, if not, modify Laboratory Electrical Safety Standards to increase electrical safety.
- Benchmark practices for MCC bucket insertion/removal with other Laboratories and industrial sites. If a change in procedures is warranted, modify Laboratory Electrical Safety Standards to increase electrical safety.
- Train the Laboratory's electrical workers in the updated procedures

Background

One of the DOE Type B Team members indicated that at the facility he previously worked at these practices were not allowed as they were felt to be too hazardous. No discussion relating to the potential incident energy exposures was provided.

Actions Taken by LESC

To provide a basis of decision, the LESC solicited input from other knowledgeable sources including:

- DOE Electrical Safety community, through the DOE Electrical Safety list-serv
- General industry, through the IEEE Electrical Safety Forum, Appendix 1 & 2)
- DOE Facility Managers, through a questionnaire (Appendix 3).

In addition, data on electrical switchgear and MCC equipment maintenance obtained from the Plant Engineering Maintenance Management Group (Appendix 1) and was assessed against the recommendations of NFPA 70B, "Recommended Practice for Electrical Equipment Maintenance".

Discussion

The responses received were quite varied generally falling into one of three categories which were:

1. Concurrence that the tasks were too hazardous as opined by the DOE Type B team member.
2. Indication that the tasks were allowed and that the PPE guidelines found in NFPA Table 70E Table 130.7©(9)(a) were followed. It should be noted none of those responding in this manner specifically stated they had insured they were within the bounding conditions set forth in the tables footnotes.
3. Indication that the tasks were allowed, but that specific hazard analysis was used to determine PPE requirements.

Four things are clear in NFPA 70E relating to these actions:

- They are not specifically prohibited
- The worker must always be protected by appropriate PPE when performing energized work
- Energized work should only be performed as a last resort with appropriate review to ensure it the work must be performed energized.
- That work above 40 cal/cm² is very hazardous due to the potential arc-blast and shrapnel hazards. While protective clothing has been developed to protect against radiant energies above 40 cal/cm² they do not address these other hazards.

Recommendations of the Laboratory Electrical Safety Committee – 7/13/06

NFPA classifies Risk/Hazard Categories up to 4 for incident energies up to 40 cal/cm². While there is no specific prohibition of operations above that level specifically stated the NFPA 70E handbook explains in Article 130.7©(5) in the explanation section:

“Some FR clothing is rated for use with incident energy exposures up to 100 cal/cm². The 70E Technical Committee determined that although it might be possible to protect a person from such extreme thermal exposure, the clothing would be unlikely to protect the worker from the effects of the accompanying pressure wave. If the arc flash analysis indicates an exposure of more than 40 cal/cm², the task must not be performed until an electrically safe work condition exists. FR clothing with a very high incident energy rating might be needed to perform the steps necessary to establish an electrically safe work condition. However, this is the only task that should be accomplished with the equipment energized.”

LESC Recommendations

We recommend these tasks be allowed provided that ALL the following conditions are met:

1. An energized work permit is generated to validate that the task is necessary and that the proper PPE is used.
2. That an arc-flash analysis is performed to ensure that appropriate PPE was determined.
3. The arc-flash incident energy must not exceed 40 cal/cm²

If these conditions can not ALL be met then the equipment must be deenergized in order to rack a breaker or insert or remove an MCC bucket.

Submitted By: Original signed by John F. DiNicola
Chair Laboratory Electrical Safety Committee, on behalf of the full committee

Concurrence: Original signed by Michael Bebon, Deputy Director for Operations

APPENDIX 1

IEEE ELECTRICAL SAFETY FORUM QUESTION #1

IEEE POSTING

A recent recommendation made by a consultant as part of an investigation of an arc-flash event at our site was that MCC started buckets should not be installed or removed while the MCC is energized. NFPA 70E Table 130.7(c)(9)(a) allows this type of operation and rates it a Hazard/Risk Category 3 operation provided the bounds of Note 4 are met. Note 4, as revised by the Standards Council decision SC-04-4-9/Log 799 and as issued in TIA 04-1 revised the note to be "Maximum of 42kA short-circuit current available, 0.33 seconds fault clearing time." This note translates to about 38 cal/cm² incident energy. Our calculations show that MCC's will generally not exceed this limit..

The question I pose is how are other sites treating the insertion/removal of MCC buckets?

RESPONSES

We are located at a Nuclear Power Generating Plant. We have dozens of 480 VAC MCC's. The activities we perform require us to remove these MCC buckets regularly (daily). Our Calc's indicate that none of our MCC's exceed the maximum of 42kA short-circuit current available, 0.33 seconds fault clearing time that is indicated in NFPA-70E. We typically utilize 40 Cal/cm PPE with VR gloves/protectors to remove/install these buckets and a 10 ft Arc zone with physical barriers installed. We generally have a second individual stationed just outside the Arc zone as a "Safety Observer" trained in CPR/First Aid to respond in the case of an event. We think this is a pretty good method of performing this work. De-Energizing the entire MCC on a daily basis would not be feasible.

We perform this task per NFPA 70E. It is allowed as long as all of the "appropriate" PPE is worn by all involved in the work and a Job hazards analysis has been done. Arc flash calculations have been done for all of our MCCs and they are tagged with the results. I see no reason why this should not be acceptable. Seems like the consultant took the easy way out. Easy for him that is.

We have done hot plugging of MCC buckets but we try to avoid it. We have had several incidents where the stabs on the bucket did not properly engage with the MCC bus. In some cases we caught it in others we replaced the bucket and the bus. We also have several cases where the clearing time of the upstream breaker is quite long and the risk is too high. I was involved in one case where the rationale for not shutting down the MCC was "the feed breaker doesn't work and if we get it open we may not get it to close again" If the feed breaker does not work and you are hot plugging the bucket your clearing time may be related to burn down of the feed. In this case you should never do it hot. Our MCC cells are equipped with disconnects and we use these for isolation purposes when doing maintenance. This eliminates one of the big reasons for pulling the bucket.

At our site, we require our electricians to wear level 4 PPE when inserting or removing a bucket from a live mcc and he must have a watchman present.

We group the insertion and removal of MCC buckets right along with racking breakers in or out, and installing or removing bus duct switches (or breakers) and we de-energize all of the MCC's, switchboards, and bus ducts during non-standard hours to perform these tasks to minimize the impact on to our customers. It may be acceptable under the right circumstances in NFPA 70E, but, I have heard of too many incidents in just the past few years to convince me that doing these types of activities with equipment energized can be a big mistake.

APPENDIX 2
IEEE ELECTRICAL SAFETY FORUM QUESTION #2

POSTING

A recent recommendation made by a consultant investigating an arc-flash event at our location was that switchgear breakers (LVPCB's) should not be racked in or out while the switchgear is energized. NFPA 70E Table 130.7(c)(9)(a) allows this type of operation and rates it a Hazard/Risk Category 2 or 3 operation provided the bounds of Note 5 are met. Note 5, as revised by the Standards Council decision SC-04-4-9/Log 799 and as issued in TIA 04-1 revised the note to be "Maximum of 35kA short-circuit current available, 0.5 seconds fault clearing time." This note translates to about 38 cal/cm² incident energy. Our calculations show that secondary side switchgear who rely on transformer primary fuses as the upstream protective device may be exposed to between 100-200 cal/cm² incident energy. Our past practice, now under review, was to require H/R Cat 4 protection for this type of operation.

To affect this change would require us to use transformer primary switches to shutdown secondary side switchgear and in many cases isolating entire buildings in lieu of individual circuits. Please provide input as to your current practices and comments on the above.

RESPONSE

We are at the same Nuclear Generating Facility that responded to your question regarding MCC bucket removal/insertion. We utilize the guidance provided in NFPA-70E for racking breakers in 480 VAC switchgear (600 VAC class), as well as all other situations. Currently we are utilizing the 20 Cal/cm PPE clothing to perform racking with the door closed. This exceeds the requirements of the protection level required in the NFPA-70E matrix. We are preparing to perform our hazard analysis. I understand that if hazards exist that exceed 40 Cal/cm, the only activities that can be performed in PPE would be to safely shut down the equipment (to make it safe) otherwise, design changes may be warranted to install transformer secondary protection devices, or consider utilizing remote racking (robotic) devices

**APPENDIX 3
DOE FACILITIES MANAGER QUESTIONNAIRE**

Do you allow insertion and removal of MCC buckets while the MCC is energized? If so, how do you determine PPE requirements?

Site 1: NO, do not allow

Site 2: NO! We perform these functions (MCC bucket insertion or removal, racking breakers or switches in or out...) with MCC's, panels or switchboards de-energized.

Site 3: No

Site 4: We allow insertion and removal of MCC buckets while the MCC is energized, however PPE is based and driven by energized work permit which include arc flash calcs.

Site 5: Yes, however the task is infrequent and avoided as much as possible. The HRC category and corresponding PPE requirements are determined via the table in 70E.

Site 6: This is not allowed. It is considered "hot work" and we arrange a power interruption to do this

Site 7: No specific prohibition, though the task has not been performed on our site in several years. No specific requirements. If conductors exposed, it is controlled by the hazard class of the MCC.

Site 8: Yes we allow this with the proper PPE

Recommendations of the Laboratory Electrical Safety Committee – 7/13/06

Do you allow operation of low and medium voltage power circuit breakers and/or the racking in or out of these breakers located in switchgear while the equipment is energized? If so, how do you determine PPE requirements?

Site 1: Yes for breakers, but racking out only with doors closed.

Site 2: See response to question #6 above. Not with equipment energized.

Site 3: No, we do not allow any work on energized breakers. We have no processes or systems that would require work on energized circuits, except for testing. Then the appropriate PPE is required.

Site 4: We allow operation of low and medium voltage power circuit breakers while the equipment is energized as stated in the answer of Questions 3 with the door closed. Racking an open door operations require appropriate PPE determined by our procedures.

Site 5: Yes, however, the arc-flash resistance design of the gear determines the level of PPE with a minimum standard requirement

Site 6: This is not allowed. It is considered “hot work” and we arrange a power interruption to do this

Site 7: Yes. No specific requirements

Site 8: Most of these breakers are operated remotely. We allow breaker racking in or out with the proper PPE.

**APPENDIX 4
PLANT ENGINEERING PREVENTIVE MAINTENANCE**

A list of preventive maintenance and MCC and substation related equipment was provided for review and discussion. While there was evidence that some equipment had been inspected and tested per the desired frequency there was also evidence that some had not been. In addition, after discussion it was determined that some equipment may not even be in the system. A review of the data for actual verification is possible but is made difficult in that a new maintenance system was implemented less than two years ago and pertinent information such as the last inspection test date was not passed on from old system to new system allowing for direct verification. However, the data can be retrieved and combined to allow review. It was also discussed that this issue was also present the previous time the maintenance system was replaced. This complicates the verification process and creates a credible issue of things being missed.