

QA Assessment of the MI Cable Abatement Process

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Background

On October 29, 2013 an Accelerator Division (AD) Technical Specialist with the Instrumentation Department received an electrical shock while working in the Main Injector (MI) 30 Control Room troubleshooting an instrumentation problem. An access into the MI enclosure found the source of the electrical shock was a cable with the damaged outer jacket that the ground shield was contacting the MI quadrupole bus.

The cable was moved away from the bus and the AD Head ordered the MI be kept in stand-by-mode until an evaluation of the entire MI bus could be completed. After the inspection and evaluation was completed, the MI was powered back up on October 30, 2013 and an ORPS report number: SC-FSO-FNAL-FERMILAB-2013-0008ⁱ was issued.

An investigation into the incident found that the cable involved was installed in 1998 and abandoned in place in approximately June 2012. The investigation committee concluded that there were no uniform policies or work practice standards in AD for installing or removing cables in the beamline tunnels. The requirements and recommendations in the Fermilab Environment, Safety, and Health Manual (FESHM) Chapters 5043 and 5044ⁱⁱ were not followed with regards to removing unused cable from trays, and protecting objects from contact with exposed high voltage or high current bus.

The investigation committee recommended that AD establish a uniform work and housekeeping policy regarding cables in the MI and to remove abandoned cables where ever possible. In places where cables cannot be removed or cables are installed for future applications, National Electrical Code (NEC) requirements to remove the accessible portion of abandoned communication/signal cables and cables remaining in place must be identified at each end with a tag, and insulating cover. The tag and insulating material shall be of sufficient durability to withstand the environment involved.

On January 13, 2014 the AD Deputy Head issued a memorandum on cable maintenance and remediation activities to all division department heads completing one of the recommendations from the investigation committee. Department heads were directed by the AD Head to perform some remediation work during each accelerator maintenance period and to complete all MI cable remediation work by the end of the calendar year 2014. MI cable remediation efforts were completed on October 24, 2014 and the ORPS report was finalized and closed out on November 7, 2014.

Overview

Upon completion of the MI cable remediation efforts, a quality assurance assessment of the abatement process was completed. The goals of the assessment were to look at following three aspects:

1. The effectiveness of the division management communication regarding the expectations for spare and abandoned cables in the beamline enclosures.
2. The actual abatement process that was utilized to address spare and abandoned cables in the MI.
3. Identify any Lessons Learned from the abatement process that could be used for abatement of cables in other beamline enclosures.

The review process consisted of reviewing applicable documents and interviews of MI staff members Denton Morris and Dave Capista.

QA Assessment

The assessment team consisting of John Anderson Jr. and Allan Sondgeroth reviewed the AD management memo from Paul Czarapata, AD Deputy Head, which was distributed to all AD Department heads on January 13, 2014, AD Document Database # 4723ⁱⁱⁱ. The memo clearly outlines the expectations to AD Department Heads to categorize cables by “in-use”, “spare”, or “abandoned” and what actions are to be taken with cables in the beamline enclosures, service buildings, and work areas. The actions identified are:

- A. Actions to be taken for cables “in-use”:
 1. If you know the source and end-point of the cable and it is not labeled, enter it in the cable data base. The link is on the AD home page, under databases and label the cable at both ends.
 2. Use a Bridle Ring or Spring Steel Fastener or equivalent installed in the nearest Unistrut® channel then coil and secure the excess cable so it cannot come in contact with any nearby bus. If the cable is not flexible enough to coil, dress the cable away from the bus and secure it in place with appropriate clamps.
- B. For “spare” cables or cables reserved for future use:
 1. Same actions as above plus, insulate the cable on both ends so there is no exposed conductor, connector or shield. Again, enter the information in the cable database and label the cable.
- C. For cables that are “abandoned” or damaged.
 1. If possible, remove the cable back to the cable penetration. Cut the cable and insulate it.
 2. Label the cable as abandoned and enter that information in the cable database.
 3. At the source end of the cable, remove it back to the penetration. Again cut the cable, insulate the end and apply the label.

4. If a cable cannot be removed back to the penetration, cut it at the cable tray, insulate it and apply the label as in number C.2.

The memo further went on to discuss the use of radiation hardened materials for securing spare cables in beamline enclosures. The assessment team found the management expectations were clearly outlined and the memos were archived in the AD document database for future use.

In addition to the expectations memo, AD management periodically reiterated these expectations at the bimonthly Department Heads meetings, the weekly scheduling meetings, and at the AD All Hands pre shutdown meeting. The communications mechanisms used were very effective during the abatement process.

The assessment team conducted interviews with MI staff to discuss the abatement process. The process consisted of:

1. A thorough MI tunnel tour to identify dangling or poorly secured cables.
2. Categorize cables into the three types, "in-use", "spare", or "abandoned".
3. Booting spare and unused cable ends with a PVC and chlorine free plastic insulating material.
4. Securing cables with PEEK (Polyetheretherketone) radiation hard cable ties.
5. Updating the cable database.

The abatement process steps were iterated three times by the AD Electrical Electronic (EE) Support Power Supply Group, the AD Instrumentation Department, and AD MI Department Staff members Denton Morris and Dave Capista. In all 3,500 cables were identified and abated over calendar year 2014.

The very active role by AD Management in continually communicating expectations and the active role of MI staff members to continually assess the abatement efforts contributed significantly to the success of the MI cable abatement process. The assessment team identified one lessons learned from the assessment. There are no additional recommendations that would assist in improving the process.

Lessons Learned

All of the cables that were booted were left from previous jobs such as upgrades or removal of equipment. Management efforts to continually stress the importance of recognizing that a job is not complete until cables have been abated and the database has been updated are needed to create a lasting cultural change. Safely isolating and securing spare or abandoned cables should be included in job planning.

References:

- ⁱ *ORPS report number: SC-FSO-FNAL-FERMILAB-2013-0008, Contact with abandoned heliax cable causes employee electrical shock.*
The web link is: http://www-esh.fnal.gov:8001/Occurr_Rep/2013/2013_0008.pdf
- ⁱⁱ *Fermilab Environment Safety & Health Manual Chapters 5043 and 5044.*
The web link is: <http://esh.fnal.gov/xms/FESHM>
- ⁱⁱⁱ *Maintenance Activities and Remediation, Paul Czarapata, December 22, 2014. Accelerator Division DocDB # 4723.*
The web link is: <http://beamdocs.fnal.gov/AD-public/DocDB/ShowDocument?docid=4723>