Department of Energy
Review Committee Report

on the

Technical, Cost, Schedule, and
Management Review

of the

MAIN INJECTOR EXPERIMENT ν-A (MINERνA)

August 2007

EXECUTIVE SUMMARY

A Department of Energy (DOE) Office of Science review of the Main INjector ExpeRiment ν-A (MINERνA) project, to be located at the Fermi National Accelerator Laboratory (Fermilab), was conducted in Germantown, Maryland on August 21, 2007. The review was conducted at the request of Dr. Robin Staffin, Associate Director for High Energy Physics and chaired by Mr. Stephen Tkaczyk, Office of Project Assessment. The purpose of the review was to evaluate the project's readiness for approval of Critical Decision (CD) 3b, Approve Construction.

This review satisfied the requirements set forth in DOE Order 413.3A for an Execution Readiness Independent Project Review for CD-3b, Approve Construction. The Committee judged that the project documentation was sufficiently complete and that the project was ready for CD-3b approval.

The MINERνA project is the fabrication of a high resolution neutrino detector that will utilize the world's most intense neutrino beam at the Neutrinos at the Main Injector (NuMI) neutrino beam line at Fermilab. The detector will be capable of distinguishing explicit final states from neutrino interactions in the energy range of 1 to 20 GeV and measuring their neutrino cross-sections. The improved understanding of low-energy cross sections gained with MINERνA will provide reduced systematic uncertainties for the ongoing and planned neutrino oscillation experiments.

The MINERνA Total Project Cost is $16.8 million with a Total Estimated Cost or Major Items of Equipment (MIE) of $10.7 million and Other Project Cost of $6.10 million. The total project MIE base (actual year) is $7.88 million with a total MIE contingency of 36 percent or $2.82 million. The total project R&D Base (actual year) is $4.81 million with a total R&D contingency of 27 percent or $1.28 million.

The overall schedule for MINERνA is approximately 4.25 years, starting with CD-0, Approve Mission Need, approved on June 23, 2006 through CD-4, Approve Start of Operations, scheduled for September 2010. The project critical path includes approximately ten months schedule contingency to the CD-4 date in the Project Execution Plan.

The MINERνA project created an appropriate management structure and has assembled a competent management team.

The ES&H aspects of the project are properly addressed given the project's current stage of development.

The Committee made several recommendations, which are included in this report. There were no specific Action Items resulting from the review.

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1. INTRODUCTION

The Main INjector ExpeRiment ν-A (MINERνA) project is the fabrication of a high-resolution neutrino detector that will utilize the world's most intense neutrino beam at the Neutrinos at the Main Injector (NuMI) neutrino beam line at Fermi National Accelerator Laboratory (Fermilab). The detector will be capable of distinguishing explicit final states from neutrino interactions in the energy range of 1 GeV to 20 GeV and measuring their neutrino cross-sections. The improved understanding of low-energy cross sections gained with MINERνA will provide reduced systematic uncertainties for the ongoing and planned neutrino oscillation experiments.

MINERνA will be a relatively small detector with an active medium of finely-segmented solid scintillator. The detector design and technology choices, very similar to existing experiments, were made to minimize technical risk. The detector will be sited upstream from the MINOS Near Detector in the NuMI line. The installation and commissioning of the detector are not part of the MINERνA project. While Fermilab has primary management responsibility, the execution of the MINERνA project will be accomplished in close collaboration with several universities.

Critical Decision (CD) 0, Approve Mission Need, for MINERνA was approved on June 23, 2006. The CD-1/2/3a (CD-1, Approve Alternative Selection and Cost Range; CD-2, Approve Performance Baseline; and CD-3a, Approve Limited Construction) were subsequently approved on March 30, 2007.

The Office of High Energy Physics (HEP) requested that the Office of Project Assessment conduct a review of the project in preparation for CD-3b, Approve Construction. The review was held on August 21, 2007 and was chaired by Mr. Stephen Tkaczyk. The purpose of the review was to evaluate the project's readiness for approval of CD-3b, Approve Construction.

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2. TECHNICAL SYSTEMS EVALUATIONS

2.1 Scintillator Extrusions (WBS 1.0)

2.1.1 Findings and Comments

Large numbers of both the triangular strips (for the active target), and rectangular strips (for the outer detector) were successfully extruded at Fermilab/NICADD facility. This includes most of the extrusions needed for the Tracking Prototype. The outer diameter of the holes in the extrusions was increased to allow better flow of the glue that is forced into the holes after the wavelength-shifting fiber is inserted.

The production process is well defined and tested, and should allow successful completion of the necessary number of extrusions.

2.1.2 Recommendations

None.

2.2 Wave-Length Shifting Fibers (WBS 2.0)

2.2.1 Findings and Comments

To extract the signals from the active target and the outer detector, the MINERνA project is using the well-tested technique of wavelength-shifting fiber embedded in scintillator, with spectral matching between the scintillator light output and the absorption of the fiber. Due to variations in the fiber outer diameter, the diameter was changed from 1.19 mm to 1.18 mm. This allows a better fit of the fiber into the connector.

Some problems were encountered in the process of gluing the fibers into the scintillator. Some bubbles, and possibly voids, were found that gave rise to anode current variations as the scintillator/fiber assembly was scanned longitudinally.

Two quality control methods were used to look for imperfect mirroring of the fiber end. However, these methods do not share a common scale for reflectivity.

One end of each fiber is mirrored using an aluminum vacuum deposition technique.

2.2.2 Recommendations

1. The project should investigate the possible use of a commercial reflectometer to measure the light reflection from the mirrored end of each fiber.

2. Close attention should be paid to longitudinal scans of scintillator/fiber assemblies to avoid large, local response variations.

2.3 Scintillator Detector Assembly (WBS 3.0)

2.3.1 Findings and Comments

Tests were made of the assembly techniques for the scintillator planes in the active target. Initial tests resulted in somewhat irregular arrays of the triangular extrusions. The large size of the planes was causing a problem with the long reach required to place each scintillator strip. A revised assembly technique resulted in each scintillator plane being assembly in five "planks."

Critical experience should be gained from the assembly of the twenty layers of the Tracking Prototype.

The new assembly procedure gives visibly improved results in terms of the uniformity of the placement of the scintillator strips.

2.3.2 Recommendation

1. An internal, in-depth review of the assembly of the Tracking Prototype should be made, and lessons learned, prior to the start of the main detector production. This should not affect the ordering of materials, but could result in improved assembly procedure(s) and a better overall detector.

2.4 Clear Fiber Cables and Connectors (WBS 4.0)

2.4.1 Findings and Comments

The clear fiber cables convey the light from the wavelength-shifting fibers to the photo-multiplier boxes. There was an issue with the connector polishing in which the polishing

diamonds were damaged by the fiber-glass material of the connectors. A new technique was developed in which epoxy on the end of the fibers/connector is polished instead of the fiber-glass.

The new polishing technique has been successful, and has been adopted as the new baseline technique.

2.4.2 Recommendations

None.

2.5 Photomultiplier Tube Boxes (WBS 5.0)

2.5.1 Findings and Comments

These boxes mechanically support the 64-channel photomultiplier tubes (PMT) and bring the clear fiber cables to the front face of the PMT. Sixty-four fibers from eight DDK connectors are connected to an Optical Decoder Unit and from that 64 fibers are routed to a cookie, which aligns the fibers with the PMT channels. The alignment with the dynode structure of the PMT is achieved by optically locating reference marks on the structure through the photocathode. The light injection system is part of the National Science Foundation (NSF) MRI grant and was not described in detail.

Progress on preparations for construction advanced well with both Tufts and Rutgers ready to begin construction.

2.5.2 Recommendations

None.

2.6 Photomultiplier Tubes (WBS 6.0)

2.6.1 Findings and Comments

The MINERvA project plans to use approximately 500 of the 64-channel Hamamatsu phototubes R7600U-00-M64. These same tubes have proved to operate satisfactorily in the MINOS near detector. One hundred tubes were bought as part of the R&D program and many of them will be used in the tracking prototype. The purchase of these tubes from Hamamatsu is on

the detector construction critical path. A test stand is being built at Rutgers, which will measure different properties of the phototubes, like linearity, operating voltage, and dark current. Once complete the setup will be shipped to JMU for the PMT testing.

The purchase of the PMTs will be a large foreign sole-source purchase that will require significant lead time to establish.

2.6.2 Recommendation

1. Begin the preparation of the PMT purchase order at the earliest possible date.

2.7 Electronics and DAQ (WBS 7.0)

2.7.1 Findings and Comments

There was good progress since the December 2006 DOE review. The PMT high voltage supply is an inboard Cockcroft-Walton that supplies a single bias voltage to each PMT. The readout makes use of the TriP-t chip developed for the D0 VLPC readout and it is equipped with a three range ADC output, an on-chip 12-bit ADC and internal buffering that permits readout between beam spills.

The readout of the front-end boards is though the Chained Readout Controller (CROC), which is a custom board developed for the experiment. Only ten boards are required to readout the entire detector with a daisy-chained readout. The high voltage control signals are distributed on the same cables. The whole readout sits in two VME crates.

2.7.2 Recommendations

None

2.8 Frames, Absorbers, and Stand (WBS 8.0)

2.8.1 Findings and Comments

Absorber material and nuclear targets will be purchased and machined at Fermilab. The nuclear absorbers are covered by the NSF MRI grant. Due to changes in the manufacture of the scintillator planes the thickness of the steel absorber was increased.

Useful experience since the December 2006 DOE review was gained with the full-sized prototype module.

2.8.2 Recommendations

None

2.9 Module Assembly and Mapping (WBS 9.0)

2.9.1 Findings and Comments

The detector modules will be assembled at Fermilab. A mapping device that steps a source across the surface of the tracker is used to find the relative positions of the scintillator strips. Before assembly of the final detector the tracking prototype detector will be assembled by the same team of people.

Experience gained with the assembly of the tracking prototype will be useful for the assembly of the final module. It is important that the mapper development and construction is not delayed, as it will provide data that will inform on the overall detector quality, especially the scintillator-fiber assembly and the scintillator placement.

2.9.2 Recommendation

1. Management should track carefully the mapper development and performance.

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3. COST and SCHEDULE

3.1 Findings

The MINERνA Project Total Project Cost (TPC) is $16.80 million with a Total Estimated Cost (TEC) or Major Items of Equipment (MIE) of $10.70 million and Other Project Cost (OPC) of $6.10 million. The total project MIE base (actual year) is $7.88 million with a total MIE contingency of 36 percent or $2.82 million. The total project R&D base (actual year) is $4.81 million with a total R&D contingency of 27 percent or $1.28 million.

The total project funding profile/guidance for MIE is $10.70 million. Specifically the funding profile for MIE is $5.40 million in FY 2008; $4.90 million in FY 2009; and $0.40 million in FY 2010. The percentage of MIE contingency is 32 percent ($1.30 million) in FY 2008; 41 percent ($1.42 million) in FY 2009; and 41 percent ($0.12 million) in FY 2010. Notable changes to the MIE costs since the CD-2 review includes: a $46K increase in WBS 4.0—to address wastage fraction/quality control failure rate higher in ODU weaving and clear fiber cables/ODU production; a decrease of $35K in WBS 6.0—that was a result of updated PMT cost quote; an increase of $49K in WBS 7.0—addressing updated electronics costs (e.g., PMT bases, FESB, Transition Boards); and an increase of $27K in WBS 8.0—as a results of requiring thicker steel for the outer detector frames. Appendix D contains a summary of the project's MIE costs and associated funding profile/guidance.

The total project funding profile/guidance for R&D is $6.10 million. The funding profile for R&D is $0.8 million in FY 2006, $4.9 million in FY 2007 and $0.4 million in FY 2008. The percentage of R&D contingency is 29 percent ($0.18 million) in FY 2006; 10 percent ($0.38 million) in FY 2007; and 150 percent ($0.78 million) in FY 2008. Notable changes to the R&D costs includes: a decrease of $75K in WBS 1.0—as a result of removing an ID/OD die iteration; an increase of $54K in WBS 4.0—resulting from higher wastage in ODU weaving quality control failure rate higher, requiring extra iteration of light-tightening mold fabrication; a decrease of $35K in WBS 6.0—as a result of better PMT cost and less money spent on test stand; a decrease of $24K in WBS 7.0—resulting from less money spent on quality assurance stations for PMT boxes, and updated electronics costs; an increase of $24K in WBS 8.0—for an increase in prototype steel cost and stand M&S higher; an increase if $27K in WBS 9.0—because of higher module mapper costs; and an increase of $29K in WBS 10.0—as a result of requiring additional Rochester integration support. Appendix D contains a summary of the project's R&D costs and associated funding profile/guidance.

The project also developed a detailed cost chart that identifies the costs (by WBS) associated with each activity. The detailed cost chart includes: Fund Type (e.g., R&D or MIE); M&S Cost; M&S Contingency Factor; Labor Cost; Labor Contingency; Contingency Total; TPC without Contingency; Burdened, Escalated Base Cost; TPC; and Total Burdened, Escalated Cost. Appendix F contains the detailed Funding Chart.

A WBS and a WBS Dictionary were developed for this project. There are ten Level 2 activities that are then subdivided down in detail, in some instances to Level 5. The ten major WBS activities include: 1.0 Scintillator Extrusion; 2.0 WLS Fibers; 3.0 Scintillator Plane Assembly; 4.0 Clear Fiber Cables; 5.0 Photomultiplier Tube Boxes; 6.0 Photomultiplier Tubes; 7.0 Electronics and DAQ; 8.0 Frames, Absorbers, and Stand; 9.0 Module Assembly and Veto Wall; and 10.0 Project Management. For each WBS subactivity within the WBS Dictionary, details are provided on the specific resources (e.g., M&S, labor) required, activity duration, start/finish dates, and associated costs. Additionally, each subactivity provides references that support how the Basis of Estimate (BOE) is determined for M&S, Labor, and Schedule.

The project escalation rates, as advised by the Fermilab Directorate are 2.5 percent per year for M&S and 4.25 percent per year for labor, respectively. The overhead rates applied to the project are: 54.4 percent for Fermilab labor; 15.5 percent for Fermilab M&S; and 15.5 percent for University costs incurred on the first $100K/University, and then the rate reduces to 1.5 percent for the remaining costs.

The overall schedule for this project is approximately 4.25 years. The project commenced with CD-0, *Approve Mission Need*, which was approved on June 23, 2006. CD-1, 2, and 3A were approved on March 30, 2007. The project will culminate with CD-4, *Approve Project Completion*, which is scheduled for September 2010. Aside from the work being performed by Fermilab, a significant portion of the work is going to be performed at a number of universities from around the country. The resource-loaded schedule, organized by Level 2 WBS activities, has leads from five different academic institutions managing nine of the ten Level 2 project activities. The project resource-loaded schedule has six Level 1, twenty Level 2, and twenty-seven Level 3 milestones that are distributed throughout the entire life of the project. A confidence level of 85 percent was calculated and applied to all schedule durations on the resource-loaded schedule and project critical path. A 95 percent confidence level was calculated and applied to the dates for the DOE project milestones. Appendix E contains the project's resource-loaded schedule.

A critical path for the project was established, and started on August 1, 2007, with milestone L4 - *Rochester Pre-purchase Funds Released*, and continues through May 3, 2010 (CD-4 forecasted date). The critical path schedule focuses primarily on the fabrication, assembly, testing and shipment to Fermilab of the PMT boxes/bases and associated components. The critical path also includes approximately six months schedule contingency (based on forecasted dates). It should be noted that the critical path schedule is based on the forecasted (or working) schedule durations, which are in advance of the baseline schedule Level 1 milestones described in Table 7.4 of the PEP. Overall there is more than ten months of schedule contingency between the forecasted completion date for *MINERvA Detector Ready for Installation* and the "committed to" CD-4 date in the PEP. Appendix E contains the critical path schedule portion of the project's overall resource loaded schedule.

Because of the FY 2007 Continuing Resolution (CR) and the delay in FY 2007 funding guidance from DOE was outside the control of the project. The MINERvA Federal Project Director approved the re-planning of revised R&D milestone dates. Based on an analysis by the project, only two Level 2 milestones needed to be revised and approved by the FPD. The two specific R&D milestones that were approved to be shifted one month were: L2 – *Tracking Prototype* OD Frames Complete (4/16/2008 to 5/15/2008); and L2 – *MINERvA Tracking Prototype Detector Ready for Evaluation* (8/18/2008 to 9/18/2008). Based on shifting the two R&D milestones, there was no impact to the overall Resource Loaded Schedule or Critical Path.

Because this project is under $20 million, application of an Earned Value Management System (EVMS) is not required and will not be utilized. The project has identified 53 milestones that are populated in the resource-loaded schedule that are to be used as indicators of project progress *in lieu of* earned value. Project performance is addressed in monthly reports to the Federal Project Director. These reports provide a project description, overall project status, project milestone summary, procurement and financial status, project highlights, and project costs and obligations summary.

An analysis identified potential scope contingency, including the associated impact to the project. It was determined that the only way to save costs and still conduct physics, is to build less of everything, except the following: Nuclear targets (paid for by NSF); and Electromagnetic and Hadronic Calorimetry. The scope contingency would come from a decision in at the beginning of FY 2009 to decide to build 20 percent less detector and associated components, including cutting back on plane production, steel, PMT, FEB purchases, and associated labor. This would result in a 12 percent cost savings in MIE costs ($1.3 million), however, there would be a loss of about 40 percent of the fiducial volume for scintillator target (60 target planes, need

approximately ten for tracking before calorimetry). The experimental physics planned with the MINERνA detector would need to run 1.7 times as long. Also, the reduction in scope would require a change CD-4 definitions, since they include absolute numbers of components built, which would require approval by the project's Acquisition Executive.

3.2 Comments

The Project TPC, MIE, and R&D cost estimates are consistent with the approved mission need, technical scope, and stated performance. Appropriate project contingency was established based on "bottoms-up" estimates that were established for each individual scheduled activity or task. Based on the risks defined for this project, it was concluded that the overall level of contingency assigned to this project for both MIE and R&D is reasonable and adequate. The WBS Dictionary appropriately breaks down the project into manageable tasks and provides sufficient detail on the BOE for each of the activities or tasks and the costs associated with completing that activity. Additionally, the MINERνA Project Manager and Level 2 Leads were very knowledgeable on the basis and justification for all aspects of the project costs estimates and associated contingency.

The proposed detailed resource-loaded schedule is reasonable and appropriate based upon the technical tasks required and the proposed funding profile and includes adequate schedule contingency. The critical path was identified, is reasonable, and appropriately includes more than ten months of schedule contingency when compared to the CD-4 milestone date in the PEP. Application of an 85 percent confidence level for the overall schedule and critical path is a sound and defensible approach. Applying a 95 percent confidence level to the DOE project milestones is an excellent approach to ensure milestones are achieved on time. The MINERνA project Manager and Level 2 Leads demonstrated a sound understanding of both the project resource-loaded schedule and associated critical path.

Project performance is reported to the FPD monthly in a comprehensive report that allows the FPD to monitor and evaluate project performance. Consideration should be given to including percent complete by WBS based on work accomplished (vs. funds expended) in section "V. Project Highlights by WBS Section." This would be an additional indicator for the FPD to evaluate project performance.

The project should continue to seek opportunities to identify appropriate scope contingency that would not impact the Project Mission Need or CD-4 deliverables.

The project costs, schedule, and contingency appear to be well developed and reasonable. The project TPC, MIE, and R&D cost estimates are consistent and aligned with the project funding profile/guidance provided by the DOE. The current cost projections are also consistent with the approved baseline, including appropriate contingency level. Overall, in regards to cost, schedule, and contingency; the MINERνA project is adequately prepared for CD-3 approval.

3.3 Recommendations

None.

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4. MANAGEMENT (WBS 10.0) and ENVIRONMENT, SAFETY and HEALTH

4.1 Findings

The MINERνA project documented its management structure and assembled the management team. The project provided the following documentation: a set of final design documents, including final design drawings and bid packages for near term purchases, a resource-loaded schedule, a detailed WBS dictionary to Level 5, a critical path analysis, a funding profile, a Construction Management plan, a signed Acquisition Strategy, a signed Project Execution Plan, a signed Project Management Plan, a requirements document (Conceptual Design Report), a Value Engineering plan, a Risk Management plan, a set of safety documents including a Hazards Assessment, a Preliminary Safety Assessment Document, a NEPA determination and an Integrated Safety Management plan, a Project Change Request summary, a Configuration Management plan, a signed Quality Assurance plan and a Technical Design Report. The project has processed 13 change requests to date.

The MINERνA project has identified Level 2 managers and integration coordinators (interfaces between WBS 3,8,9; WBS 5-7; and WBS 1,2,4), as well as overall project integration by the Deputy Project Manager. The Integrated Project Team was appointed.

A Fermilab Director's CD-3b review was held on June 11-12, 2007. This review was thorough and the project responded to its recommendations.

The MINERνA project provided a self-assessment of its preparedness for CD-3b. The project provides monthly reports to the Federal Project Director (through June 2007). Documentation required by DOE Order 413.3a for CD-3b is available.

4.2 Comments

The MINERνA project created an appropriate management structure and assembled a competent management team. The management structure and key personnel are well documented in the Project Execution Plan and the Project Management Plan.

The Value Engineering process was effectively implemented on a wide range of tasks within each subsystem.

The project team is being proactive on ES&H issues and has well documented its policies and procedures. The Hazards Assessment contains a rather thorough assessment of project hazards. The Preliminary Safety Assessment Document includes project, as well as post-project safety assessments. The Integrated Safety Management plan clearly delineates the MINERνA project safety teams' role within the overall Fermilab safety environment.

While MINERνA is not undertaking any civil construction, they adopted a Construction Management plan that includes project activities and continues through the transition to the installation of the detector, which is off-project. Memoranda of Understanding between the MINERνA collaboration and the MINOS experiment regarding installation of the MINERνA detector and sharing of data are in various stages of approval. This planning activity is clearly of value to the overall success of the MINERνA experiment.

Risks associated with incomplete gluing of the fibers into the scintillator strips and possible mitigation strategies may be worth documenting.

An integration review of WBS 3,8,9 was held in June 2007 and another is planed for the fall. Regular weekly meetings with the Level 2 managers of these subsystems are held. The committee encouraged close attention to these integration tasks. Review plans for the completed Tracking Prototype, including a commissioning plan, could be better documented.

Project management considered mitigation strategies for the possibility of a Continuing Resolution in FY 2008. This planning is very prudent. The current schedule assumes MIE funding on December 1, 2007, which seems to be somewhat optimistic at this time. The project may want to consider additional mitigation strategies in case the Continuing Resolution is longer than anticipated.

Many parts of the project have complete, detailed final designs, with the remaining parts of the project well along towards final designs. The total project scope, cost, and schedule were fully detailed, with an appropriate critical path analysis and sufficient milestones. The WBS dictionary is sufficiently detailed and complete. The Acquisition Strategy, Project Execution Plan, and Project Management Plan are complete and signed. The Committee felt that the project satisfied the criteria for CD-3b (see Appendix H) and that CD-3b approval is appropriate at this time.

4.3 Recommendations

None.

APPENDIX A

CHARGE MEMORANDUM

DOE F 1325.8
(08-93)

United States Government
Department of Energy

memorandum

DATE: July 6, 2007

REPLY TO
ATTN OF: SC-25

SUBJECT: Request to Conduct a CD-3B Review of the MINERυA Project

TO: Daniel R. Lehman, Director, Office of Project Assessment, SC-1.3

The Main INjector ExpeRiment ν-A (MINERνA) Project will build a detector to study low energy neutrino interactions using the NuMI neutrino beam. I would like to request that you conduct an Independent Project Review of the MINERνA project on August 21, 2007 at DOE Headquarters, Germantown, Maryland. The purpose of this review is to evaluate the project's readiness for approval of Critical Decision 3B (Approve Construction).

On March 30, 2007, the project obtained Critical Decision 1, 2, 3A approval for its conceptual and preliminary design and for its baseline cost and schedule. With CD-3A, DOE approved limited construction in order to allow the project to initiate early procurements on a limited number of critical items. CD-3B will be an approval of the remaining items of construction necessary prior to CD-4.

In your review, please evaluate whether the final design is complete and whether the MINERυA project is prepared to enter the construction phase. 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. Final Design: Is the design sufficiently mature so that the project can initiate procurement and construction? For those elements of the design that are still not finalized, has the project convincingly shown that there are no major issues that need to be addressed and that they are on a clear path to a final design?
2. Baseline Cost and Schedule: Are the current project cost and schedule projections consistent with the approved baseline cost and schedule? Are the initial allocations of contingency adequate?
3. Management: Evaluate the management structure as to its adequacy to deliver the proposed final design within specifications, budget, and schedule. Has the project responded satisfactorily to the recommendations from the previous independent project review?
4. Construction: Has there been adequate progress on the construction activities approved under CD-3A? Have Fermilab and the project done the necessary preparations to execute the remaining construction activities?
5. Documentation: Is the documentation required by DOE Order 413.3A for CD-3B complete? Has the CD-2 documentation been updated to reflect any changes resulting from the final design?

Saul Gonzalez is the program manager for the MINERνA Detector Project in this office and will serve as the Office of High Energy Physics (OHEP) contact person for the 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 30 days of the review.

/signed/

Robin Staffin
Associate Director
Office of High Energy Physics

cc:
Ray Orbach, SC-1
Aesook Byon, SC-2
Joanna Livengood, SC/FSO
Pier Oddone, FNAL

APPENDIX B

REVIEW PARTICIPANTS

Department of Energy Review of the
Main INjector ExpeRiment ν-A (MINERνA) Project

REVIEW COMMITTEE PARTICIPANTS

Department of Energy

Stephen Tkaczyk, DOE/SC

Review Committee

Steve Kettell, BNL
Joe May, DOE/TJSO
Roger Rusack, U. of Minnesota
Andrew White, U. of Texas, Arlington

Observers

Glen Crawford, DOE/SC
Saul Gonzalez, DOE/SC
Steve Webster, DOE/CH

APPENDIX C

REVIEW AGENDA

Department of Energy Review of the
Main INjector ExpeRiment ν-A (MINERνA) Project

AGENDA

Tuesday, August 21, 2007—U.S DOE Germantown, Conference Room E-401

8:30 am	DOE Executive Session	S. Tkaczyk
9:00 am	Project Overview	D. Harris
9:45 am	Scintillators (WBS 1.0), WLS Fibers (WBS 2.0), and Clear Fiber Cables (WBS 4.0)	K. McFarland
10:15 am	Break	
10:30 am	Phototubes (WBS 6.0), PMT Housing (WBS 5.0), and Electronics and DAQ (WBS 7.0)	R. Ransome
11:00 am	Scintillator Planes (WBS 3.0), Frames (WBS 8.0), and Module Assembly (WBS 9.0)	B. Bradford
11:30 am	Lunch	
12:30 pm	DOE Executive Session	
4:00 pm	Closeout Presentation	
4:30 pm	Adjourn	

APPENDIX D

COST TABLE

Detailed Cost Estimate: MIE

	WBS		Base w/Indirects (AY M$)			Contingency Estimate			Contingency (AY M$)	Base+ Contingency (AY M$)
			Labor	M&S	Total	Labor	M&S	Total		
M I E	1.0	Scintillator Extrusion	0.27	0.08	0.35	25%	29%	26%	0.09	0.44
	2.0	WLS Fibers	0.34	0.32	0.66	21%	8%	15%	0.10	0.75
	3.0	Scintillator Plane Assembly	0.61	0.21	0.81	30%	48%	34%	0.28	1.09
	4.0	Clear Fiber Cables	0.70	0.39	1.09	37%	13%	28%	0.31	1.40
	5.0	Photomultiplier Tube Boxes	0.41	0.14	0.55	30%	27%	29%	0.16	0.71
	6.0	Photomultiplier Tubes	0.01	1.07	1.08	36%	33%	33%	0.36	1.44
	7.0	Electronics and DAQ	0.10	0.87	0.96	40%	34%	34%	0.33	1.29
	8.0	Frames, Absorbers, and Stand	0.11	0.55	0.66	20%	25%	24%	0.16	0.82
	9.0	Module Assembly and Veto Wall	0.23	0.16	0.39	21%	37%	28%	0.11	0.50
	10.0	Project Management	1.24	0.08	1.32	55%	315%	70%	0.93	2.25
		Total MIE:	**4.01**	**3.87**	**7.88**	**37%**	**34%**	**36%**	**2.82**	**10.70**
OPC		R&D	3.13	1.69	4.81	24%	32%	27%	1.28	6.10
		Total OPC:	**3.13**	**1.69**	**4.81**	**24%**	**32%**	**27%**	**1.28**	**6.10**
		TPC:	**7.14**	**5.55**	**12.69**	**31%**	**33%**	**32%**	**4.10**	**16.80**

- MIE Changes since DOE Review (net change of +108k):
  - WBS 4: up 46k, realize that wastage fraction / QC failure rate is higher in ODU weaving and clear fiber cables / ODU production (PCR#9)
  - WBS 6: down 35k, updated PMT quote
  - WBS 7: up 49k, updated electronics costs (PMT bases, FESB, Transition boards) (PCR#4)
  - WBS 8: up 27k, thicker steel for outer detector frames (PCR#5)

Detailed Cost Estimate: R&D

	WBS		Base w/Indirects (AY M$)			Contingency Estimate			Contingency (AY M$)	Base+ Contingency (AY M$)
			Labor	M&S	Total	Labor	M&S	Total		
R & D	1.0	Scintillator Extrusion	0.20	0.01	0.22	15%	27%	16%	0.03	0.25
	2.0	WLS Fibers	0.12	0.08	0.20	24%	16%	21%	0.04	0.24
	3.0	Scintillator Plane Assembly	0.31	0.22	0.53	28%	27%	27%	0.14	0.67
	4.0	Clear Fiber Cables	0.36	0.16	0.52	41%	20%	34%	0.18	0.70
	5.0	Photomultiplier Tube Boxes	0.16	0.11	0.27	10%	13%	11%	0.03	0.30
	6.0	Photomultiplier Tubes	0.05	0.25	0.30	18%	11%	13%	0.04	0.34
	7.0	Electronics and DAQ	0.80	0.40	1.20	27%	14%	23%	0.27	1.47
	8.0	Frames, Absorbers, and Stand	0.25	0.24	0.49	24%	26%	25%	0.12	0.62
	9.0	Module Assembly and Veto Wall	0.34	0.19	0.52	20%	27%	23%	0.12	0.64
	10.0	Project Management	0.53	0.03	0.56	15%	710%	54%	0.31	0.87
		Total R&D:	**3.13**	**1.69**	**4.81**	**24%**	**32%**	**27%**	**1.28**	**6.10**

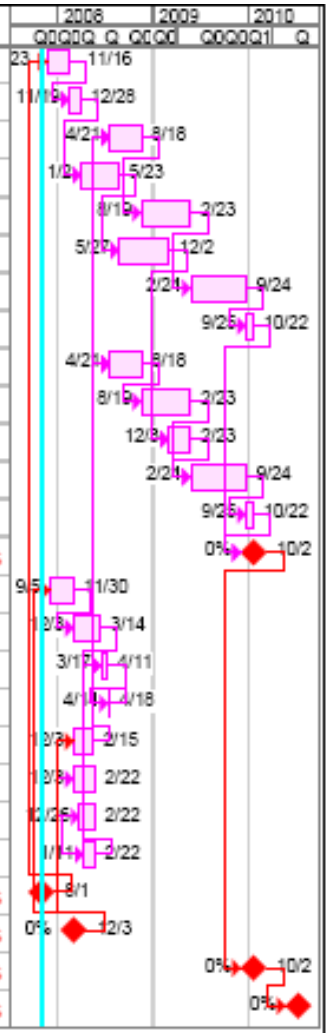
- R&D Changes since DOE Review (net change of +22k$):
  - WBS 1: down 75k, removed ID/OD die iteration
  - WBS 4: up 54k, higher wastage in ODU weaving QC failure rate higher, need extra iteration of light-tightening mold fabrication (PCR#8)
  - WBS 6: down 35k, better PMT cost and less $ spent on test stand
  - WBS 7: down 24k, less $ spent on QA stations for PMT boxes, updated electronics costs (PCR#4)
  - WBS 8: up 24k, prototype steel (PCR#5) and stand M&S higher,
  - WBS 9: up 27k: higher module mapper costs (PCR #3)
  - WBS 10: up 29k, more Rochester integration work

APPENDIX E

SCHEDULE CHART

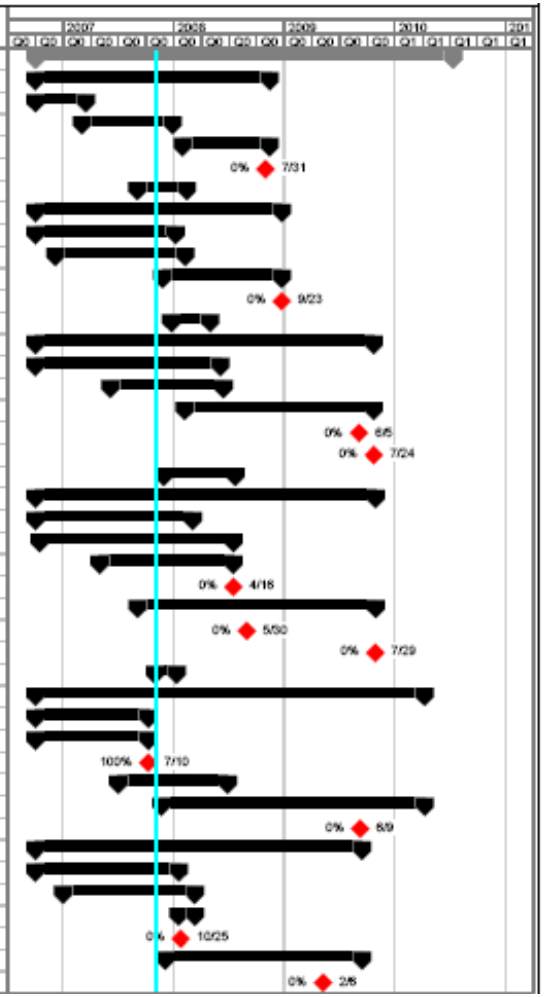
Critical Path

WBS	Task Name	Duration	Start	Total Slack
5.3.1.1	Produce production alignment holders	12.2 wks	Thu 8/23/07	0 wks
5.3.1.3	Produce cookies for 20% of PMT Boxes (110)	5.2 wks	Mon 11/19/07	0 wks
5.3.1.7	Assemble and test 1st 20% of PMT boxes at Tufts (55)	16.8 wks	Mon 4/21/08	0 wks
5.3.1.9	Produce cookies for 21-50% (166) of PMT Boxes	20.4 wks	Wed 1/2/08	0 wks
5.3.1.13	Assemble and test 21% to 50% (83) of PMT boxes at Tufts	25.4 wks	Tue 8/19/08	0 wks
5.3.1.15	Produce cookies for 51-100% (274) of PMT Boxes	26.4 wks	Tue 5/27/08	0 wks
5.3.1.19	Assemble and test 51% to 86% (98) of PMT boxes at Tufts	30 wks	Tue 2/24/09	0 wks
5.3.1.20	Ship 51-86% PMT boxes from Tufts to Fermi (98)	4 wks	Fri 9/25/09	0 wks
5.3.2.4	Assemble and test first 20% of PMT boxes at Rutgers (55)	16.8 wks	Mon 4/21/08	0 wks
5.3.2.9	Assemble and test 21% to 50% (83) of PMT boxes at Rutgers	25.4 wks	Tue 8/19/08	0 wks
5.3.2.13	Weave ODU's into 51-100% (137) of Cookies at Rutgers	10.8 wks	Wed 12/3/08	0 wks
5.3.2.14	Assemble and test 51% to 86% (98) of PMT boxes at Rutgers	30 wks	Tue 2/24/09	0 wks
5.3.2.15	Ship 51-86% PMT boxes from Rutgers to Fermi (98)	4 wks	Fri 9/25/09	0 wks
5.3.4	L3 - All PMT Boxes Shipped to Fermilab	0 wks	Thu 10/22/09	0 wks
6.3.1.1	Prepare/submit Procure req for production PMT's	12 wks	Wed 9/5/07	0 wks
6.3.1.3	Receive first 40 PMT's at JMU	14 wks	Mon 12/3/07	0 wks
6.3.2.1	Attach Holders, Align, and Test first 40 PMT's	4 wks	Mon 3/17/08	0 wks
6.3.3.1	Ship first 40 PMT's to box factories	1 wk	Mon 4/14/08	0 wks
7.3.2.2.2	Produce and ship jmpr cbles & Transition brds to Tufts/Rutgers	10 wks	Mon 12/3/07	3 wks
7.3.2.4.1	PMT Base production	11 wks	Mon 12/3/07	3 wks
7.3.2.4.2	PMT Base checkout and testing	8 wks	Wed 12/26/07	3 wks
7.3.2.4.4	Ship PMT Bases to JMU	6 wks	Fri 1/11/08	3 wks
10.3.6	L4 - Rochester Pre-purchase Funds Released	0 wks	Wed 8/1/07	0 wks
10.3.8	L4 - FY08 Construction Funds Released	0 wks	Mon 12/3/07	0 wks
10.3.13	L1 - MINERvA Detector Ready For Installation	0 wks	Thu 10/22/09	0 wks
10.3.14	L1 - CD 4	0 wks	Mon 4/12/10	0 wks



Resource Loaded Schedule: Overview

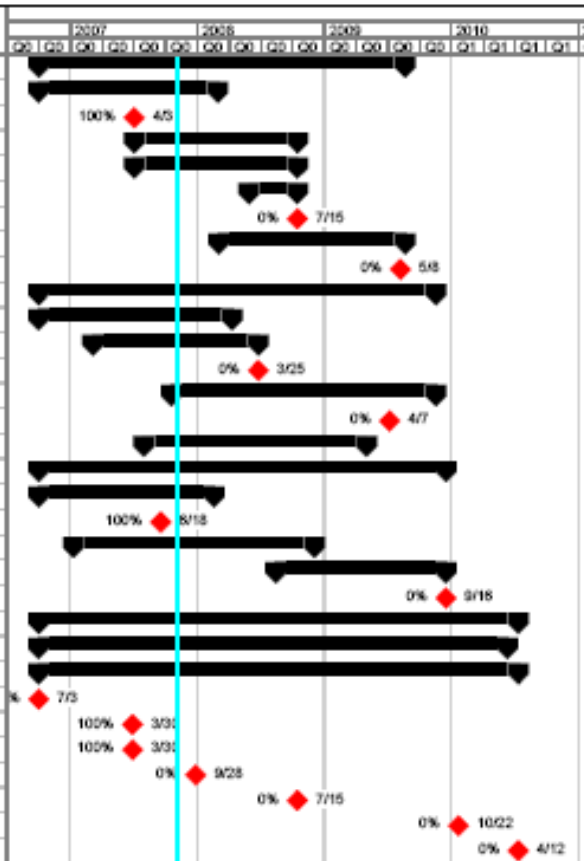
WBS	Task Name	Duration	Start	Finish
0	Minerva_DOE_CD3b_Review.mpp	189.6 wks	7/3/06	4/12/10
1	Scintillator Extrusion	106.8 wks	7/3/06	8/14/08
1.1	Scintillator Extrusion Prototype Work	23.2 wks	7/3/06	12/15/06
1.2	Tracking Prototype (TP) Scintillator Extrusion	41.6 wks	12/4/06	9/28/07
1.3	Production Scintillator Extrusion	39.4 wks	11/1/07	8/14/08
1.3.4	L2 - Scintillator Shipping Complete	0 wks	7/31/08	7/31/08
1.4	Test Beam Detector Scintillator Extrusion	23.2 wks	6/4/07	11/14/07
2	WLS Fibers	112.2 wks	7/3/06	9/23/08
2.1	WLS Fiber Prototype Work	64 wks	7/3/06	10/8/07
2.2	WLS Fiber Tracking Prototype	59.6 wks	9/7/06	11/8/07
2.3	WLS Fiber Full Production	54.2 wks	8/27/07	9/23/08
2.3.4	L2 - All Detector WLS Fibers Shipped To W&M	0 wks	9/23/08	9/23/08
2.4	Test Beam Detector WLS Fiber	17 wks	9/25/07	1/30/08
3	Scintillator Plane Assembly	154 wks	7/3/06	7/24/09
3.1	Plane Prototypes and Outfitting	63.8 wks	7/3/06	3/4/08
3.2	Tracking Detector Scintillator Plane Components	51.6 wks	3/7/07	3/14/08
3.3	Plane Production	85.6 wks	11/8/07	7/24/09
3.3.9	L2 - All Outer Detector Towers Shipped To Fermilab	0 wks	6/5/09	6/5/09
3.3.10	L2 - All Inner Detector Planes Shipped To Fermilab	0 wks	7/24/09	7/24/09
3.4	Test Beam Scintillator Plane Assembly	32.4 wks	8/30/07	4/23/08
4	Clear Fiber Cables	154.8 wks	7/3/06	7/30/09
4.1	Clear Fiber R&D	71.6 wks	7/3/06	12/3/07
4.2	Clear Fiber For Tracking Prototype	88.2 wks	7/17/06	4/16/08
4.2.4	Tracking Prototype Clear Fiber Work (Fermi)	61.2 wks	1/31/07	4/16/08
4.2.4.5	L2 - Tracking Prototype Clear Fiber Cable Production Complete	0 wks	4/16/08	4/16/08
4.3	Clear Fiber Production Cables and ODU's	108.2 wks	6/6/07	7/30/09
4.3.7	L2 - Detector ODU Shipments Complete	0 wks	5/30/08	5/30/08
4.3.8	L2 - Detector Clear Fiber Cable Production Complete	0 wks	7/29/09	7/29/09
4.4	Test Beam Connectors	10 wks	8/2/07	10/11/07
5	PMT Boxes	176.6 wks	7/3/06	1/8/10
5.1	PMT Box and Light Injector Prototyping & Development	51.4 wks	7/3/06	7/10/07
5.1.2	Set -up PMT Box Factories at Rutgers	51.4 wks	7/3/06	7/10/07
5.1.2.3	L2 - PMT Box Factories Ready For Production	0 wks	7/10/07	7/10/07
5.2	Tracking Prototype PMT Box and Light Injection Assembly	50 wks	4/2/07	3/28/08
5.3	Production PMT Box and Light Injection Construction	119 wks	8/23/07	1/8/10
5.3.3	L2 - 75% of PMT Boxes Complete	0 wks	6/8/09	6/8/09
6	PMT Procurement and Testing	148.4 wks	7/3/06	6/15/09
6.1	Photomultiplier Tube R&D	65.8 wks	7/3/06	10/19/07
6.2	Tracking Prototype PMT Procurement and Testing	60 wks	10/2/06	12/10/07
6.2.3	Ship Tracking Prototype PMT's	7 wks	10/19/07	12/10/07
6.2.3.4	L2 - Ship First 40 Tracking Prototype PMT's To Box Factories	0 wks	10/25/07	10/25/07
6.3	Production PMT Procurement and Testing	89 wks	9/5/07	6/15/09
6.3.4	L2 - 60% of PMT's Shipped To Box Factories	0 wks	2/6/09	2/6/09



Resource Loaded Schedule: Overview II

- Second page of 2 page summary:
  - Installation and Infrastructure is WBS 11
  - Helium target is WBS 12

WBS	Task Name	Duration	Start	Finish
7	Electronics and DAQ	145.4 wks	7/3/06	5/22/09
7.1	Electronics and DAQ Prototyping	71.2 wks	7/3/06	11/29/07
7.1.7	L2 - Prototype System Integration Test Complete	0 wks	4/3/07	4/3/07
7.2	Tracking Prototype Electronics and DAQ	64.6 wks	4/4/07	7/15/08
7.2.4	Tracking Prototype Electronics Integration	64.6 wks	4/4/07	7/15/08
7.2.4.4	Final TP Integration	19.4 wks	2/28/08	7/15/08
7.2.4.4.3	L2 - Tracking Prototype Electronics and DAQ Complete	0 wks	7/15/08	7/15/08
7.3	Production Electronics and DAQ	74 wks	12/3/07	5/22/09
7.3.5	L2 - DAQ and Electronics Complete	0 wks	5/8/09	5/8/09
8	Frame, Absorbers and Stand	157.4 wks	7/3/06	8/18/09
8.1	Design and Prototype Procurements	76.4 wks	7/3/06	1/10/08
8.2	Tracking Prototype Materials and Assembly	65.2 wks	12/8/06	3/25/08
8.2.4	L2 - Tracking Prototype OD Frames Complete	0 wks	3/25/08	3/25/08
8.3	Production Materials and Assembly	104.6 wks	7/20/07	8/18/09
8.3.1	L2 - Purchase of OD and Nuclear Target Materials Complete	0 wks	4/7/09	4/7/09
8.4	Test Beam Stand and Absorbers	87.8 wks	5/1/07	1/30/09
9	Module Assembly	161.4 wks	7/3/06	9/16/09
9.1	Assembly R&D	70 wks	7/3/06	11/19/07
9.1.6	L2 - Full Module Prototype Assembly and Mapping Complete	0 wks	6/18/07	6/18/07
9.2	Tracking Prototype Module Assembly and Mapping	95.4 wks	10/11/06	9/3/08
9.3	Production Module Assembly and Mapping	67.4 wks	6/15/08	9/16/09
9.3.6	L2 - All Modules Ready For Installation	0 wks	9/16/09	9/16/09
10	Project Management	189.6 wks	7/3/06	4/12/10
10.1	Fermi Management and Administration	185.4 wks	7/3/06	3/12/10
10.3	Project Milestones	189.6 wks	7/3/06	4/12/10
10.3.1	L1 - CD-0 Granted by DOE	0 wks	7/3/06	7/3/06
10.3.2	L1 - CD-1 Granted by DOE	0 wks	3/30/07	3/30/07
10.3.3	L1 - CD-2 and CD-3A Granted by DOE	0 wks	3/30/07	3/30/07
10.3.4	L1 - CD-3B Granted by DOE	0 wks	9/28/07	9/28/07
10.3.11	L2 - MINERvA Tracking Prototype Detector Ready for Evaluation	0 wks	7/15/08	7/15/08
10.3.13	L1 - MINERvA Detector Ready For Installation	0 wks	10/22/09	10/22/09
10.3.14	L1 - CD 4	0 wks	4/12/10	4/12/10



APPENDIX F

FUNDING CHART

MIE Cost Profile

WBS		FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	Total
1.0	Scintillator Extrusion	0.00	0.00	0.35	0.00	0.00	0.35
2.0	WLS Fibers	0.00	0.00	0.64	0.02	0.00	0.66
3.0	Scintillator Plane Assembly	0.00	0.00	0.34	0.47	0.00	0.81
4.0	Clear Fiber Cables	0.00	0.00	0.67	0.42	0.00	1.09
5.0	Photomultiplier Tube Boxes	0.00	0.00	0.27	0.22	0.06	0.55
6.0	Photomultiplier Tubes	0.00	0.00	0.51	0.57	0.00	1.08
7.0	Electronics and DAQ	0.00	0.00	0.54	0.42	0.00	0.96
8.0	Frames, Absorbers, and Stand	0.00	0.00	0.06	0.59	0.00	0.65
9.0	Module and Veto Wall Assembly	0.00	0.00	0.16	0.22	0.00	0.39
10.0	Project Management	0.00	0.00	0.53	0.56	0.23	1.32
	MIE Base (AY M$)	0.00	0.00	4.10	3.48	0.28	7.86
	MIE Contingency Estimate (%)	0	0	32%	41%	41%	36%
	MIE Total Budget Profile (AY M$)	0.00	0.00	5.40	4.90	0.40	10.70
	MIE Funding Guidance (AY M$)	0.00	0.00	5.40	4.90	0.40	10.70

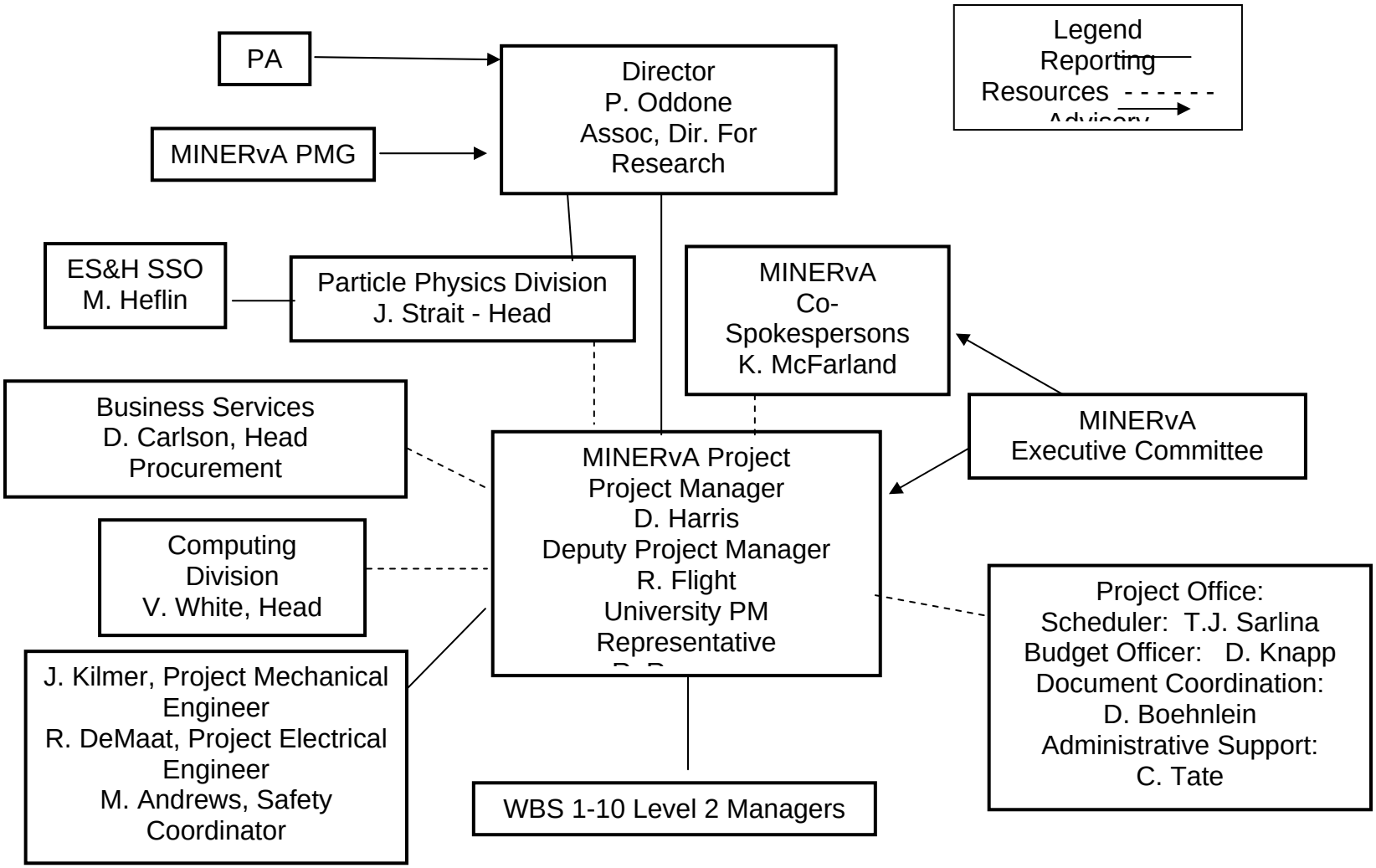
R&D Cost Profile

WBS		FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	Total
1.0	Scintillator Extrusion	0.06	0.16	0.00	0	0	0.22
2.0	WLS Fibers	0.01	0.19	0.00	0	0	0.20
3.0	Scintillator Plane Assembly	0.11	0.30	0.11	0	0	0.53
4.0	Clear Fiber Cables	0.08	0.36	0.07	0	0	0.51
5.0	Photomultiplier Tube Boxes	0.04	0.17	0.06	0	0	0.27
6.0	Photomultiplier Tubes	0.06	0.24	0.00	0	0	0.30
7.0	Electronics and DAQ	0.05	0.96	0.17	0	0	1.18
8.0	Frames, Absorbers, and Stand	0.06	0.41	0.02	0	0	0.49
9.0	Module and Veto Wall Assembly	0.08	0.36	0.08	0	0	0.52
10.0	Project Management	0.07	0.47	0.00	0	0	0.54
	R&D Base (AY M$)	**0.62**	**3.62**	**0.52**	**0**	**0**	**4.76**
	R&D Contingency Estimate	**29%**	**10%**	**150%**	**0**	**0**	**28%**
	R&D Budget Allocation	**0.80**	**4.00**	**1.30**	**0**	**0**	**6.10**
	Baseline Funding Guidance (AY M$)	**0.80**	**4.90**	**0.40**	**0**	**0**	**6.10**

APPENDIX G

MANAGEMENT TABLE

MINERvA Project Organization



APPENDIX H

DOE ORDER 413.3A COMPLIANCE

DOE Order 413.3A Compliance

Findings

DOE O 413.3A identifies 12 criteria that need to be addressed prior to requesting CD-3 Approval. The MINERvA Project addressed each one of the criterion in the *MINERvA Scorecard for DOE Review for CD-3b Approval*, dated August 7, 2007 and subsequent *MINERvA Scorecard Addendum for DOE Review for CD-3b Approval*, dated August 19, 2007. The Project addressed the appropriate criteria and provided justification for the criteria that was not addressed. When required, the appropriate approvals were attained for project documentation. Below is a breakdown of whether the Project met the criterion or not, or if it was not applicable (N/A) to this type of project:

	DOE O 413.3A Criterion	Conclusion
1	Complete and review Final Design	Met.
2	For IT projects, Final Design Review of System Description Doc	N/A.
3	Update all CD-2 project documentation and required approvals to reflect any changes	Met.
4	Perform an IPR	Met.
5	Prepare a SAR for Haz. Cat. 1,2, or 3 nuclear facilities	N/A
6	Update Hazard Analysis Report	Met.
7	Update Preliminary Security Vulnerability Assessment Report	N/A.
8	Update Cyber Security Plan	N/A.
9	Prepare a SAR for Haz. Cat. 1, 2, or 3 nuclear facilities	N/A.
10	Prepare a Construction Project Safety and Health Plan	Met.
11	Incorporate Final Sustainable Environmental Stewardship-High Performance Sustainable Building provisions	N/A.
12	Update QAP	Met.

Comments

The Project appropriately address the DOE O 413.3A criteria that are applicable to this type of project, and provided a justification for the criteria that was not addressed. All required documentation in support of CD-3B approval was complete, and the applicable CD-2 documentation had been updated to reflect changes from the final design and the FY 2007 CR.

Recommendations

None.