Chapter 12

Safety considerations

12.1 Fermilab ES&H requirements

The Fermilab ES&H Manual (FESHM) delineates laboratory policy regarding personnel and line management ES&H responsibilities, as well as providing technical standards for control of hazards which are peculiar to Fermilab. Pursuant to Chapter 2010 of the FESHM, the Fermilab Directorate has determined that the NuMI Project changes laboratory operation sufficiently to require the drafting of a Safety Assessment Document (SAD) and adherence to the requirements of that Chapter. An analysis of hazards associated with both near and far MINOS detectors is included in this document. A Preliminary Safety Assessment Document[1], describing safety considerations for the NuMI Project on the Fermilab site, and a Preliminary Hazard Assessment Report[2], describing safety considerations for the experiment at the Soudan site, have been prepared and are under review.

In addition, the MINOS Collaboration must comply with Particle Physics Division "Procedures for Experiments" [RD-2] for identifying and characterizing hazards in proposed experiments, and reviewing the engineered and administrative controls developed to mitigate these hazards. Experimenter and Spokesperson responsibilities during the life cycle of the experiment are also specified.

The hazard thresholds specified in RD-2 have been applied to detector systems to identify those systems which require independent review and approval prior to commissioning. Reviews are conducted by the MINOS ES&H Review Committee, which reports to the head of the Particle Physics Division. The Division head grants an Operational Readiness Clearance for initial operation of each system when all findings from the review committee have been resolved.

The cost and schedule implications of all ES&H systems and protocols required by the experiment are included in the MINOS Cost and Schedule Plan[3].

12.2 Minnesota ES&H requirements

For the past decade, adherence to industry consensus standards such as OSHA and NFPA has been adequate to maintain safe operation of the existing Soudan 2 detector in the Soudan mine. The University of Minnesota holds ES&H responsibility for the Soudan 2 cavern with oversight from the State of Minnesota Department of Natural Resources.

These responsibilities are now expanded to include the MINOS cavern during and after detector construction. Operational Readiness Clearances for far detector systems are approved by a University of Minnesota representative as well as the Fermilab Particle Physics Division head. Since the detector is located on State property, structural components are stamped by a professional engineer licensed in the State of Minnesota.

12.3 Description of hazards

As for most other neutrino experiments, the MINOS detectors present a small set of well defined personnel hazards and negligible environmental hazard. From a hazard standpoint, the detector caverns are similar to a light industrial environment with the addition of several unusual hazards. Common workplace hazards such as working at elevated heights are addressed by adherence to OSHA, NEC and NFPA. The more unusual hazards and their associated controls are summarized in the following Sections.

12.3.1 Mechanical hazards

The most significant mechanical hazard is a potential buckling failure of a steel absorber plate during assembly. Without axial constraint, a single steel absorber plate could deform sufficiently to shear off the support ears. The assembly procedures described in Chapter 4 ensure that axial loads are properly transferred from the strongback to the previously installed detector planes. All mechanical hazard controls are reviewed by the MINOS ES&H Review Committee prior to commissioning.

12.3.2 Electrical hazards

There are numerous high and low voltage supplies which power the photomultiplier tubes and readout electronics. These are commercial supplies which are appropriately fused to the rating of the power distribution systems.

Electrical conductors for magnetizing the steel absorber are electrically insulated and water cooled. Thermal and voltage interlocks trip off the power supplies in the event of conductor failure or ground fault.

All electrical systems comply with the NEC and the FESHM and are reviewed by the MINOS ES&H Review Committee prior to commissioning.

12.3.3 Radiation hazards

Radioactive sources are used in two performance-testing devices which are needed at the two module assembly facilities and also at the near and far detector sites. One of these devices is the module mapper, an automated machine with scans the surface of each scintillator module with a 3 mC ^{137}Cs source to measure the energy response uniformity. The second device is wire-source driver used for calibrating module response by driving a 3 mC ^{137}Cs source, on the end of a wire, inside the source tubes attached to both ends of each module.

The use of these sources on the Fermilab site is controlled by adherence to the Fermilab Radiological Control Manual. Source hazard control at other sites is the responsibility of the institution which owns the site.

12.3.4 Fire hazards

The large inventory of polystyrene scintillator poses a fire hazard. This is largely mitigated by the highly segmented construction of the detector, since it is difficult to conceive of a credible accident scenario in which multiple detector modules are ignited. In particular, the aluminum sheets which enclose individual scintillator modules make ignition of the scintillator strips very unlikely.

The MINOS cavern is provided with smoke detection and sprinkler systems which are appropriately designed for the inventory of scintillator.

12.3.5 Laser hazards

Several pulsed UV lasers are used for calibration and monitoring. The optical paths are shielded to prevent accidental exposure. Access to the laser enclosures requires adherence to laser lock-out tag-out procedures mandated by the FESHM. These controls are reviewed by the MINOS ES&H Review Committee prior to commissioning.

12.4 Public access

The Soudan mine is a Minnesota State Park as well an underground laboratory. During the summer months, public tours of the 27^{th} level, where the MINOS far detector is located, are conducted daily. Public access to the MINOS cavern is restricted to a viewing area on the mezzanine.

12.5 Summary

Physical hazards associated with the MINOS detectors are similar to those encountered in an industrial setting. Administrative controls are defined to ensure the detectors are constructed and operated safely. The only conceivable environmental hazard would be air-borne hydrocarbons in the unlikely event of a fire.

Chapter 12 References

[1] The Fermilab NuMI Project Staff, "NuMI Project at Fermilab: Preliminary Safety Assessment Document," October 1998, Fermilab report NuMI-361.

[2] The University of Minnesota, CNA Consulting Engineers, Ericksen-Ellison Associates, Inc., and Miller-Dunwiddie, Inc., "MINOS Far Detector Laboratory Project, Preliminary Hazard Assessment Report," October 1998, Fermilab Report NuMI-L-419.

[3] The Fermilab NuMI Project Staff, "NuMI Project Cost and Schedule Plan," October 1998, Fermilab report NuMI-362.