OPA (SC-28) Mini-Review Report

Department of Energy/Office of Science Review of the NuMI Off-Axis ν Appearance Experiment (NOνA) Project

Review Date: **May 8, 2012**
Location of Project: **Fermi National Accelerator Laboratory (Fermilab)**
Committee: **7 Members, 5 Observers**
Program Manager: **Ted Lavine**
Federal Project Director: **Pepin Carolan**
Acquisition Executive: **Pat Dehmer, SC-2**
Current Critical Decision: **CD-3**

PROJECT STATUS as of May 8, 2012		
Project Type	MIE / Cooperative Agreement	
CD-1	Planned: 5/2007	Actual: 5/2007
CD-2	Planned: 10/2008	Actual: 9/2008
CD-3	Planned: 3a – 2/2009 3b – 10/2009	Actual: 3a – 10/2008 3b – 10/2009
CD-4	Planned: 11/2014	Actual:
TPC Percent Complete	Planned: 65%	Actual: 64%
TPC Cost to Date	$170.0M	
TPC Committed to Date	$219.3M	
TPC	$278M	
TEC	$204.2M	
Contingency Cost (w/Mgmt Reserve)	$26.6M	29% to go
Contingency Schedule on CD-4b	8 months	33%
CPI Cumulative	0.98	
SPI Cumulative	0.95	

1. SUMMARY

A Department of Energy/Office of Science (DOE/SC) review of the NuMI Off-Axis ν Appearance Experiment (NOνA) project was conducted on May 8, 2012. The review was chaired by Daniel R. Lehman, Director, Office of Project Assessment (OPA). The purpose of this review was to evaluate the current status of the project.

The Committee found that the NOνA project is proceeding well; however, there are two outstanding technical issues that require high-level management attention. The technical issues are: wave shifting fiber damage, and failure of the Avalanche Photo Diodes (APDs). Recommendations from prior reviews have been addressed.

2. TECHNICAL

Accelerator / Beamlines

The Accelerator and NuMI Upgrade (ANU) component of NOνA is not directly on the project critical path. Currently there are 401 days of schedule contingency from "Accelerator Shutdown Complete" to Critical Decision (CD) 4, Approve Project Completion.

ANU work shows a long slide down to Cost Performance Index (CPI), which is 0.8. This was addressed by increasing the labor in CR487. Approximately 20 percent was added to the baseline for the first four months of the shutdown, reducing Management Reserve.

Ceramic beam tube production, which was identified as a project risk since 2006, has been retired.

The Laboratory decision not to reduce the beam intensity leading up to the shutdown delayed start in MI30 by two weeks.

Off-project work is impacting available resources for accelerator upgrade installations. This may add two months to the installation. A detailed installation schedule including both on-project and off-project work has been created. The risk of not having sufficient manpower is one of two project priority risks still remaining.

Radio Frequency (RF) cavity fabrication is a year behind schedule (combination of vendor and technical problems) and over budget. One of the three cavities has been welded but not yet high power tested.

The project is to be congratulated on retiring the technical risk on the ceramic beam tubes. This has been identified as a major risk since 2006. The project now has sufficient ceramic tubes to be assured of success.

The major risk in the fabrication of the RF cavities has been resolved but testing has not been completed so cavity production is still a risk. The project is encouraged to begin working on the engineering for the mitigation plan to ensure that no obstacles exist.

Scheduling of the installation work effort is complex. The project is commended for vigorously working the scheduling of available technician/engineering manpower. Radiation exposure potential is significant and has been thoroughly planned with ALARA considerations. Installation bottlenecks could have schedule impact if not carefully monitored and mitigated. This effort will need to continue throughout the remainder of the project.

The project is cautioned to carefully watch safety during installation; especially when working heavy overtime. This is when accidents occur.

Recommendation

1. Keep the pressure on Laboratory management to provide the needed installation manpower.

Detector

The detector team has continued to make progress since the August 2011 DOE/SC review. The entire production of scintillator waveshifters has been received. About a quarter of the scintillator mineral oil has been received. Differentials between the price of oil from the production source

specified in the contract, and the contractor's source, required a renegotiation of prices between the Renkert Oil and the project. Current prices are covered by the base cost plus contingency assigned for mineral oil acquisition. About 20 percent of the pseudocumene has been received. About ten percent of the final scintillating oil has been blended; storage tanks are nearly full.

About 80 percent of the wavelength shifting fiber is in hand. The option to extend production must be exercise by July, before production is complete in mid-October 2012, about a quarter year later than planned.

Production of 23,000 PVC extrusions started in January 2011. About 45 percent of the resin production is complete, as well as 35 percent of the extrusions. The waste rate is somewhat higher than expected. The cost of the titanium dioxide filler powder has doubled since the bid price.

PVC module production is in two parts: assembly of two extrusions into a module that is trimmed-to-length, and final assembly of that module including fiber, end cap, manifold, and seals, and finished off with a pressure test. The first part is about 30 percent complete. The second part is in the debug-production stage; the production rate is about half of the expected steady state rate. Scrap rates have been high. Enough parts are in hand or in the pipeline so that this is not a limitation on keeping up with the full production rate. The Quality Assurance (QA) processes are all being exercised. Failure rates are down to seven percent, where the goal is two percent. At this stage, the failure rate has no single key mode.

Two shipments of completed modules have been delivered to Ash River. Both module stacks had damaged fibers: 21 percent and 25 percent. All were good leaving the factory. Failures may take place during loading, in transit, and during unloading. An investigation plan testing transport and unloading that includes shock and temperature monitoring is being developed.

The Full Height Engineering Prototype was constructed and, after fill with water, is leak tight. The Far Detector layout was finalized. The South Bookend was installed. Delivery of the Block Pivoter table top, expected in November, was not realized until mid-February. A design flaw in the pivoting section was identified, and successfully dealt with, but at the loss to schedule of an additional month. A survey of flatness indicated a saddle shape flat to +/- 1 inch (specification is +/- 1 cm). A determination of need for shimming will be made soon. Two lifting fixtures, the adhesive dispenser, and the leak tester are available. Safety review for processes and structures at the assembly site will be complete in May. Hiring of the assembly crew is in full swing. The expectation is that by mid-June the headcount will be large enough to populate two shifts. Assembly of the first block should begin in June.

Outfitting of the Ash River site has begun. Hall infrastructure is progressing to completion; most tasks are complete or in progress. More than half of the block outfitting procedures are ready. About half of the balance is almost ready.
A contractor has been selected for the Near Detector cavern excavation and outfitting. The Near Detector horizontal dimensions have been increased by 50 percent to increase performance: the plan is to build the blocks on the Fermilab site. The team intends to reuse the acceptable portions of rejected full length Far Detector extrusions to construct these blocks. About 78 percent of near detector material is thus available now.

The detector assembly will begin in earnest in the next few months. Startup and debug of the block assembly process is expected to be complete after the construction of several blocks. Block assembly is on the critical path. The next six months will be key to determining the course of the project. Considering the technical progress to date, and the status of planning for the remaining activities, it appears that the project will be able to meet its baseline scope objectives. However, success here requires proactive planning of solutions for problems which may arise.

The recommendations from the last independent project review concerning the detector have been addressed.

Management has good understanding of the commodities situation and has responded appropriately to the associated cost challenges.

The decision date for expanding the fiber order is near, requiring prompt resolution of production issues (module assembly and module transport) since it is likely that it will be necessary to expand this order.

The production team is considering acquiring an additional die for PVC extrusion. This would make difficulties with extrusion production less likely to affect the schedule. The Committee encourages this acquisition.

The substantial number of fiber damage problems arising during the transport process is cause for concern and requires prompt attention. It is not clear whether the damage is occurring during loading, transit, or unloading. The team proposes to transport a shipment to Ash River and return it without unloading. The Committee endorsed this and suggested that the loading stage also be checked. An autopsy of the failed modules, to understand the source of the problem and whether the assembly process or design might need modification, should also be performed as soon as possible. In order to understand whether there are any design or construction issues that might cause fiber damage during block filling, the team should conduct filling tests of full size modules as soon as possible.

Though planning for block assembly appears to be in good shape, with the Block Pivoter issues under control, the schedule for block assembly cannot be evaluated until construction of the first few blocks is complete.

Preparations for outfitting the detector appear to be making good progress, as is Near Detector work.

Recommendation

2. Conduct an autopsy of the modules damaged in transport as soon as is possible.

Electronics

Data acquisition and other associated electronics production is proceeding well. In preparation for production, resources for production APD testing and installation appear to be adequate.

APDs remain a critical item. As-delivered APD performance meets or exceeds specifications, in particular with leakage currents considerably lower than specification. Installed APD modules, however, still display a higher than tolerable failure rate. The precise failure mechanism of the APDs is not understood; however, empirical tests show that insufficient sealing of the device leads to failures.

Recently delivered devices are, for the first time, passivated, which appears to be helpful. In order to seal the APDs and prevent contamination-induced breakdown, the team is studying silicone vs. parylene coating.

A dry gas system has been chosen to reduce possible moisture content. A further option is to operate the APDs warm, reducing the possibility of condensation if neither coating is sufficient. To meet performance requirements, light output would need to be increased, and the team has a potential plan to increase light output by 14 percent by modifying the scintillator composition. It is now too late to make changes to the APD (and meet schedule).

The dry gas system appears promising, but has only been in operation for a few weeks.

During FY 2013, 12,000 APDs will be delivered and installed at a rate of roughly 1,000 per month. This will allow an early determination of the most probable installation failure rate. Sufficient spares should be planned for.

Recommendations

3. Prior to starting production, convene an expert review once there are sufficient statistics to justify a coating choice.
4. Once a coating is selected, begin long-term aging studies, including with the dry gas system.

3. COST and SCHEDULE

The Committee determined that the project's plan and performance are consistent with the approved baseline and that remaining costs and schedule contingency are appropriate for the current project risks. However, the Committee was concerned that without continued diligent cost and schedule contingency management, the remaining contingency may be insufficient to complete the project. The project responded satisfactorily to the recommendations from the previous independent project reviews.

At this time, the NOvA project is approximately 65 percent complete. Cost and schedule performance to date is satisfactory. The Basis of Estimate has been recently revised. Based on the latest revised estimate, a total of $19 million cost contingency remains with only $2.1 million still unassigned; the balance being assigned to existing project risks. The Committee is concerned that the remaining $2.1 million may be insufficient to address unforeseen project risks. Since August 2011, schedule contingency has decreased from ten months to eight months as the project addressed delays in RF cavity production, initiated detector module production, and addressed APD performance issues.

Critical production and assembly activities have been recently initiated and performance trends are uncertain. The Committee noted that the next six months will be critical in determining project success.

Recommendations
None.

4. MANAGEMENT

The Committee noted that the project team has been working well with vendors. The RF cavity work is one year behind schedule and over budget; however, the project team felt that the electron beam welding being used will resolve this issue. The project team also felt that most of the major issues with the RF cavities have been addressed in the fabrication of the first cavity.

The Committee was informed that one of the issues increasing cost with the accelerator (ANU) work is competition with trades' personnel (pipe fitters). The project implemented a 60-hour work week to keep personnel on the project.

The ANU shutdown coordination appears well-planned and rigorous.

The Committee judged that the proper management resources are adequate to deliver the project within the existing baselines. However, the project team must remain vigilant to ensure that all the known (and unknown) challenges are being addressed in a timely manner.

The Committee noted that project team has implemented a structured readiness/operations process for production activities. It was also determined that the module production rate is improving.

The Committee strongly believed that the project team needs to more quickly understand and act expeditiously in resolving major issues. The two most significant issues at the time of the review were: 1) the APD issue, which requires timely resolution; and 2) the project needs to fully evaluate and understand the fiber damage issues.

Recommendations
5. Initiate discussions during the weekly HEP/Fermilab conference call with specific detail on the APD and fiber damage issues, status, and path forward.
6. Schedule a mini-review in three months on major issues such as:
   a. APD coating issue.
   b. Fiber integrity during transportation, assembly and filling of the modules.

Department of Energy
Washington, DC 20585

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MEMORANDUM FOR DANIEL LEHMAN, DIRECTOR,
OFFICE OF PROJECT ASSESSMENT

FROM: MICHAEL PROCARIO, DIRECTOR
FACILITIES DIVISION
OFFICE OF HIGH ENERGY PHYSICS

SUBJECT: Request to Conduct Independent Project Review of the NOvA Project

I am writing to request that you conduct a review of the status of the NOvA Project on May 8-9, 2012 at Fermilab.

The major remaining NOvA Project activities include, but are not limited to: (a) installation of accelerator and NuMI upgrade components during the accelerator shut-down starting in May 2012; (b) production of PVC extrusions; (c) assembly of the extrusions into detector modules in Minneapolis; (d) assembly of the modules into detector blocks at Ash River; (e) fabrication of the Avalanche Photo-Diode electronics system; (f) delivery of the liquid scintillator, waveshifter and optical fiber; and (g) construction of the underground detector cavern at Fermilab. As part of assessing the project's status and identifying potential issues with the remaining activities, your committee should address the following specific items:

1. Technical: Are the accomplishments to-date and remaining activities as planned sufficient to meet baseline scope objectives?
2. Baseline Cost and Schedule: Is project's plan and performance consistent with the approved baseline? Are remaining costs and schedule contingency adequate for the risks?
3. Management: Are the management resources adequate to deliver the project within specifications, budget and schedule, including management and mitigation of remaining technical, cost and schedule risks?
4. Has the project responded satisfactorily to the recommendations from the previous independent project review?

As Program Manager for the NOvA Project, Dr. Theodore Lavine will serve as the Office of High Energy Physics contact person for this review.

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We appreciate your assistance in this matter. As you know, these reviews play an important role in our program. I am looking forward to your Committee's report.

Michael Procario
Director, Facilities Division
for High Energy Physics

cc: Patricia Dehmer, SC-2
James Siegrist, SC-25
Theodore Lavine, SC-25
Alan Stone, SC-25
Pepin Carolan, Fermi Site Office
Mike Weis, Fermi Site Office
Pier Oddone, FNAL

DOE/SC Review of the
NuMI Off-Axis Neutrino Appearance (NOνA) Experiment
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REVIEW COMMITTEE PARTICIPANTS

Department of Energy

Daniel R. Lehman, DOE/SC, Chair

Review Committee

SC 1—Accelerator and Beamlines
*Pat den Hartog, ANL

SC 2—Detector
*Bill Wisniewski, SLAC

SC 3—Electronics
*Peter Denes, LBNL

SC 4—Cost and Schedule
*Ethan Merrill, DOE/SC
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Observers

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Brian Huizenga, OECM

Appendix C:
Review Agenda

Department of Energy Review of the
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AGENDA

Tuesday, May 8, 2012—Fermilab, Wilson Hall, The Comitium

7:30 am	DOE Executive Session ..... D. Lehman
8:00 am	Welcome ..... P. Oddone
8:05 am	Project Summary Assessment ..... J. Cooper
	• Technical Status
	• Cost, Schedule, EVM and Milestone Performance
	• Contingency Assessment
	• Response to Recommendations from Previous Review
9:15 am	Break
9:30 am	Accelerator and NuMI Upgrades ..... P. Derwent
	• FY2012 Shutdown—Status of installation readiness, plan and progress
10:30 am	Detector Module Production……...K. Heller
10:50 am	Far Detector Assembly Status & Schedule…… ..... P. Lukens
11:10 am	Detector Electronics/DAQ……..….L. Mualem
	• APD/Other Electronics/DAQ issues, status and plans
11:40 am	Far Detector Outfitting Status & Schedule ..... R. Tesarek
12:00 pm	Lunch
12:30 pm	DOE Executive Session, Close-Out preparation ..... D. Lehman
2:00 pm	Closeout
3:00 pm	Adjourn

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