Fermilab

Closeout Presentations

Director's
CD-3b Review
of
the NOvA Project

June 16-18, 2009

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Table of Contents

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Executive Summary

This Director's CD-3b Review of NOvA focused on the technical and management aspects of the project in preparation for a DOE Lehman CD-3b Review that's scheduled for July 21-23. An additional mini-Director's Review of NOvA that will look at the updated cost and schedule based on new funding guidance will be held in mid-July prior to the DOE Review.

NOvA has been subjected to the vicissitudes of wild budget fluctuations over the past 2 1/2 years. The project was baselined in late 2007 only to be zeroed out in February for the FY2008 budget. Most technical work was halted at that time with only some R&D continuing. The project management staff was also downsized. Subsequently NOvA was included in a supplemental 2008 funding, in the 2009 budget, and in the Recovery Act funding. However, getting the staff back on board has proven difficult. Nonetheless, the NOvA project team made a good showing at this Director's Review.

Technical
There has been very good progress on NOvA R&D and design in spite of the problems noted above! Overall design is at about 85% complete and the design status has been analyzed at quite detailed levels of the WBS for all systems. The Level 2 and 3 Managers have clear plans in mind to complete designs prior to placing orders and these will be reflected in a yet to be updated NOvA Open Plan "working schedule" that will be presented at the mid July mini Director's Review. Given the progress noted above and the L2 & L3 Managers' clear plans for finishing the design this committee judges that NOvA is (will be by late July) ready for CD-3b.

Cost
There are two salient features worth noting in the real cost area: 1) the Far Site Building bids have come in significantly below the baseline cost estimate, and 2) NOvA has redone their oil price Monte Carlo study that is based on trend data to date and Energy Information Agency projections. At least the EAC (Estimate at Completion) will be changed to reflect this information. NOvA will process formal Change Requests and change the Cost / Schedule Baseline where they feel new information warrants such a formal change.

Schedule
Some number of activities (order of ten or so) will undergo major adjustments in the schedule, mostly acceleration, to reflect efficient use of the new increased funding (in early years) guidance.

The NOvA Project Management team plans to implement an appropriate combination of 1) revising the cost / schedule baseline through the change control process and 2) developing a current EAC for items where a formal change request is felt to be premature. This approach is consistent with the FRA EVMS procedures presented during the recent EVMS Certification Review. This approach will be iterated until it results in a "current working schedule" that is resource loaded and is fully consistent with the most recent DOE funding guidance for NOvA.

Management
Given the progress reported, the detailed description of design status, and their clear description of the path forward for completing design, procuring materials and components, installing the accelerator and NuMI (ANU) components and fabricating and installing the detectors, it seems the NOvA team is quite competent, resourceful, and resilient.

However, staffing in the Project Office and throughout the project, especially in AD, has not recovered to the needed levels. Furthermore, significant additional staff increases will be needed by the September time frame to maintain schedule and accelerate the project, and efficiently use the major bump in funding over the near term. Several of the NOvA-related Accelerator NuMI Upgrades (ANU) activities have been delayed to accommodate lab-wide priorities. Given the high priority of NOvA expressed by Director Oddone, the project and laboratory management will need to work closely together to optimally provide, develop, or acquire staff for executing the NOvA project.

1.0 Introduction

A Director's CD-3b Review of the NOvA Project was held on June 16-18, 2009. The charge included a list of topics to be addressed as part of the review. The assessment of the Review Committee is documented in the body of this closeout presentation.

Each section in this closeout presentation is generally organized by Findings, Comments and Recommendations. Findings are statements of fact that summarize noteworthy information presented during the review. The Comments are judgment statements about the facts presented during the review and are based on reviewers' experience and expertise. The comments are to be evaluated by the project team and actions taken as deemed appropriate. Recommendations are statements of actions that should be addressed by the project team. A response to recommendation(s) is expected and the statuses of actions are to be available for the DOE CD-3b Review of NOvA scheduled for July 21-23, 2009.

2.0 Accelerator and Beamline

Primary Writer: Alireza Nassiri

Contributors: Mike Church, Kathy Harkay

Findings

- The scope of the accelerator upgrade of the NOνA project is to provide the capability of increasing the beam power of the 120 GeV beam from the Main Injector (MI) onto NuMI target to 700 kW.

- For NOνA, the Main Injector (MI) has to accelerate 4.9E13 protons to 120 GeV every 1.33 sec.

- The MI is regularly operated with 340 kW per pulse using multi-turn slip stacking; the peak intensity is within 20% of the goal. Beam losses have been analyzed, with 98% of the losses occurring near 8 GeV, and the collimation system is deemed adequate for the upgrade assuming 95% injection efficiency (the latter has been demonstrated). The gap-clearing kicker (GCK) addresses an important ALARA issue for the RR injection line installation; it should mitigate the significant activation of the injection dipole. The GCKs are to be installed during summer 2009 shutdown.

- A plan for the MI upgrades was presented. The major elements of this plan consist of an upgrade of a MI quad power supply, which is essentially complete, and the addition of two more RF stations. The cavities to be installed currently exist as spares so there is no design and prototyping required.

- The status of the gap clearing kicker was presented. The design is complete and 3 out of 8 kickers have been assembled and meet specifications. The kickers will be installed in the MI during the current shutdown and are required to dramatically reduce local injection losses in the MI. The project team intends to use a faster thyratron and better cable for the pulser to further improve performance.

- The design and status of the long pulse kickers was presented. The design is approximately 40% complete and on track.

- The status of the kicker ceramic beam tubes was presented. The project team has worked with 5 different vendors but none have yet been able to reliably make leak tight bonds to the kovar flanges for the long tubes. One vendor can reliably make short leak-tight tubes and the project team has 9 of these on site, which is adequate for summer 2009 shutdown.

- The Recycler Ring (RR) transfer line design for injection is complete. Final design for the extraction line will be completed after *in situ* inspection planned during current shutdown; main interference is from the MI collimators.

- The status of the NOνA transfer line and RR30 section magnets was presented. No new design work is expected. Most work consists of modifications of existing magnets or new fabrication based on existing designs. To accommodate dipoles in the injection line, a new test dipole magnet with SMCo5 has been designed and fabricated. Measurement and analysis are underway. The project plans to work with industry on a small prototype unit to establish the design parameters of the final magnet.

- Target Hall (TH) infrastructure design is virtually complete and has been reviewed internally (preliminary). MINOS target experience and thermal modeling has been used to mitigate risks. All drawings for the shielding blocks are complete and ready for procurement.

- Medium energy target uses the IHEP design; main technical issues have been addressed. Oxidation of graphite at the anticipated temperatures will be mitigated by filling the canister with helium. The medium energy target is outside of the horn 1. Two main concerns are to be analyzed further: the beryllium target window vacuum and thermal stresses will be verified through additional calculations and optimization; and the thermal stability of the target carrier and support will be analyzed to verify that NOvA alignment requirements are met.

- The status of the NuMI 700-kW pulsed toroidal electro-magnets (horns) was presented. Extensive FEA thermal analyses were done for horn 1 design incorporating the necessary modifications needed to have an adequate safety margin at 700 kW. No design change is needed for horn 2.

- The project plans to modify the existing RR LLRF system for the transfers from Booster and slip-stacking by reusing existing hardware. No specific presentation on LLRF system was presented to the committee.

- The scope of the RR instrumentation upgrade includes Beam Position Monitor (BPM) system, DCCT, toroids, beam profile monitors (in the transfer lines) and transverse damper. The project will keep all the existing BPM electrodes but will develop new transition and VME boards to sample and monitor beam structure at 53 MHz instead of 2.5 MHz. Design work and prototyping are progressing.

Comments

- We consider the ANU team to be experienced, well prepared and dedicated to the project. We commend the team for their excellent work.

- We note that the NOνA project partially relies on off-project elements for the 700kW on target.

- The committee feels insufficient staff resources will adversely impact the project. The committee encourages the ongoing discussions with the lab management to resolve this in a timely manner.

- The gap clearing kickers have the most demanding specifications of all the new kickers required for the NOVA project. Their successful early completion will greatly facilitate the design and fabrication of the remaining kickers. The performance specifications for the long pulse kickers are less demanding than the gap clearing and injection kickers. We see no problems in the design and fabrication of either the magnets or power supplies.

- ALARA issue of radiation levels at MI/RR injection region should be emphasized in the MI upgrade plan.

- Decision to coat ceramic kicker tubes with a resistive material with low secondary emission coefficient is commended.

- Target Hall (TH) infrastructure designs are well documented. Engineering resource issues raised at DOE CD-2/3a Review have been successfully mitigated through out-source contracting and through engineering support from Particle Physics Division (PPD).

- The project has decided to build the DCCT in-house. The committee supports this effort since the technology and design of this device is well developed and well known.

Recommendations

1. Develop a procurement strategy for the remainder of the short and long kicker ceramic beam tubes as soon as possible.

2. Work with Fermilab management to acquire resources needed to complete the accelerator and beamline.

3.0 Site and Building & Near Detector Cavern

Primary Writer: Karen Hellman

Contributors: Jeff Sims

Findings

WBS 2.1

- Design of Far Detector Building is complete and construction proposals were received in May of 2009. The project team including the University of Minnesota and Hines (CM) is currently negotiating the details of the outfitting portion of the GC at risk contract with Adolphson and Peterson, the selected source. The University of Minnesota has decided to reduce risk of unforeseen site work and excavation changes by negotiating an option for the contractor to accept all site risks. Site work began on June 1 2009. The site clearing is currently 80% complete.

- At final negotiation the Far Detector Building total contract cost is anticipated to be under $25M which is approximately $9M less than was estimated and included in the project baseline. In addition, Adolphson and Peterson has proposed to complete all construction activities by November 2010 which is 6 months earlier than the planned construction completion of May 2011 which was part of the performance baseline.

- The results of the far detector building construction coming in significantly below estimated cost and schedule is great news for NOvA . The use of the American Recovery and Reinvestment Act funding to move forward with the far detector building construction during this economic downturn has yielded a significant opportunity for the NOvA project.

- The project is currently revising the resource loaded schedule to conform with the Adolphson and Peterson construction cost and schedule. In addition, risk and contingency are being reviewed to better understand how contingency may be redistributed throughout the project. Installation of experimental equipment can be accelerated to meet the earlier delivery of the far detector building.

- The University of Minnesota has decided to use internal Construction Manager services instead of subcontracting to Hines who has performed all CM services to date.

- The Project team presented break out discussions including construction bid summaries, risk management, and IPND enclosure design.

- Reporting requirements of ARRA funding appear to be the responsibility of University of Minnesota. At this time, only limited information regarding reporting requirements for the Cooperative Agreement is available.

- The review team understands that far detector operation and emergency response plans will be prepared by the University of Minnesota in concert with local governmental agencies.
- The 2.1 L2 Manager has developed responsibility and interface matrices to support the integration and management of the conventional construction. These tools are very useful to maintain scope definition and to meet schedule commitments.

WBS 2.8.1

- Dixon Bogert discussed the latest pre-conceptual plans for the construction of a cavern that would house the near detector adjacent to the MINOS hall. A study has been prepared by MWH and commented upon by Toby Wightman to establish preliminary cost estimates and identify project vulnerabilities related to the cavern construction. There currently do not appear to be any show stoppers related to this activity. Excavation by roadheader appears to be the preferred construction technique. Excavation is anticipated to cost $2.6M without contingency and take between 6 and 12 months. The extent of permitting requirements is currently unknown. Protection of existing experimental equipment in the MINOS hall is planned to be part of the scope of the cavern construction.
- The NOvA project is currently negotiating a contract with a consulting firm to provide all design, PM and construction phase services for the cavern construction including outfitting. The cavern construction would be performed during the planned 1 year shutdown currently estimated to start in October 2011. The consultant that the project is negotiating with has substantial previous experience at Fermilab with the NuMI project.
- FESS is supporting the NOvA project exploring options for construction of the IPND Enclosure on the surface. Conceptual cost estimates have been completed. Final site selection has not been determined.

Comments

WBS 2.1

- The NOvA Level 2 CAM appears to be appropriately integrated into the construction through the weekly meetings with the Construction Manager. In addition, the NOvA level 2 CAM will make monthly visits to the construction site.
- University of Minnesota must prepare operation and emergency response plans at least 6 months prior to the completion of construction so the NOvA team has a good understanding of operation procedures prior to initiation of installation activities.

WBS 2.8.1

- The cavern construction team must coordinate with the experimental programs in the MINOS Hall to properly integrate the construction and experiments.

Recommendations
WBS 2.1

3. Revise all procedures to reference University of Minnesota as the CM agent instead of Hines.

4. Revise the project resource loaded schedule to reflect the final negotiated cost and construction delivery date.

5. Reduce and distribute contingency within the NOvA project to reflect the latest construction project risk.

WBS 2.8.1

6. The review committee recommends that the project complete negotiations with a consulting firm. Begin conceptual design as soon as practical so a 30% design can be established with a conceptual estimate. This will also likely clarify permitting needs.

4.0 Commodities: Scintillator, Fiber and PVC

Primary Writer: Bill Cooper

Contributor: Gaston Gutierrez

Findings

- Designs, R&D, and prototyping have progressed sufficiently in each of these areas to justify a request by NOvA to initiate procurement and construction.

Comments on Liquid Scintillator

- We are satisfied that the desired scintillator blend is understood and should work well. Plans for procurement of components of the blend are clear and procurement of the wavelength shifter components has begun. Extensive studies of potential liquid scintillator candidates have led to a good understanding of the desired chemical composition, the methods to be followed during mixing of scintillator components, and scintillator transport and storage. Light yield from scintillator of the prescribed composition meets NOvA requirements, as does light transmission through the liquid scintillator. A prototype batch of 4500 gallons has been blended at Fermilab and tested at the University of Indiana.

- Plans for "toll" blending of scintillator from components provided by NOvA are understood. Three "toll" blending companies have been identified and visited in the Chicago area, each of which should be able to do the blending: Kinder Morgan, Lambert, and Hydrite Chemical. Two additional toll blending companies will be investigated. Available tank sizes vary with the vendor and range from 2,500 gallons to 50,000 gallons for some processes and up to 220,000 gallons for others. In general, tanks would be cleaned to "food grade" conditions prior to use. At least one of the vendors requires a lead time of a year to ensure that appropriate tanks will be available when needed. The tanks another vendor would use are sufficiently small that QC may be necessary for each transport tanker, a potential burden on personnel conducting QC measurements and analyses. Blending of 15,000 gallons of scintillator for IPND could begin in early calendar 2010.

- Methods for scintillator quality control have been developed which are appropriate for monitoring composition, light output, and light transmission through the liquid during production.

- Results of tests were not available to demonstrate that, once blended, the concentration of scintillator components will not vary later over the height of a vertical extrusion. While we agree that such variation is unlikely, a centrifuge may allow such tests to be done in a convenient way.

Comments on Scintillating Fibers

- We see no technical show-stopper that should delay the procurement of the scintillating fibers. NOvA is planning to use 750 micron diameter S-type Kuraray wave length shifting (WLS) fibers in their detector. These fibers are widely used in our field and Kuraray have been making these fibers for a long time. So there is minimal technical risk.

- The WLS fiber will be tested at Michigan State University. The QA assurance program is sound. As part of the testing procedure they are planning to measure the attenuation length at several different wavelengths. It is certainly a good idea to test the uniformity of the different batches of fibers, but since the light attenuation in fibers depends on the details of the original light phase space the attenuation in the real detector may be different from the attenuation measured during QA. We suggest that, independent of the fiber procurement, the attenuation length be measured in a full length extrusion channel so there will be no ambiguities in the expected attenuation and light output in the real detector.

Comments on PVC

- NOvA has selected the resin (NOvA-27) to be used for PVC extrusions. Production of three extrusion batches has demonstrated that the formulation is extrudible with the proposed dies and that the extrusions meet reflectivity, structural, and mechanical requirements. QC procedures have been developed for measuring reflectivity, structural, and mechanical properties and ensuring that specifications are met. Some of the procedures to verify that geometric requirements are met are still under development Procurement could be initiated as soon as QC procedures have been fully developed and approved. If there were high confidence that procedures and equipment for geometric checks would be available by the time they are needed, procurement could begin earlier. We understand that a new set of dies acceptable to the chosen vendor will be needed to obtain extrusions with the appropriate final dimensions. Performance of the new dies will have to be verified by testing of the extruded product. We suggest that the specifications of the PVC extrusions and all associated parts be reviewed to ensure that extrusions and PVC parts will include all features that might be advantageous during later fabrication and use. We note that the development of equipment and procedures for handling and shipping the extrusions has progressed well. That development should be completed before extrusions are ready to be shipped.

- We note that the QC procedures are properly documented but that sign-off on procedures appears to be informal.

Recommendations

7. Formalize the approval of QC procedures to be used during procurement and fabrication of scintillator, fiber, and PVC.

5.0 Extrusion Module Production

Primary Writer: Linda Stutte

Contributors: Jim Freeman

Findings

- Our report is based on presentations by Ken Heller and breakout presentations by Tom Chase, Dan Cronin-Hennessy and Ron Poling.

- The module factory takes extrusions, joins them together, loads fibers, seals the modules, and performs relevant QC testing.

- Major QC tests include fiber continuity, leak pressure test, step height between the 2 16-cell extrusions composing a module, and glue hardening.

    - Specialized tooling and QC stations are largely existing.

    - Automated QC and automatic loading of construction database software are largely existing. There is a well developed bar coding and part tracking plan.

- The current production plan is to produce FHEP, Near Detector and then Far Detector modules.

    - FHEP is about 60 approximately full-length modules with bottom plates on both ends. Modules production starts in July 2009. The goal of the FHEP test is to learn about assembly of the Far Detector and test its structure.

    - Near Detector construction starts in October, and exercises the full production and QA/QC procedures. Near Detector consists of 500 modules.

    - Remaining parts for Near Detector are close to being ordered. Most parts have been ordered, some are in hand.

- There is an existing factory facility (used for FHEP and Near Detector). They will move into larger final one in January 2010 for Far Detector production.

    - The group will outfit the new factory and be ready to construct Far Detector modules when the extrusions and fibers arrive, at latest June 2010.

    - The new facility will have substantial storage space for buffering incoming and outgoing materials.

- The final production facility produces 30 modules a day with a dwell time of 5 days. Production of a module takes 5.5 hours of student time and 1 hour of senior tech time.

- The production schedule is no longer limited by funding but by how fast fiber can be made and the readiness of the Ash River site for delivery.

- Far Detector has dimensional differences from Near Detector, requiring new sizes for the injection molded parts. This is already in their project schedule and costing.

- No detailed plan for decommissioning the detector was presented.

Comments

- The team is in a very advanced state of preparation for the module production and most if not all tooling, QC steps and procedures are in place. We feel they are ready to start production.

- The storage buffer space in the factory gives great advantages for slippages in materials delivery, problems in shipping to Far Detector and lack of readiness to receive and construct blocks. It also gives the possibility of re-ordering the production of different types of modules.

- Training videos and procedures for construction are well developed.

- The group has carefully tested all chemical components to verify there is no interaction of glues with the scintillator. They have designed a two stage gluing process to minimize interactions with the scintillator.

- The group is currently performing a 20 psi pressure test to look for leaks. We note the operating pressure is 19 psi. We felt uncomfortable with this lack of margin.

Recommendations

8. Increase the module pneumatic pressure test to 110% of maximum allowable working pressure to be consistent with ASME standards.

9. Establish glue strength test procedure for each glue batch.

10. Consider using QC and data base procedures for FHEP production.

11. Develop and use the step height measuring tool in time for the FHEP module production.

12. Develop a more detailed conceptual plan for removing the oil at the end of the experiment. If possible, incorporate any needed changes into the injection molded parts for the Far Detector vertical modules.

6.0 Electronics and DAQ

Primary Writer: Jonathan Lewis

Contributors: Doug Glenzinski, Ben Kilminster

Findings

- Electronics designs are mature. Preproduction modules or designs are available for the ASIC, APD, Front-end board, and data concentrator. The design of the timing control board is close to completion. An integration test of the FEB and DCM is planned for this summer. The preproduction units that have been produced meet the needs of the experiment with only minor improvements foreseen for the production run. There appear to be no obstacles to assembling a preproduction system for the IPND.

- The controls software will be based on the EPICs framework. The low-level interfaces are included in the package, so only high-level programming is needed. The design work appears appropriate for CD3b. The IPND will be the first test of the controls system.

- The cabling and power distribution plans are well advanced. The only significant missing element is the mounting fixtures for power supplies. This should be resolved in the course of building the FSAP.

Comments

- The plans for the APD carrier include a desiccant to prevent condensation at the face of the APD. As yet no testing of the desiccant lifetime has been done.

- During the hiatus, the NOvA team has developed an air-cooling alternative to the water system baseline for APD. The air-cooling scheme could eliminate the need for 50,000 water hose connections that will need to be made and leak checked as the detector is instrumented. The current plan to test the air-cooling alternative on the IPND is sound.

Recommendations

13. During the period that the project was shut down, there has been significant progress in silicon photomultipliers. While the baseline APDs meet specifications, SiPMs provide an opportunity for value engineering by eliminating the need for the cooling system thus simplifying installation and improving long-term reliability.

14. The yearlong shutdown of the project has caused a major disruption in the software effort. At the time of CD2, the manpower available was estimated to be marginal. As a result of the interruption, the project has been forced to rely on physicists instead of computing professionals to write the online software. While requirements documents have been written for the major components, very few have a design specification that can be used as a basis for writing code. The

current level of effort may not be sufficient to provide the plans in a timely way consistent with CD3b. Also, the change in manpower strategy may require a substantial rework of the resource-loaded schedule; however the L2 manager is the person primarily responsible for two significant software elements. Furthermore, because several key components (e.g. event builder) are essential to getting data from the IPND, the software has the potential to become a critical path item. Therefore, the NOvA project should work to identify quickly additional personnel to work on the online software.

7.0 Near and Far Detector Assembly

Primary Writer: Charlie Cooper

Contributors: Tom Diehl

Findings

- NOvA has two detector systems, "Near" located at Fermilab and "Far", located at Ash River. These are WBS 2.8 and 2.9, respectively. The L2 Manager and CAM is Pat Lukens.

- The team is requesting CD3b approval for all of WBS 2.8 and 2.9, with the exception of construction of 6 blocks of modules for the Near Detector. Four of the blocks are to be built for the IPND, and 2 additional blocks recently received CD-3a approval which will allow for completion of the Near Detector.

- Bill Miller presented information on the general assembly schedule and procedures. Victor Guarino addressed the glue machine used to glue layers of the PVC extrusion together. Victor also discussed FEA done on the various components of the superstructure of the detector. Dave Pushka discussed the current design status of the block pivoter which will be used as an assembly stage for the PVC blocks and as a tool to move the blocks into place. Karen Kephart presented work on the near detector and associated work on the IPND. Pat Lukens presented information on the scintillator delivery system.

- The Near Detector (WBS 2.8) will be constructed from 4 blocks used in the IPND, 2 new blocks, and a muon catcher which consists of ten 1 inch thick sheets of steel. Recently the two additional blocks needed for the near detector have been given CD-3a approval because of the availability of ARRA money. The present plan is to operate the IPND as a prototype in the MINOS Service Building until such time as it should be moved into the new nearby cavern. Extensive work has been done on ensuring proper spill containment for the liquid scintillator.

- A majority of the allotted time was spent discussing the Far Detector (2.9) assembly. The 14 kton far detector is made from 6 super blocks and 31 blocks. There are 31 planes per block. One end of the Far Detector is supported by the wall. The other end of the detector is unsupported during construction and will be supported by the block pivoter when the construction is complete. Extensive FEA was done to show that the super structure can support its own weight, when filled with scintillator. The safety factor of a single block filled with scintillator is 2.6 at 4 years. Total construction time is approximately 2 years. No decommissioning plan was shown.

- The construction of the Far Detector is JIT with a two day buffer on PVC extrusions. The construction consists of assembly of a block on the pivot table, moving a block into place with the pivot table, filling the block with liquid scintillator and assembly of the electronic and DAQ system.

- The Far Detector assembly schedule is based on a plan that includes details of the steps being performed and the manpower required. It takes 2.6 weeks to assemble and position a block. The assembly will occur over a two year period using 2 shifts of approximately 13 people per shift for five days a week. 2 people from each shift, called crew chiefs, are scheduled with “minimal tasks” and are meant to fill in for other employees. A change order will soon be made assigning a second technician to each module mover for each shift (total 4 additional FTE).

- A video was shown that demonstrated the function of the glue table and associated pivoter. The video also showed the assembly of one PVC extrusion to a block. The pivoter requires the use of a “dead-mans” switch which protects the operator. The entire area that the single PVC extrusion is rotated in is protected with guards. Extensive work was done to measure the amount of MMA released from the Devcon two part epoxy. MMA is a carcinogen. The most MMA detected was 2 ppm. The TWA for MMA is 125ppm. QC for the mixture of epoxy can be done each shift from a port near the applicator. It is currently unknown whether 3 or 4 glue tables are needed. The storage of the epoxies will be in a separate temperature controlled building. No engineering controls are in place to check for MMA.

- The conceptual design of all parts of the block pivoter is done but the FEA is only done on a few components. Engineering controls are not finalized. It is unknown if workers will be tied off or if guard rails will be placed to avoid someone falling approximately 30 feet from the assembly level to the floor below. It was stated that the only spare parts that are thought to be needed are pneumatic seals. The pallet that is attached to the pivoter will remain with the block when the block is lowered into position. The pallet is intentionally shorter than the thickness of the block to insure the blocks have proper contact.

- There is a 1.5 mm of waviness allowed per meter of PVC extrusion. This may require shimming between extrusions during assembly.

- FEA work was done to analyze for potential failures in the PVC and adhesive. Both the PVC and adhesive strength were found to be sufficient for the lifetime of the project. The bottom of a vertical layer will have 19 psi of pressure on it and will be most susceptible to creep. The proposed effect of creep on the superstructure is that it will cause the bottom of the vertical extrusions to bow out in one direction creating the possibility of buckling. The safety factor of a single block failing while unsupported in the construction time frame was shown as 2.6 over 4 years. The safety factor of the adhesive failing in 20 years was shown at close to 5 for an assumed thickness of 0.030 inches. After 20 years the whole assembly would collapse were it not supported by “bookends”.

- Liquid scintillator is scheduled JIT. The loading dock incorporates full spill containment. The scintillator must go through a heat exchanger to be within 10 °C of the hall ambient temperature. Scintillator goes through QC upon delivery. There is no QC between the heat exchanger and the detector. Air that is forced out of the detector is forced back up to the delivery truck as the truck empties into the detector to avoid fume accumulation in the detector hall. No engineering controls are in place to check for pseudocumene vapors. Scintillator expansion tanks will no longer be used.

Comments

- The level of design is appropriate for CD3b.

- The current design of the glue dispenser and the associated extrusion rotator seem to function well as evidenced by the video shown and the time studies completed. Cleaning, QC and general maintenance of the glue machine appear easier than originally thought.

- The experience of building the FSAP (10 days ago) has been valuable in validating procedures and in performing the time and motion study for Far Detector assembly.

- The Far Detector assembly team maintains some of the expertise and experience developed during MINOS assembly and installation.

- Assembly crew bosses are expected to perform several tasks. Namely, they will be in charge of shift operations, maintaining quality control, “filling-in” in case the shift is short-handed, and coordinating just-in-time deliveries. These tasks seem to require the crew bosses to be in more than one place at a time. The role of coordinating the work and providing quality control is in conflict with performing the actual assembly. The arrangement of upcoming parts deliveries seems to be in conflict with both of those tasks.

- The block pivoter design concepts do not describe the support “dunnage” that prevents the table from inadvertently pivoting during block assembly. The engineering controls (“tie-offs” or rails) to ensure that people do not fall off the block pivoter need to be determined.

- The team indicated there were various scenarios for design/operation/schedule of the Near Detector prototype and it seemed that they weren’t sure what the plan was. The design state of the muon catcher and pivot table for the near detector was also unclear.

Recommendations

15. Continue to monitor the amount of and maintain the capability to ventilate the methyl methacrylate released by the gluing operations of block assembly.

16. The Project should hold a suitable review of the pivot block design demonstrating that it meets requirements during operation as an assembly table and as a “bookend” for the assembled detector. The review should include safety considerations.

17. The role of the Crew Chief should be designed so that they can focus on coordination and quality control and are not planned to be responsible for filling-in on routine assembly tasks or maintaining the logistics of just-in-time supply.

18. The team should present a clear plan for the Near Detector.

19. The team should evaluate the need of pseudocumene sensors during filing of the blocks with scintillator.

20. The team should evaluate the need for quality control of the scintillator down stream of the heat exchanger to analyze/avoid the potential of contamination of the scintillator with the heat exchange fluid.

8.0 Project Management, Cost, Schedule, Funding and ES&H

Primary Writer: Cat James

Contributors: Ed Temple, Fran Clark

8.1 Project Management

Findings

- The management team has openings which need to be filled.
- Technical resources which were reassigned during the zero-funding period have not yet been fully restored.
- All the concerns from the CD-2/3a review have been satisfactorily addressed.
- QA plans were presented in the detector WBS breakout sessions.

Comments

- The Project has lost staff from its management team, notably the Deputy Project Manager, the ES&H Coordinator, and the Documentation Coordinator. There is concern that the Project Office will have difficulties keeping up with its work load if these positions remain unfilled for an extended period.
- This Project has endured a funding rollercoaster. Restarting work has not been swift, as technical resources re-assigned during the low period were not automatically returned when funding was restored. The PMG meetings are designed to assist with these sorts of requests.
- Funding was not only restored, allowing work to proceed again, but given a boost, allowing some activities to possibly move forward. While the opportunity to catch up is positive, moving tasks from the future to the near-present has the potential to create additional pressure on available resources.
- While QA plans were presented, it was observed that these appeared to be under development. More detailed descriptions of written QA procedures were not yet in place.

Recommendations

21. A formalized sign-off process for written QA procedures used in the detector construction needs development.

8.2 Cost, Schedule and Funding

Findings

- The RLS is in the process of an update to bring it into agreement with a new funding profile. CAMs, the construction contractor, and the U of MN are all participating in the schedule update being done to fit the new funding profile.

- Also presented was a method of using the Estimate to Complete (ETC) to identify future tasks which might benefit re-analysis.

- NOvA went through a successful EVMS Certification and approval is expected.

Comments

- Involving as many of the project team as possible in the schedule update will enable team members to take ownership of their work scope.

- It was not possible to closely examine the RLS at this review. A mini-review to focus on the updated RLS before the DOE Review will soon be scheduled. The processes involved in updating the RLS were described. The baseline schedule is not being changed. The Total Project Cost is not changing, nor is the Project completion date. In general, the resource costs and durations associated with tasks are not changing. What is changing are the starting dates of tasks which have not already started.

- The process developed for tracking the ETC is well thought out. It takes a proactive approach by allowing the CAMs to forward plan and use the schedule as a management tool. By using the ETC process, the Estimate at Completion will provide a good estimate of the final project cost and available contingency.

Recommendations

22. The Project should create a table or listing of upcoming manpower needs which summarizes the resource requirements extracted from the updated Resource Loaded Schedule. The Project and the Lab should work together to meet these manpower needs wherever possible, and so take advantage of the funding being provided.

8.3 ES&H

Findings

- Romesh Sood provided a thorough update on the PSAD, guiding documents, and inventory and mitigation of construction/installation phase hazards. SAD will cover the operation phase.

Comments

- Consider adding a radiological hazards section to the PSAD to address residual radiation hazards and mitigations during the installation phase.

Recommendations

23. None

9.0 Charge Questions

9.1 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 final design?

The design is sufficiently mature in a majority of the technical areas. In these areas, procurement and construction can start. The project has completed the design of the Far Site and Building and the construction contract has been awarded. For those elements of the project that are not in the final design stage yet, the project has demonstrated significant progress toward the completion. We believe designs will be sufficiently mature before procurements are issued.

9.2 Baseline Cost and Schedule: Is the approach in updating the cost and schedule appear to be sound and defensible? When the updates are completed should the following two questions be able to be answered by the DOE IPR (Are the current project cost and schedule projections consistent with the approved baseline cost and schedule? Is the contingency remaining adequate for the risks?)?

The approach presented is sound. Once the updates are completed, the questions about cost, schedule and contingency will be answered.

9.3 Management: Evaluate the management structure as to its adequacy to deliver the proposed final design within specifications, budget and schedule. Yes, the NOvA management structure appears to be appropriate to deliver the design within the performance baseline. **Has the project responded satisfactorily to the recommendations from the previous independent project review?** Yes

9.4 Construction: Has there been adequate progress on the construction activities approved under CD3A? Have Fermilab and the project done the necessary preparations to execute the remaining constructions activities?

The original CD3a activities included several accelerator and NUMI upgrade items, Ash River Site Preparation package, liquid scintillator waveshifter acquisition, and front-end board readout ADC packaging. The latter 3 items have been fully committed. Because of the circumstances the Project has faced, some parts of the original CD3a request in WBS 2.0 have been replaced, through change control, by four other items that are more ready to advance. We find there has been adequate progress on the new list of CD3a tasks. Preparations and plans for the remaining construction activities are adequately underway.

9.5 Documentation: Is the documentation required by DOE Order 413.3A for CD3-B complete? Has the CD-2 documentation been updated to reflect any changes resulting from the final design?

Yes, CD-2 project documentation has been updated. For CD-3B, yes for the most part. Project will provide a table for IPR outlining status of design documents to demonstrate design maturity. Hazard Analysis Report aligns with PSAD. PEP will be updated due to new funding profile. QA Plan will be updated to align with Fermi QA Program now undergoing revision.