Report of the Production Readiness Review of the ProtoDUNE Single Phase PSL Anode Plane Assemblies

April 27, 2017

DEEP UNDERGROUND NEUTRINO EXPERIMENT

1.0 PURPOSE/ SCOPE

The purpose of this review is to ensure there is a fabrication process in place and documented. The fabrication process should include the fabrication steps taken to complete the component and the define the quality control inspections and tests that will be performed to ensure the component meets its design and intended function.

The scope of the review included a review of the applicable documentation that had been uploaded to an Indico site and Docdb. The documentation reviewed is listed at the end of this report in Attachment A. These documents were reviewed by the Project Electrical and Mechanical Engineers, the Project ESH Manager, the Project QA Manager and the DUNE-US Project Manager. The DUNE QA Manager held the review at Physics Science Laboratory (PSL) on April 27, 2017. Regina Rameika, ProtoDUNE Construction Coordinator attended the review.

2.0 Comments

The ProtoDUNE Single Phase Anode Plane Assemblies (APA) team at PSL are very experienced and very knowledgeable. The fabrication of the APA consists of the assembly of the frame, preparation of the frame for winding, winding of the X, V, U and G layers of wires and performing Continuity Tests and Leakage tests of the wires and the PC Boards. Frame assembly will be performed by a vendor who has qualified welders and weld procedure specifications. Assembly of the PC Boards, combs, winding and testing is performed at PSL. Travelers have been developed for the fabrication of the APA. The traveler has been put into practice during the fabrication of APA #1. Drawings have been developed for APA ME Frame Assembly, Frame Assy w Comb Base and Mesh, Frame Assy w Four Wire Layers and Factory APA. A drawing is in development for the Fully Integrated APA Assembly which will be used during the integration/installation at CERN.

Open recommendations from the APA Design Review were reviewed during this review. There were nineteen recommendations, one recommendation was previously closed. Eight recommendations could be closed based on this review. Procedural recommendations that require further work are included as a recommendation to this report. The other types of recommendations do not affect production readiness. An updated status of the recommendations will be provided to the ProtoDUNE US Project Manager.

Hazard analysis has been performed for the Winder activity. It has been completed on 8/10/2016. For Cryogenic work a hazard analysis was completed for an outdoor environment on the Horizontal Test for the 40% APA. A Cryogenic Hazard Analysis and procedure needs to be developed for the CR Board Test and the Cold Box Testing (if performed). The Hazard Analysis for crane operations and overhead lifting is in the Kegonsa Research Campus Safety Policy and Procedures. Safety Data Sheets are maintained electronically and hard copy book is in the Rowe Building where work is being performed.

PSL has a documented process for addressing nonconforming items with the use of a Nonconformance Report. Eleven Nonconformance Reports have been issued to date. Nonconformance Reports NC-PSL-8757-004, 005, 009, 10, 11 states that the planned disposition has been completed and preventive action has been initiated but the date in the closure of the report is not filled in. Nonconformance

Report NC-PSL-8757-006 appears to be completed but there are no dates listed for the completion of the Disposition, Preventive Action or Closure of the report.

PSL has a plan to get CERN's approval for structural integrity of the APA based on a detailed engineering analysis. This is being coordinated with the ProtoDUNE Construction Coordinator. The CERN HSE approval for handling of the APA at CERN is being coordinated through the ProtoDUNE Installation and Integration group.

3.0 Recommendations

3.1 Drawings used in the assembly and fabrication of the APA need to have the approval process completed. The status is that the drawings have the initials of the preparer and the date drawn. There is no evidence the drawings have been reviewed and approved. The manager responsible for the APA as a minimum should review and approve the fabrication drawings.

3.2 Verify the dates of the actions completed on the Nonconformance Reports and fill in is as necessary. If the Nonconformance Report is still open, the Closure section should not state the actions have been completed, section should be lank until actions are completed. Once actions completed complete section and put in name and date.

3.3 Complete the final version of the QC Plan based on the latest procedure revisions.

3.4 Complete the procedure for the CR Board Testing and finalize the manufacturing procedures.

3.5 Complete the ESH Documentation for the cryo testing for the board testing.

3.6 Upload the following documentation to the Docdb:

a. Grid CR Board (Schematic, BOM, layout files, location on the APA and complete wiring diagram from bulkhead to the board)

b. Electron Diverter Board (Schematic, BOM, layout files, location on the APA and complete wiring diagram from bulkhead to the board)

c. FC Termination board (Schematic, BOM, layout files, location on the APA and complete wiring diagram from bulkhead to the board)

d. Adapter Board which goes between the CR board and the BNL Cold Electronics Board (Schematic, BOM, layout files)

NOTE: It is understood that some of this information must be obtained from the PSL APA interfaces such as BNL.

4.0 PSL Anode Plane Assemblies Production Readiness Review Team

Name	Title
Kevin Fahey	LBNF/DUNE QA Manager
Michael Andrews	LBNF /DUNE ESH Manager
Theresa Shaw	DUNE Project Electrical Engineer
Jack Fowler	DUNE Project Mechanical Engineer
Jolie Macier	DUNE-US Project Manager
Steve Kettell	DUNE International Project Manager

4.0 PSL Anode Plane Assemblies Team

Name	Title
Robert Paulos	Manager for APA
Pam Marr	PSL Engineer
Jeff Wong	PSL Mechanical Designer
Kevin Koehler	PSL Mechanical Engineer
Andy Laundrie	PSL Engineer
Dan Wenman	PSL Engineer

5.0 Summary

Upon completion of the recommendations 3.3, 3.4 and 3.5, PSL will be ready to begin production. A written response to the recommendations is requested within two weeks of the receipt of this report. If there any questions or a need for more information, contact Kevin Fahey at 630-840-2693.

Attachment A

Anode Plane Assembly Production Readiness Review Documentation

- Anode Plane Assembly Description
- Anode Plane Assembly Design Review Recommendations
- 8752Doc001, Rev. C, ProtoDUNE Frame Assembly APA Manufacturing Procedure
- 8752Doc003, Rev. A, ProtoDUNE Preparation for Winding APA Manufacturing Procedure
- 8752Doc005, Rev. A, ProtoDUNE Installation of first (X) wire layer APA Manufacturing Procedure
- 8752Doc006, Rev. -, ProtoDUNE Installation of first (X) wire layer APA Manufacturing Procedure
- QC Plan for Anode Plane Assembly
- Travelers for Frame Assembly, Wind G, Wind U, Wind V
- Drawing Series 8757 002, Frame Assembly w 4 Wire Layers
- Drawing Series 8757 003, Frame Assembly w Comb Base and Mesh
- Drawing Series 8757 004, APA ME Frame Assembly
- Drawing Series 8757 030, Factory APA
- PSL Nonconformance Log
- PSL Nonconformance Reports NC-PSL-8757-001 through 011

Note: These documents are filed in the PSL Doc Base.