

NuMI



MINOS

February 15, 2005

TO: Michael Witherell, Director

FROM: Greg Bock, NuMI Project Manager

SUBJECT: NuMI Project Transition to Operation

I am delighted to report to you that the NuMI Project construction, installation, testing, and commissioning are complete and the facility is now ready to be turned over to the Laboratory for operation. Only one routine punch list item remains and is described in this report. All commissioning goals have been met or exceeded, and the Particle Physics Division and Accelerator Division have already established appropriately staffed organizations to carry out the physics commissioning and operation. Thus the operation of the NuMI facility, beam and MINOS detectors at Fermilab is now fully integrated into the normal laboratory operations. Operation of the Far Detector at Soudan continues as per our Memorandum of Understanding with the University of Minnesota. The project is in its final stages of financial closeout with only one project management task remaining on each of the OPC and TEC.

CD4 Performance Requirements

As shown in the attached “NuMI Commissioning Report”, all the commissioning goals specified in the DOE Project Execution Plan have been achieved—in fact all have been exceeded. Those goals (shown in the following table) included operation of the primary beam, the production of secondary particles and the subsequent focusing with the horns in the Low Energy configuration. Non-interacting protons and secondary particles were observed in the proper alignment towards Minnesota. Neutrinos from the beam were clearly observed in the near detector. Both muons and atmospheric neutrinos have been observed in the Far Detector in Soudan. All systems are complete and signed off by the appropriate Level 2 and Level 3 managers. We feel we are ready for CD4.

| Parameter | Measurement | Commissioning Goal |
|--|--|---|
| Proton intensity in target hall | Toroid (or equivalent) beam intensity monitor at entrance to the target hall | Greater than 1×10^{12} 120 GeV protons per spill |
| Beam alignment | Transverse distributions of the proton beam and secondary beams | Proton direction established to within 1 mr of the known direction to the far detector in the Soudan mine |
| Neutrino beam energy | Near Detector event energy | low energy, 2-4 GeV |
| Cosmic ray muons detected in the MINOS Near Detector | Near Detector data read out through DAQ system | Majority of the 153 Near Detector planes sensitive to muons |
| Near Detector neutrino flux | Charged-current event rate in 1.5 ton fiducial region | Observe neutrinos produced in the Near Detector by the NuMI beam |
| Cosmic ray muons and atmospheric neutrinos detected in each of the two MINOS Far Detector Supermodules | Far Detector data read out through DAQ system | Majority of the 484 planes of the Far Detector sensitive to muons and atmospheric neutrinos |
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Table: NuMI technical commissioning goals

Safety Overview

A Hazard/Risk Analysis for the operation of the NuMI Beamline and Main Injector Neutrino Oscillation Search (MINOS) detectors has been performed in order to identify the hazards associated with the NuMI Project in a systematic manner. Through this analysis and the resulting Safety Assessment Document (SAD), the NuMI Project staff has identified the environmental protection and safety concerns related to this Project. The SAD has been prepared in accordance with FNAL Environment, Safety and Health Manual (FESHM), Chapter 2010, dated 18 June 1999, and describes in detail how each of the identified concerns have been

abated or mitigated. The NuMI SAD was approved on November 24, 2004, prior to our commissioning runs.

All shielding requirements are verified by the Accelerator Division (AD) using FNAL approved methodologies and are documented in the approved NuMI Shielding Assessment. In addition, limits associated with groundwater activation, air activation, on-site above-ground dose rates, and off-site dose rates, are exceeded as described in the Fermilab Radiological Control Manual (FRCM). Through the approval of the NuMI SAD, NuMI Shielding Assessment and the NuMI Safety Envelope, the project is approved for the full design intensity of $4E20$ protons per year.

Operating and Maintenance Procedures Overview

All the NuMI facilities were designed and constructed to be operated and maintained by the existing Fermilab Divisions and Sections. In fact, the commissioning activities themselves were carried out by the operating divisions, not the project. This clearly demonstrates their readiness.

The operation and maintenance of most elements of the NuMI Project are similar in nature to the existing elements in the other areas at FNAL. These are covered in existing Lab-wide and Division and Section procedures and plans. An agreement between the Accelerator and Particle Physics Divisions assigns responsibilities for specific geographical areas of the NuMI facility to each of these divisions.

The NuMI facilities are included in the Fermilab building manager program. This program assigns the conventional operations, systems and functions of each building at the laboratory to a specific individual. This individual serves as the point of contact for occupants and visitors to the building as well as the representative of the division/section to interact with maintenance, janitorial, building inspection personnel or outside contractor personnel, when such work is to be completed on or within the building.

The Fermilab Environmental Monitoring Program assesses the potential impact of NuMI activities on the environment and verifies compliance with relevant permits, state and federal standards, and laboratory goals such as ALARA (As Low As Reasonably Achievable) for ionizing radiation. The program includes the monitoring of air, surface water, and ground water.

Some elements of the NuMI facilities are unique and specific documentation for NuMI exists to address them. For example, documentation and procedures have been developed for the horns, the beam permit, and the horn power supply. Underground facilities inspection responsibilities have been added as appropriate.

Acceptance testing and deficiencies

The project is complete and free of deficiencies. All commissioning tests have been passed and NuMI can operate at full design specifications. The conventional facilities were accepted by the Laboratory in March 2004 as documented in the Laboratory's usual "Final Inspection and Acceptance Certificate." Additionally project acceptance check-off sheets exist for each NuMI WBS Level 2 (and in some cases Level 3) element.

Only one punch list item remains—the electrical and plumbing connection to a chiller in the target hall support room. The chiller is set in place and has already passed operational acceptance tests. The connections will take place over the next weeks, interleaved in the schedule with the beam intensity ramp up planned by the Accelerator Division. Funds for this work are already obligated. There is no serious cost or schedule risk associated with this routine work.

Operations Readiness Overview

Operational readiness of the NuMI primary beam, secondary beam and Near Detector is verified by reviews performed by the NuMI Environmental, Safety and Health/Quality Assurance (ESH/QA) Review Committee. This committee was appointed jointly by the AD and PPD Heads and is charged with the responsibility of assuring that the NuMI line organization has developed the NuMI beamline and detector in accordance with all applicable ES&H regulations, standards and good practices. Safety reviews and inspections were performed during the course of design, construction, installation and pre-commissioning of components. Startup and testing of MINOS Near Detector subsystems required the approval of this committee and the PPD Head. The MINOS Near Detector has regularly collected cosmic ray data since receiving its Operational Readiness Clearance. The committee also advised the University of Minnesota in starting cosmic ray data collection with the MINOS Far Detector. The start of initial and routine operation of the NuMI beam required explicit approval by this Committee as well as AD Operations and the Director through the Accelerator Readiness Review and approval in accordance with FNAL Environment, Safety and Health Manual (FESHM), Chapter 2010, dated 18 June 1999. At the Project level, checkout is a multi-step process that culminates in the documentation of readiness by the Level 3 or Level 2 manager responsible for the system on the NuMI Project WBS 1.1 NuMI Technical Components Level 3 System Completion Certification for CD-4 and on the NuMI Project WBS 2.0 MINOS Detectors Level 2 System Completion Certification.

In December 2004, the NuMI Project Manager requested a review to assess the readiness of the laboratory to assume responsibility for the physical plant of the NuMI facility. The review was led by the deputy manager of the Facility Engineering Services Section's Engineering Department and extended over a period of 2 months. This review included discussions with staff from the Facilities Engineering Services Section, AD/ES&H Building Management, and PPD/ES&H Building Management. The readiness for all components reviewed was rated from satisfactory to excellent. The Safety Envelope states the maximum beam intensity that is authorized. As all system checkouts and safety reviews are now completed, the NuMI facility is physically ready for commissioning with beam, in accordance with AD Policy.

Trained and Qualified Operations and Maintenance Staff Overview

Key management and staff from the NuMI project occupy corresponding positions in the major Lab Divisions and Sections. The Accelerator Division Main Injector Department, NuMI Department and External Beams Department, as well as the Particle Physics MINOS Department all have former NuMI project managers and staff already in place in key management and staff

positions. Conventional facility maintenance is similarly in place, including assigned building managers and operating budgets.

Since the operation and maintenance of most elements of the NuMI Project are similar in nature to the existing elements in the other areas at FNAL, personnel are already trained in the operation and maintenance of most of the Project elements. As noted earlier, a few exceptions exist and the documentation for these elements has been prepared. Personnel have been trained on these procedures specific to NuMI and will continue to be trained on these procedures as they are updated and modified to fit the needs of the program. As part of the FNAL Building Management Program, Building managers have been assigned to the NuMI Facilities. These building managers are developing an understanding and working knowledge of the assigned building and underground systems, their hazards, and day-to-day operation.

The AD Operations Department has a long-standing, well-documented training program for its personnel, consisting of reading materials, videotapes, lectures, walk-arounds, self-assessment quizzes, and on-the-job training (OJT). Operation of the NuMI facility is being integrated into this program as well. FNAL users in the MINOS Collaboration are trained in accordance with the provisions of FNAL *Procedures for Experimenters*. All personnel working in the underground facilities at MI-65 and MINOS sites are required to attend a one hour training course entitled NuMI/MINOS Underground Safety Training. The course includes discussion on facility layout, significant hazards, occupancy requirements, personnel protective equipment requirements, access control procedures, and emergency procedures. Additional training also required prior to working in either facility includes the appropriate radiation training and at the MI-65 facility LOTO II. These training requirements are tied to the ITNA program.

The FNAL Fire Department takes an annual mine rescue training class. The Laboratory's Fire Department personnel are required to familiarize themselves with the layout of the facilities and to understand how to gain access to the area in the event of an emergency. As new FNAL or subcontractor personnel are assigned to work in the NuMI areas, they will be trained on the emergency response procedures and how to summon aid.

Conclusion

The NuMI Project construction and commissioning are complete. Final NuMI Project closeout will occur during Summer 2005. Following Critical Decision 4 we will complete the demobilization of the project, which is already far along. Some documentation will be finalized as part of our experiences during the early months of operation. This includes the final update to the Technical Components Design Report along with the Accelerator Division "Rookie Book" and "Tuning Guide" as well as the "MINOS Training Guide" as needed. We will prepare a lessons learned report. Final financial closeout should be complete this summer. I will report to you when these items have been completed.