Office of High Energy Physics
Office of Science

CD-2, Approve Performance Baseline for the NOνA Project

A. Purpose

The purpose of this paper is to document the review by the Office of Science Energy Systems Acquisition Advisory Board-equivalent for the critical Decision "Approve Performance Baseline (CD-2)" for the for the **N**uMI **O**ff-axis electron neutrino (ν_e) **A**ppearance (NOνA) Project.

B. Mission Need

Among the currently known elementary particles, the least well understood is the neutrino. The NOνA experiment will enable study of the structure of the pattern of neutrino masses and the details of neutrino mixing by using the Neutrinos at the Main Injector (NuMI) facility at Fermilab to provide an intense flux of neutrinos to a large new detector in Northern Minnesota. A coordinated neutrino program developed from an American Physical Society joint HEPAP/NSAC advisory subpanel review includes the NOνA detector. The National Academy of Sciences "EPP2010" report recommended a diverse HEP program using a variety of tools to attack the exciting opportunities in elementary particle physics, including a staged internationally coordinated program in neutrino physics. One of those opportunities, the observation of electron neutrinos from a muon neutrino beam, can be met by this project with a new detector optimized to detect electron neutrinos, namely the NOνA detector. The CD-0 Mission Need for an Electron Neutrino Appearance experiment was approved by the Director of the Office of Science, Raymond L. Orbach, on November 22, 2005. The proposed NOνA experiment has been selected to meet that mission need

C. Project Performance Scope Baseline

The NOνA project consists of a small "near" detector located at the Fermilab site; a much larger 14, 000 ton "far" detector located in Ash River, Minnesota; a detector enclosure for the far detector; and accelerator and NuMI beamline upgrades to increase beam power to 700 kW and operate in the medium energy neutrino configuration to provide the intense neutrino flux to the NOνA far detector. The near detector measures how many neutrinos are in the beam before it leaves Fermilab, while the far detector looks for the muon to electron neutrino oscillation. The far detector will be constructed from alternating planes of vertical and horizontal cells of liquid scintillator contained in rigid polyvinyl chloride (PVC) extrusion modules, and includes optical fiber, electronics and data acquisition systems for signal and data processing and analysis. The far detector enclosure will be

sized to accommodate a slightly larger mass detector, should project performance enable an increase in the detector mass.

D. Project Performance Cost and Schedule Baseline

The Total Project Cost (TPC) is $278M, with a scheduled completion of November 2014. The planned resources from the DOE SC OHEP to support the performance baseline are listed below, subject to the annual Federal appropriations process.

Table 1. Planned Budget Authority Profile For Performance Baseline ($ in Millions)

AY $M	Prior Yrs FY 06-07	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	Total
TEC	1.00	0	7.00	34.00	62.00	51.24	32.08	187.32
OPC	15.86	1.60	30.00	34.00	9.22	0	0	90.68
TPC	16.86	1.60	37.00	68.00	71.22	51.24	32.08	**278.00**

NOTE: Rgarding FY2008 funding, the FY2008 Supplemental Funding appropriation has provided funding of $9.5 M for the NOvA Project. The project plan has not yet been revised to incorporate this funding into the baseline. The current project plan reflects the FY2008 Omnibus funding and this plan has been fully reviewed and endorsed by DOE independent and external project reviews as a valid and appropriate baseline. The FY08 Supplemental funding will be used to advance the project schedule against the baseline plan.

The table includes MIE funding, which is the majority of funding and represents a Total Estimated Cost (TEC), as well as operating funds to cover Other Project Costs (OPC). The TEC is all of the MIE funded equipment, detector and accelerator fabrication costs, which is the majority of the project. The OPC covers operating funded project Research & Development (R&D), operating activities, and the far detector experiment enclosure construction under a DOE Cooperative Agreement with the University of Minnesota. The split between the TEC/OPC/Cooperative Agreement funding will be managed and adjusted by the NOνA Program and Project Management and OHEP as needed for optimal benefit to the project, while maintaining the TPC.

The project will respond to risks or opportunities arising from changes to the DOE funding profile, employing mitigation strategies if funding is reduced or delayed, or working to advance the project schedule if funding is increased in any given year.

The following list is the baseline schedule of critical decision dates for the NOvA Project.

Schedule	Completion, (A) = Actual
CD-0 Approve Mission Need	November, 2005 (A)
CD-1 Approve Alternative Selection and Cost Range	May, 2007 (A)
DOE Cooperative Agreement awarded	September, 2007 (A)

CD-2 Approve Performance Baseline	October, 2008
CD-3A- Project Start (site access road + procurements)[1]	February, 2009
CD-3B Approve Start of Construction	October, 2009
CD-4 Approve Start of Operations/Project Completion	November, 2014

E. Performance Baseline Reviews

In the Fall of 2007, the project completed DOE Independent (Office of Science/Office of Project Assessment) and External Independent (Office of Engineering and Construction Management) Reviews in support of approval of the project baseline and CD-2 validation. In late December 2007 Congress passed the FY2008 Omnibus budget, which reduced DOE Science and High Energy Physics budgets for specific DOE Science project work, including NOνA. The project adjusted the baseline plan within a subsequently revised funding profile (Table 1) and schedule, to support project continuation in FY2009. The revised performance baseline incorporated the project's response to the Independent and External Independent review recommendations and findings.

The revised performance baseline was reviewed in late April 2008 in a DOE Independent review, and in June-July 2008 in a supplemental External Independent review. The Independent review concluded that all the findings from the previous reviews have been addressed and documentation has been updated and is essentially ready for CD-2 approval. The supplemental External Independent review closed all major findings and concluded the revised project planning and documentation is sufficient for CD-2.

F. Project Controls and Reporting Systems

Cost, schedule and technical performance will be monitored using an earned value process that is described in the Fermilab Earned Value Management System document, and a NOνA-specific document for implementation. The NOνA Project will participate with Fermilab in the DOE EVMS certification process, as agreed to with DOE OECM and the SC Office of Project Assessment (OPA). The Change Control process is documented in section 7 of the Project Execution Plan. The Federal Project Director (FPD) will provide quarterly reports on the project to the Acquisition Executive, the OPA, and the HEP Program Office; and provide monthly updates to the Project Assessment and Reporting System (PARS).

The NOνA Project Manager will provide the FPD formal monthly reports. The core integrated project team (IPT) meets regularly (weekly) and as needed to support successful project execution. In addition, the Fermilab Associate Director of Research will convene regular NOνA Project Management Group meetings to monitor and support project progress. Cooperative Agreement (CA) activities by the University of Minnesota are subject to the terms and conditions of the CA, and implementation of an MoU between Fermilab and the University of Minnesota, including reporting requirements.

[1] The Project Execution Plan delegates approval of CD-3(A/B) and CD-4 to the Associate Director of High Energy Physics.

Reviews of the project status are anticipated to be conducted by the SC Office of High Energy Physics and OPA on an annual basis.

G. Acquisition Strategy

The NOνA project is being executed under an Acquisition Strategy (AS) approved by the Acquisition Executive (AE). Fermi Research Alliance, LLC/Fermilab has been chosen to lead the project based on the need to deeply involve the collaborating physicists to participate in the design and construction, and to simplify the interfaces of the project to the rest of the Laboratory. Procurement of the wide variety of components and materials needed to support fabrication and assembly of the accelerator and NuMI upgrades and the near and far detectors will be made using Fermilab's extensive in-house capabilities and the capabilities of institutions participating in the scientific research collaboration. The primary source of materials for these projects will be commercial vendors vying for purchase orders under competitive conditions. Several components will be provided by universities. In addition to the AS, NOνA has prepared a detailed Acquisition Plan for the critical procurements that has been concurred on by the DOE FPD and the Fermi Site Office Contracting Officer, per DOE O 413.3A.

A Cooperative Agreement (CA) awarded to the University of Minnesota by DOE and administered by the Chicago Office includes both a portion of the NOνA TPC (for site preparation, access road upgrade and construction of the far detector experiment enclosure) as well as subsequent research activities. The University will manage these activities using the same methods and personnel it uses for its other civil construction activities, and an MoU between Fermilab and the University of Minnesota addresses the integration and coordination needed for execution of authorities among the parties, communication mechanisms between the Project and University, work authorization and flow, and overall implementation of the CA as it relates to the NOνA project.

H. Environmental Strategy

An Environmental Assessment (EA) required under NEPA evaluates the potential for environmental impacts associated with the full NOνA Project, including proposed construction or upgrade and operation of facilities for NOνA at Fermilab and its far detector facility located at Ash River, MN. Although not strictly required by MN state law, the University of Minnesota prepared a discretionary Environmental Assessment Worksheet (EAW) for State review in accordance with the State of Minnesota environmental review process, and this process concluded that the project does not have the potential for significant environmental impacts and does not require an environmental impact statement. The federal EA incorporates the Minnesota EAW by reference, and addresses all federal requirements specified under the NEPA process for both the Fermilab and MN sites. DOE/CH, Fermi Site Office, Fermilab/ NOνA and the University of MN coordinated closely with the MN State Historic Preservation Office, National Park Service, U.S. Army Corp of Engineers, MN tribal organizations and other State and Federal entities necessary to complete the NOνA EA in accordance with the NEPA process. The NOνA EA was distributed for Federal, State and Public comment. A

"Finding of No Significant Impact" determination has been made and documented to bring the NEPA process to conclusion.

I. Safety & Health

Safety in the execution of NOνA Project work is accomplished through the implementation of Integrated Safety Management systems and Worker Safety & Health programs at DOE sites (Fermilab and ANL), and adherence to applicable institutional ES&H regulations and requirements. ES&H interfaces with institutions are addressed through an MOU process and for all project work at institutions, compliance with OSHA, State, University, and local ES&H regulations and procedures is required.

The NOνA Project will be responsible for fabrication and assembly of the far detector in the newly constructed building, and a cooperative and closely coordinated approach to this work will be implemented. This is specifically addressed in the MoU between Fermilab and the University of Minnesota. Once the far detector is completed and the NOνA Project closed out, the University of Minnesota will be implementing its management procedures through a Far Detector Laboratory organization, similar to that used to successfully operate the existing MINOS detector at the Soudan Underground Laboratory.

J. Hazard Assessments

The NOνA Project work is unclassified and does not include any category 1, 2, 3 or below nuclear facilities as defined in 10 CFR 830 subpart B. Hazard Analysis documentation for NOνA Project work has been prepared using a standardized hazard identification and assessment methodology in accordance with the Fermilab ES&H Manual (FESHM) and updated for CD-2.

A safety assessment process is used to address the safety of planned accelerator and detector operations, in accordance with the FESHM and the DOE approved Work Smart Standards (WSS) set included in the DOE-FRA contract. Updates to the existing Accelerator Division (AD) Safety Assessment Document (SAD) and the NuMI/MINOS SAD will be prepared and approved prior to commissioning the accelerator and NuMI Beamline systems upgraded in the NOνA Project, as well as the NOνA near detector to be operated in existing MINOS areas. FESHM and WSS requirements will be met for operational readiness, Accelerator Readiness Review (ARR) and accelerator safety envelope (ASE) revision prior to approval of sustained accelerator operations for the NOνA experiment.

K. Risk Management

The project has been planned, developed and is executed in a manner that reduces risk to acceptable levels. Risks are identified, documented and managed according to a NOνA Risk Management Plan. The institutions involved have extensive experience with the accelerator, detector and conventional construction technologies and methods to be used.

Prototypes are being constructed to test and validate appropriate design elements. Extensive Value Management/Engineering has been incorporated into this performance baseline. Contingency allowances cover both estimated uncertainties and consideration of identified risks, in particular those associated with key cost drivers.

L. Sustainable Building Design

Regarding Executive Order 13423 "Strengthening Federal Environmental, Energy, and Transportation Management", in terms of new construction and major renovations, the Executive Order applies to "new construction and major renovations of agency buildings" (E.O. #13423, Section 2(f)). The only building to be constructed for this project, the far detector building in Ash River, Minnesota, will be owned by Minnesota and will not be DOE or federal agency owned, and so EO 13423 does not apply. Though not required, the project has followed a Fermilab Leadership in Energy and Engineering Design (LEED) procedure where applicable for the far detector building, but a LEED certification will not be obtained. Most NOνA facility energy usage is process related; accelerator modifications offer little opportunity to apply sustainable design concepts.

Submitted by:

Pepin Carolan — 8/5/08
Date

Pepin Carolan
DOE NOvA Federal Project Director
Fermi Site Office
Office of Science

Joanna Livengood — 8/6/08
Date

Joanna Livengood
Site Manager
Fermi Site Office
Office of Science

8/15/08
Date

Michael Procario
DOE NOvA Program Manager
Office of High Energy Physics
Office of Science

8/15/08
Date

Dennis Kovar
Associate Director
Office of High Energy Physics
Office of Science

Recommendations

The undersigned "Do Recommend" (Yes) or "Do Not Recommend" (No) approval of CD-2, Approve Performance Baseline, for the NOvA Project as noted below.

ESAAB Secretariat, Office of Project Assessment	8/15/08 Date	Yes X	No____
Representative, Non-Proponent SC Program Office	8/15/08 Date	Yes ✓	No____
Representative, Office of Budget	Date	Yes ✓	No____
Representative, Environmental, Safety and Health Division	Date	Yes____	No____
Representative, Security Management Team	8/15/08 Date	Yes ✓	No____
Representative, Laboratory Infrastructure Division	Date	Yes____	No____
Representative, Grants and Contracts Division	Date	Yes____	No____

Approval

Based on the information presented above and at this review, Critical Decision-2, Approve Performance Baseline, is approved. Therefore, the DOE HEP Program and Fermi Site Office are authorized to submit a budget request for the total project cost and to complete design, engineering and other preparations needed to ready the NOvA Project to begin execution of construction, procurement and fabrication activities within the funds provided.

Raymond L. Orbach
Director
Office of Science

9/15/2005
Date