

Closeout Report

on the

*Department of Energy
Review Committee Report*

on the

review of

**NuMi Off-Axis Neutrino
Appearance (NOvA)
Experiment**

**(One of the Proposals for the Electron Neutrino
Appearance (EvA) Detector)**

April 4-6, 2006

memorandum

DATE: January 24, 2006

REPLY TO

ATTN OF: SC-25

SUBJECT: Request to Conduct a CD-1 Review of the NOVA Project.

TO: Daniel R. Lehman, Director, SC-1.3

The NuMI Off-Axis Neutrino Appearance (NOVA) Experiment is one of the proposals for the Electron Neutrino Appearance (EVA) Detector. I would like to request that you conduct a CD-1 Review of the NOVA proposal on April 4-6, 2006 at Fermi National Accelerator Laboratory. The purpose of this review is to validate the conceptual design and the cost range, which are needed for Critical Decision 1, Approval of Alternative Selection and Cost Range.

The NOVA project proposes to utilize the existing NuMI beamline and construct two new detectors optimized to detect electron neutrino interactions in order to observe the oscillation of muon neutrinos into the electron neutrinos and measure the parameters of that oscillation. One detector would be located on the Fermilab site and one would be approximately 800 kilometers away in a site to be determined in northern Minnesota.

In performance of a general assessment of progress, current status, and the identification of potential issues, the committee should address the following specific items:

1. Does the conceptual design satisfy the performance requirements?
2. Does the conceptual design report and supporting documentation adequately justify the stated cost range and project duration?
3. Does the proposed project team have adequate management experience, design skills, and laboratory support to produce a credible technical, cost, and schedule baseline?
4. Are ES&H aspects being properly addressed and are future plans sufficient given the projects current stage of development?
5. Is the documentation required by DOE O 413.3 in order and ready for Approval of CD-1?

Michael Procaro is the program manager for the EVA Detector Project in this office and will serve as the Office of High Energy Physics (OHEP) contact person for this review.

We appreciate your assistance in this matter. As you know, these reviews play an important role in our program. I look forward to receiving your Committee's report. You are asked to submit a formal report to OHEP within in 60 days of the review.

Robin Staffin /signed/
Associate Director
Office of High Energy Physics

cc: Ray Orbach, SC-1
James Decker, SC-2
Joanna Livengood, SC-FSO
Pier Oddone, FNAL
AesookByon-Wagner, SC-25

REVIEW COMMITTEE PARTICIPANTS

**Daniel R. Lehman, DOE,
Chairperson**

SC1

Scintillator

- * Bill Louis, LANL
Richard Hahn, BNL

SC2

Mechanical and Assembly

- * Bill Wisniewski, SLAC
Steve Kane, BNL
Martin Nordby, SLAC

SC3

Trigger and Data Acquisition

- * Klaus Honscheid, OSU
Gunther Haller, SLAC

SC4

Civil Construction

- * Jack Stellern, ORNL
Marty Fallier, BNL

SC5

Cost, Schedule, and Funding

- * Mark Reichanadter, SLAC
Rick Korynta, TJNAF
Steve Tkaczyk, DOE/SC

SC6

Management

- * Murdock Gilchriese, LBNL
Randy Ogle, ORNL
Barry Miller, Consultant
[Mark Reichanadter, SLAC]

Observers

Robin Staffin, SC-25
Aesook Byon, SC-25
Mike Procario, SC-25
Steve Webster, FSO
Ron Lutha, FSO
Joanna Livengood, FSO

LEGEND

- SC Subcommittee
- * Chairperson

Count: 16 (excluding observers)

**Department of Energy
NOVA Experiment Review at Fermilab**

DRAFT AGENDA

Tuesday, April 4, 2006—Wilson Hall Bldg.—Comitium

8:00 am	DOE Executive Session	D. Lehman
9:00 am	Welcome and Laboratory Overview— One West	P. Oddone
9:10 am	Scientific Performance Requirements.....	G. Feldman/or M. Messier
9:25 am	Project Overview	J. Cooper
10:10 am	Break	
10:40 am	Project Cost Drivers	R. Ray/R. Cibic
10:55 am	Site and Building.....	S. Dixon
11:20 am	Scintillator.....	S. Mufson
11:50 am	Fiber	C. Bromberg
12:05 pm	Lunch	
1:05 pm	PVC and Extrusions.....	R. Talaga
1:25 pm	Extrusion Modules.....	K. Heller
1:40 pm	Electronics and DAQ.....	L. Muallem
2:10 pm	Near/Far Detector Assembly.....	D. Ayres
2:40 pm	Cost and Schedule Range.....	J. Cooper
2:55 pm	Cost and Schedule Methodology	W. Freeman
3:10 pm	Break	
3:25 pm	Subcommittee Breakout Sessions	
	• Site and Building— Blackhole	
	• Commodities—Scintillator, Fiber, and PVC— One North	
	• Extrusion Module Production— Snakepit	
	• Electronics and DAQ— Racetrack	
	• Far and Near Detector Assembly— One East	
5:00 pm	DOE Executive Session— Comitium	D. Lehman
6:00 pm	Adjourn	

Wednesday, April 5, 2006

8:00 am	Subcommittee Breakout Sessions	
	• Site and Building— Blackhole	
	• Commodities—Scintillator, Fiber, and PVC— One North	
	• Extrusion Module Production— Snakepit	
	• Electronics and DAQ— Racetrack	
	• Far and Near Detector Assembly— One East	
	• Management, Cost and Schedule— Comitium	
10:00 am	Break	
10:15 am	Subcommittee Breakout Sessions, Con't	
12:00 pm	Lunch	
1:00 pm	Subcommittee Breakout/Working Session	
3:00 pm	DOE Full Committee Executive Session— Comitium	D. Lehman
6:00 pm	Adjourn	

Thursday, April 6, 2006

8:00 am Subcommittee Working Sessions—**1 North**
10:00 am DOE Full Committee Executive Session Dry Run—**1 North** D. Lehman
12:00 pm Working Lunch
2:00 pm DOE Summary and Closeout—**One West**..... D. Lehman
3:00 pm Adjourn

**Department of Energy Review of the
NuMI Off-Axis Neutrino Appearance (NOvA) Experiment at Fermilab**

REPORT OUTLINE/WRITING ASSIGNMENTS

Executive Summary.....	Tkaczyk
1. Introduction	Procario
2. Technical	
2.1 Scintillator.....	Louis/Subcommittee 1
2.1.1 Findings	
2.1.2 Comments	
2.1.3 Recommendations	
2.2 Mechanical and Assembly	Wisniewski/Subcommittee 2
2.3 Trigger and Data Acquisition.....	Honscheid/Subcommittee 3
3. Conventional Construction.....	Stellern/Subcommittee 4
4. Cost Estimate.....	Reichanadter/Subcommittee 5
5. Schedule and Funding.....	Reichanadter/Subcommittee 5
6. Environment, Safety and Health	Ogle/Subcommittee 6
7. Procurement.....	Miller/Subcommittee 6
8. Management	Gilchriese/Subcommittee 6

Appendices

- A. Charge Memorandum
- B. Review Participants
- C. Review Agenda

2.1- Scintillator and Fiber

Bill Louis and Dick Hahn

2.1.1 Findings

- Committee was impressed with the competence, depth of knowledge, and extensive experience of the scintillator team in doing physics with liquid scintillators (LS) and wavelength-shifting (WLS) fibers.
- Experience was obtained in previous successful neutrino experiments, such as MINOS, NuTeV, and MACRO.
- The team has excellent conceptual designs that satisfy the NOvA performance requirements for:
 - the composition and preparation of the LS and the WLS fibers
 - the blending of the components of the LS in multi-ton amounts at FNAL, the testing and QA of the final LS mixture, the transport to the far-detector site, and the loading of the detectors at the far and near sites.
- The team is properly addressing ES&H issues, with attention given to key issues, such as fire prevention and prevention of LS release into the environment.
- The present cost & schedule estimates seem reasonable and are based on quotations from oil and fiber vendors.

2.1.2 Comments

- The conceptual designs presented for fiber and especially for LS are much more thorough and detailed than are required for CD-1.
- Further R&D is required over the next year to finalize the specifications for the WLS fibers.
- The fiber delivery schedule is on the critical path, so it is prudent to explore proposals from more than one vendor.
- For future CD-2 and CD-3 reviews, it will be useful to follow through on the following actions:
 - 1) Perform aging tests on prototype extrusion cells with the LS and the WLS fibers, as soon as the specs for all the materials have been finalized.
 - 2) Periodically check the attenuation length and light output of archival LS-WLS samples as a function of time.
 - 3) Determine plans for clean up of spills of a few gallons or more at the near and far detector sites and at each location where the LS is being handled and blended, including the transport and transfer of the organic liquids.

2.1.3 Recommendations

The Committee recommends approval of CD-1.

PVC Extrusions

Comments:

The committee commends the team's approach to extrusion procurement:

- optimization of the resin for mechanical and reflective properties with the help of a PVC expert.
- engagement with vendors to develop extrusion production.

We suggest that the team:

- complete an evaluation of the tradeoffs between the choice of 16 cell versus 32 cell extrusions.
- give higher weight to PVC mixtures that are easier to extrude consistent with acceptable physics performance.
- complete evaluation of transverse as well as longitudinal PVC extrusion material properties.
- use the 16 cell extrusions to develop the quality assurance plan (need for ultrasonic or weight inspection, and/or thickness measurements at the extrusion ends good enough?).
- document in the CDR in more detail the structural analyses showing the minimum material thicknesses are adequate.

PVC Extrusions

Comments (cont'd):

We note that:

- the cost, cost basis, and contingency estimate and schedule appear reasonable.
- the task manager shows good connection to the schedule.

Recommendations:

- Ready for CD-1 approval.

PVC Modules

Comments:

The committee commends the team for their effort and progress so far, and comments that:

- labor estimates for module assembly appear lean.
- although 100% contingency on labor for assembly seem high, the time allotted for the tasks appear tight, so the high contingency is justified.
- more engineering effort needs to be focused on module assembly time and motion studies.
- consider increasing the number of bridge cranes to one per assembly cell; include stops to limit trolley travel in each cell.
- consider scissor tables, etc., for module movement and assembly.
- design tooling to clamp the end plug manifold and bottom plate to the extrusion during gluing.
- evaluate and define the epoxy for vertical curing.
- methodology for the cost estimate appears adequate.
- the task manager shows surprisingly good connection to the schedules.
- manpower appears to be adequate to get to CD-2. The team realizes the need to hire the first factory manager soon.
- structural analysis support appears somewhat thin.
- the team should evaluate the engineering manpower profile between the R&D and production phases for continuity.

PVC Modules

Recommendations:

- Ready for CD-1 approval.
- Revisit the time and motion studies for module assembly using experience gained with 16 cell extrusions.
- Perform an ergonomic assessment for module assembly, in particular the manual trolley crane movement.
- Design the fiber retainer to maintain fiber bend radius for filling and during transportation.
- Develop a plan for use and maintenance of the vacuum lifters.

Near & Far Detector Assembly

Comments:

The committee notes that:

- very good progress has been made on the Far Detector.
- Near Detector design did not seem as far advanced.
- the cost estimate appears credible.
- the installation schedule and manpower is well developed and credible.
- the task manager shows good ownership of the schedule.

The committee suggests that the team:

- evaluate the need for edge stiffeners.
- consider leasing a roll coating machine for the prototype effort.
- develop detailed procedures for filling the modules to assure proper process and sequence. There should be no confusion regarding filling order.
- complete the life safety evaluation, to include Near Detector containment.
- use of a consultant to assist in the evaluation of scintillator handling is a good step by the team.

Near & Far Detector Assembly

Recommendations:

- Ready for CD-1 approval.
- Develop designs for strain relief of utilities on modules.
- Develop designs for access to install utilities on the top and sides of modules blocks.
- Develop a plan for use and maintenance of the vacuum lifters.
- Reinforce systems engineering team at the project management level for control of interfaces.
- Evaluate filling operations for static electricity hazards.
- Develop a more robust plan for sensing liquid level during detector filling.

2.3:

**Electronics
DAQ**

**(WBS x.6)
(WBS x.7)**

**Gunther Haller
Klaus Honscheid**

Findings and Comments

- Experienced team
- No technical show stoppers
- Detailed designs available for most components.
- Finalize the analysis to show whether the far-detector electronics will work for the near-detector.
- Reliability requirements should be established (e.g. TE cooler)

2.3:

**Electronics
DAQ**

**(WBS x.6)
(WBS x.7)**

**Gunther Haller
Klaus Honscheid**

Findings and Comments (cont.)

- Review material (WBS, BOE etc) sufficient for CD-1.
Some more work needed for CD-2.
- Some activities need to be added/completed:
Slow Control, Data Flow, (Electronic) Calibration
- Overall, cost and schedule seem to be credible.

2.3:

**Electronics
DAQ**

**(WBS x.6)
(WBS x.7)**

**Gunther Haller
Klaus Honscheid**

Recommendations

- Include off-project labor (e.g. physicists) to be able to review the man-power resource estimates.
- Consider adding manpower to the software effort soon in order to meet the presented schedule.
- The sub-committee recommends CD-1 approval.

3.0 Civil Construction

Jack Stellern, ORNL

Marty Fallier, BNL

3.1 Findings

- The project team has developed a conceptual design for the site and building at the proposed Ash River site.
- A bottoms up estimate has been prepared by the project team.
- The contingency was assigned using guidance from the DOE cost estimating guide.

3.1 Findings (con't)

- The schedule has been developed by the project team but does not reflect the recent decision to use a design build contract strategy.
- An AE will be hired to evaluate the schedule and prepare an independent cost estimate.

3.1 Findings (con't)

- An AE will be used to prepare the 30% design package. The schedule shows the 30% design starting in October '06 and completing in January '07.
- DOE plans to award a cooperative agreement with a third party to award and cooperatively manage the design build contract for the facility.
- The risk assessment was documented in the CDR.

3.2 Comments

- The plan to use an AE to do an independent review of the conceptual design estimate and schedule is commendable.
- The schedule should be revised to reflect the proposed design build contracting method.

3.2 Comments (con't)

- Perform a comprehensive risk assessment prior to CD-2.
- A contingency analysis should be done based on identified project risks. A Monte Carlo analyses methodology should be used to evaluate the adequacy of the contingency.

3.2 Comments (con't)

- The 3 meter rock overburden on the Ash River building has a cost impact of \$6M - \$7M on the cost of the facility. This should be evaluated in more detail to determine if a more cost effective alternative could be found.

3.3 Recommendations

- Recommend approval of CD-1.

Cost Estimate - Findings

- The project team presented a TPC range between \$197MAY and \$256MAY for the NOvA project. The 'most likely' estimate was \$247M (AY\$) which includes 35% (~\$64M) contingency.
- The TPC range is fully burdened including G&A rates, fringes, etc., for all institutions at their respective rates.
- The project's cost and schedule estimates were presented down to WBS level 5 in most areas. Quotations and other pricing are in FY06 dollars.
- Project Office will centrally manage the project controls software (Open Plan and COBRA).

Cost Estimate - Comments

- The committee found the cost estimate to be well-advanced for this stage of the project. TPC range of \$197MAY-\$256MAY is reasonable.
- The NOvA location and acquisition plan are not yet finalized. The IPT should work aggressively to finalize these decisions as soon as possible. These key decisions will help to clarify uncertainties on the cost estimate and schedule (critical path) and should be given the highest priority.
- Overall, the NOvA project is made up of only a small number of systems and procurements. Areas of cost risk:
 - Scintillator and PVC - Tied to volatile oil prices.
 - Wavelength-shifting fiber - Single vendor recently increased price ~60% from earlier estimates. Quote now in hand (good!), but there remain currency and single vendor risks. Work to draw in alternate vendors.
 - Site improvements and Building – Design/Build strategy is proposed. Ensure that the science requirements are clearly identified and confirmed with collaboration. Consider a GMP at the end of the design phase.

Cost Estimate - Comments

■ Additional areas of cost risk:

- Integration – Emphasize early prototyping of the Near and Far Detectors to ensure defects (or value engineering) are identified early on.
- Quality Control/Dbase Mgmt – Many parts repeated >20,000 times. May need to add staff, testing and documentation
- Include appropriate number of spares to account for infant mortality (electronics) and breakage/defects to achieve CD-4.

■ Good methodology of contingency. Assessment is reasonable in most areas. Repeat prior to CD-2 incorporating decisions on the site location, building and acquisition strategy in the assessment. Review 100% contingency assessment on integration labor.

■ The detailed BOE (not necessary for CD-1), was not fully documented. Will need comprehensive BOE for CD-2.

Cost Estimate - Comments

- Project Office Staffing – Off-project responsibilities for key configuration and QA staffing should be reevaluated prior to CD-2.

Cost Estimate - Recommendations

- **Reassess contingency on entire project after finalizing the building acquisition plan and siting.**
- **Recommend CD-1 approval.**

Schedule & Funding - Findings

- The project team presented a schedule range between 45 and 58 months for the NOvA project. The 'most likely' estimate was 50 months for a 25kT detector.
- The project team has also identified a scope range between 25kT and 34kT for a fixed TPC of \$247MAY.
- The NOvA schedule is contained in ~3500 integrated activities in Open Plan.
- CD-4 dates and definitions have been proposed at WBS L1 and L2.

Schedule & Funding - Comments

- The committee found the 50-month schedule for a 25kT detector to be reasonable at this stage of the project. Schedule will dilate with mass.
- The proposed DOE – TBD cooperative agreement for the building siting and construction appears to be on the project critical path. Exact siting and acquisition strategy will be needed at CD-2.
- Environmental and seasonal construction risks should be well defined prior to CD-2.
- Major material procurements are a key schedule risk. Appear to be well advanced and delivery schedules tie in well with integration tasks.
- CD-4 dates and definitions have been proposed at WBS L1 and L2.
- No FTE estimates or manpower profiles provided. Will be needed at CD-2.
 - Include physicists and communicate with lab management.
- Integration tasks are well developed and under capable management for CD-1.

Schedule & Funding - Comments

- A rough funding profile was derived by the project team from the AY\$ cost and schedule.
 - Adequacy of R&D - PED funding in FY07 is dependent on resolution of acquisition strategy.
 - FY08 funding assumes construction funds which requires CD-2 approval.

Schedule & Funding - Recommendations

■ Recommendations:

- Ready for CD-1

6. ENVIRONMENT, SAFETY AND HEALTH(R. Ogle)

Findings and Comments

- The ES&H aspects of NOvA have been adequately addressed for this stage of the project.
- NOvA management and staff have included safety in work planning, ISM
- ES&H Documentation:
 - a. Environmental assessment documentation is well planned, including planning for Minnesota Environmental Worksheet with documented ownership by the University of Minnesota
 - b. NEPA documentation for construction is completed
 - c. A substantial Preliminary Hazard Analysis has been drafted and forms a good basis for future safety documentation
 - d. The schedule for completion of ES&H documents before CD-2 is reasonable.

Recommendations

- Include ES&H criteria in selection of mineral oil if a “mildly refined” of mineral oil is considered.
- Determine the impact of DOE 10 CFR 851, Worker Safety and Health Program, on the project. This rule codifies, with enforcement, the DOE worker protection program and is effective February 2007.

7. Procurement(B. Miller)

FINDINGS:

- NoVA project procurement activity is estimated at \$150 million, ~ 70% of the TPC.
- Significant progress on procurement support for this stage. Contracts are in place for:
 - prototype 16 cell extrusions,
 - 25,000 meters of wavelength shifting fiber,
 - dual sourced mineral oil orders with options valued at \$21 million,
 - wave shifter procurements with options are ready for award when final technical evaluations are complete.
- Project management knowledge of cost drivers, schedule challenges, and technical issues surrounding procurement activity is exemplary and management is aggressively working these challenges in a proactive manner.
- NoVA management staffs are involved with DOE in establishing critical milestones and controls for the collaborative agreement to support conventional facility operations. Import duties and exchange rate information are addressed on significant foreign procurements, but require further refinement.

COMMENTS:

- Project management is commended for efforts to get formal business prices to support cost estimates on key procurement activity.
 - Reduces cost risks to the project and positions NoVA to provide DOE with credible cost information to support upcoming CD-2 requests.
- Procurement personnel are placing prototype and initial orders with cost escalation indexes and options for follow on quantities.
- Need to formalize addressing potential exchange rate fluctuations in business practices.
- Import duty exemptions may be possible for the significant foreign procurements.

RECOMMENDATIONS:

1. Pursue potential import duty exemptions on major foreign procurement activities in support of NoVA prior to finalizing and placing obligating business documents.
2. Continue ensuring project personnel work closely with procurement personnel to quantify costs on major procurements prior to CD-2 submission.

8. MANAGEMENT(M. Gilchriese)

Findings

- Conceptual Design Report completed.
 - Physics requirements clearly stated
 - Technical solutions that meet requirements well described. Alternatives studied.
 - Preliminary optimization of design completed.
- Cost range of \$197-256M is credible.
- Schedule range of 45-58 months is credible.
- Far assembly building on critical path.
- Project management team functioning well.
- R&D plan in place. Critical resources identified.
- Drafts of the Preliminary Project Execution Plan and Acquisition Strategy require completion.
- Timeline for reaching critical decisions (eg. CD-2) understood.

Comments

- DoE input needed to complete all documents necessary for CD-1 approval.
- NOVA Project Manager needs to add staff (eg. for monthly reporting and QA) in the next months.

Recommendations

CD-1 approval is recommended upon receipt of final documentation.

An overall project funding profile and a mechanism for the design and construction of the far assembly building must be established by DoE and NOVA to proceed to CD-2.