Report of the Production Readiness Review of the ProtoDUNE Single Phase Cold Electronics Mechanical Components

March 28, 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 Project QA Manager held the review at Brookhaven National Lab on March 28, 2017. The Project ESH Manager, Project Mechanical Engineer and the DUNE-US Project Manager participated in the review at Brookhaven. The Project Electrical Engineer participated via teleconference. The Brookhaven personnel who participated are listed at the end of this report.

2.0 Comments

The ProtoDUNE Single Phase Cold Electronics team at Brookhaven National Lab are very experienced and very knowledgeable. The following documents had been uploaded to the Docdb 2695 for the review: Cold Electronics Installation at CERN, Cold Electronics Mechanical PRR Document Checklist, Cold Electronics QA/QC Electricals Description, Cold Electronics QA/QC Mechanicals Description, and the applicable drawings for the components. Matt Worcester of BNL gave an overview of the Cold Electronics Mechanicals and the fabrication and QC aspects of the components.

The ProtoDUNE Cold Electronics are made up of four main components:

- Cold Electronics Box
- Signal Feedthrough consisting of the Tee pipe and Crossing Tube Cable (CTC) support
- CE warm components consisting of the Warm flange, Flange PCB and Warm Interface Electronics Crate (WIEC)
- Cold Cable

BNL has proposed the following grounding plan which will be presented to the DUNE Grounding & Shielding Committee:

- 24V provided by CERN DCS slow control
- Isolate 24V with optical switches at DCS rack
- Isolate shield of db25 connector at signal FT

The Front End Mother Boards (FEMB) are individually enclosed in the Cold Electronics Box. ESD protection is provided for ASICs and FEMB circuitry and Faraday shield. The Cold Electronics Box attaches to the APA Adapter with built-in cable strain-relief. Low impedance connection is provided from FEMB ground to APA frame.

The drawings uploaded into Docdb for the Cold Electronics include signal feed-through warm flange, Cold Electronics (CE) Box for ProtoDUNE single phase FEMB, Cold Electronics and Photon Detector signal

feed-through Tee pipe, Flange Board, Warm Interface Electronics Crate, Cold Cables and Signal Feed through CTC Support. The drawings for the Warm Interface Electronics Crate (WIEC) and the Signal Feed Through Warm Flange reference the SBND Project and do not indicate any applicability to the ProtoDUNE Project. These drawings should be revised to reflect applicability to ProtoDUNE. This can be done by adding a note or given a separate ProtoDUNE drawing number. There are several drawings that have not been approved. The drawing approval status for the drawings in Docdb is shown in Attachment B. The drawings need to be approved prior to fabrication.

The roles and responsibilities for Environmental, Safety, and Health support and oversight are clearly integrated into the management of the DUNE Cold Electronics work at Brookhaven. Matt Worcester, as the L3 manager, understands his ESH oversight responsibilities for the work taking place at BNL. The daily ESH management of the work activities within the lab is completed by Ken Sexton, who resides within the laboratory space. In Addition, the BNL Physics Department ESH Manager, Ron Gill, provides ESH support and oversight to validate that the DUNE work activities are compliant with BNL ESH requirements.

An experimental review was completed on March 1, 2016 and there is a BNL Experimental Safety Review Form in place for the work activities being completed within the lab working space. The ESH training requirements for personnel are defined in Section IV of the review form. The experimental review form did identify the next Annual Review Date as March 2, 2017, which has not been completed yet. The next experimental review should address the use of Michigan State University students and acceptance of MSU equipment used within the lab space.

There are handling procedures in place for the transportation and use of both a 250-liter transport/storage dewar and a 160 Liter open-top dewar of liquid nitrogen located within the lab space. A ODH analysis was also completed with the lab space classified as a ODH 0. It was stated by Ron Gill that with the addition of new equipment being supplied by MSU that the ODH analysis will be re-evaluated. While visiting the lab space we observed an employee working with the open top liquid nitrogen dewar testing components. The employee was not wearing the required personal protective equipment which are insulated gloves and face shield, both of which were available within the lab space.

Equipment is being designed to include interlock systems to prevent injury to personnel and damage to equipment including thermal sensors.

3.0 Recommendations

- 3.1 Complete the annual experimental review and include hazards and mitigations relating to the introduction of MSU students and equipment.
- 3.2 Complete the QC Plan and receipt inspection, fabrication and testing procedures prior to the start of fabrication.
- 3.3 Upload the final version of the test software with the software verification documentation in Docdb.
- 3.4 Upload the Thermal Calculations into Docdb.
- 3.5 Develop the Job Travelers and upload into Docdb.
- 3.6 Complete the design and fabrication of the Flange Production Fixture.

3.7 Revise drawings for the Warm Interface Electronics Crate (WIEC) and the Signal Feed Through Warm Flange to indicate they are applicable to the ProtoDUNE Experiment.

3.8 Complete the applicable approvals of all drawings. Prior to final production, subsystem drawings should be signed by an engineer at BNL. Further, an integration check will be performed by the Project Electrical and Mechanical Engineers or their designees. This integration check will validate assembly interfaces.

3.9 Develop ESD safe handling procedures for electrical components sensitive to ESD damage. This includes packing, shipping, unpacking, installation and cabling. We should not rely on protection diodes on the FE cards.

3.10 Develop QC procedure to verify any low impedance connections which are required by the proposed grounding plan.

4.0 BNL Cold Electronics Mechanicals 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

4.0 BNL Cold Electronics Mechanicals Team

Name
Matthew Worcester
Hucheng Chen
Jason Farrell
Jack Fried
Shanshan Gao
Ron Gill (BNL ESH)
Jim Kierstead
Jessica Li
Ken Sexton
Bo Yu
Manhong Zhao
Carl Bromberg (Michigan State)
Jim Stewart (BNL Far Detector)

5.0 Summary

The Review Team recommends the BNL Cold Electronics Team begin production on the mechanical components once the QC Plan, travelers and fabrication, inspection and testing procedures have been put in place. Procurement of long lead time items can be procured prior to the procedures being completed but they should be procured to fully approved drawings. A written response to the recommendations is requested within two weeks of the receipt of this report. The response should be

sent to Kevin Fahey at Kfahey@fnal.gov. If there any questions or a need for more information, contact Kevin Fahey at 630-840-2693.

Attachment A

Cold Electronics Mechanical Production Readiness Review Documentation

- CE Mechanicals PRR Checklist
- Cold Electronics QA/QC for SBND and ProtoDUNE-SP, Rev. 1.2
- Cold Electronics Mechanicals QC for ProtoDUNE-SP, Rev. 1.3
- ProtoDUNE-SP CE Mechanicals Overview March 28, 2017
- Signal Feed-through Warm Flange Drawings
- Cold Electronics (CE) Box for ProtoDUNE Single Phase FEMB Drawings
- Cold Electronics and Photon Detector signal feed-through Tee pipe Drawings
- Flange Board Drawings
- Warm Interface Electronics Crate Drawings
- Cold Cables Drawings and Data
- Signal Feed through CTC Support Drawings.

Note: These documents are filed in Docdb 2695

Attachment B

BNL Cold Electronics Mechanicals Drawing Approval Status

Drawing Number	Title	Rev	Prepared By	Checked By	Approved By
PDUNE-400	PROTODUNE COLD ELECTRONICS ENGR MGR CE_BOX_ASSY	A	J Li	J. Farrell	M.Zhao
PDUNE-400-1-1	PROTODUNE CE_BOX_BASE_ASSY CE_BOX_BAS	A	J Li	J. Farrell	M.Zhao
PDUNE-400-1	PROTODUNE CE_BOX_ASSY CE_BOX_BASE_ASSY	A	J Li	J. Farrell	M.Zhao
PDUNE-400-2-1	PROTODUNE CE_BOX_COVER_ASSY CE_BOX_COVER	A	J Li	J. Farrell	M.Zhao
PDUNE-400-2	PROTODUNE CE_BOX_ASSY CE_BOX_COVER_ASSY	A	J Li	J. Farrell	M.Zhao
PDUNE-400-3	PROTODUNE CE_BOX_ASSY CE_BOX_OPENING_COVER	A	J Li	J. Farrell	M.Zhao
PDUNE-400-5	PROTODUNE CE_BOX_ASSY CLAMP_BLOCK_BASE	A	J Li	J. Farrell	M.Zhao
PDUNE-400-4	PROTODUNE CE_BOX_ASSY CLAMP_BLOCK_TOP	A	J Li	J. Farrell	M.Zhao
Tee-350-350-375	TEE	A	M.Zhao		
CE_CRATE_INSTALLED_ON_TEE	ProtoDUNE WARM ELECTRONICS CE_CRATE_INSTALLED_ON_TEE	None	J. Farrell		
PDUNE-200	SBND-DUNE WARM ELECTRONICS FEEDTHROUGH PDUNE_WARM_FT_ASSY	A	J. Farrell		H Chen
SBND-201	SBND PDUNE_WARM_FT_ASSY SBND WARM FT WELDMENT	D	J. Farrell		B Yu
SBND-201-1	SBND SBND_WARM_FT_WELDMENT- TUBE_.375"_OD_X_1.38"_LG	D	J. Farrell		
SBND-201-2	SBND SBND WARM FT WELDMENT CF_1-333_X_375_ID_ROTATABLE_CLR	D	J. Farrell		
SBND-201-3	SBND WARM FT WELDMENT SHV_CONN_ASSY	D	J. Farrell		
SBND-202	SBND ELECTRONICS FEEDTHROUGH SBND WARM FT FLANGE	D	J. Farrell		
SBND-204	SBND ELECTRONICS FEEDTHROUGH SBND_WFT_PCB_SQUASH_PLATE	B	J. Farrell		B Yu
10-1658-1	ProtoDUNE Flange Board	A	K. Wolniewicz		
	ProtoDUNE Flange Sec A-B	None	Jack Fried		
	ProtoDUNE Flange Sec C-D	None	Jack Fried		
	ProtoDUNE Flange Sec E-F	None	Jack Fried		
SBND-220	SBND SBND_WARM_FT_ASSY-CRATE-CARDS SBND_WIEC_ASSY	C	J. Farrell		
SBND-220-1	SBND SBND_WIEC_ASSY SBND_WIEC_FAN_WALL	C	J. Farrell		
SBND-220-2	SBND SBND_WIEC_ASSY SBND_WIEC_END	C	J. Farrell		
SBND-220-3	SBND SBND_WIEC_ASSY SBND_WIEC_SIDE_ASSY	C	J. Farrell		
SBND-220-3-1	SBND SBND_WIEC_ASSY SBND_WIEC_SIDE	C	J. Farrell		
SBND-220-4	SBND SBND_WIEC_ASSY SBND_WIEC_END_BASE	C	J. Farrell		
SBND-220-5	SBND SBND_WIEC_ASSY SBND_WIEC_FAN_WALL_BASE	C	J. Farrell		
PDUNE-300-1	PROTODUNE CROSS_TUBE_CABLE_SUPPORT HOOD_ASM	A	J Li	J. Farrell	M.Zhao
PDUNE-300-1-1	PROTODUNE HOOD_ASM HOOD_CYL	A	J Li	J. Farrell	M.Zhao
PDUNE-300-1-2	PROTODUNE HOOD_ASM HOOD_THIN_RING	A	J Li	J. Farrell	M.Zhao
PDUNE-300-1-3	PROTODUNE HOOD_ASM HOOD_THICK_RING	A	J Li	J. Farrell	M.Zhao
PDUNE-300-4	PROTODUNE CROSS_TUBE_CABLE_SUPPORT INNER_TUBE_ASM	A	J Li	J. Farrell	M.Zhao
PDUNE-300-4	PROTODUNE CROSS_TUBE_CABLE_SUPPORT INNER_TUBE_ASM	A	J Li	J. Farrell	M.Zhao
PDUNE-300-4-3	PROTODUNE INNER_TUBE_ASM INNER_TUBE_THICK_RING	A	J Li	J. Farrell	M.Zhao
PDUNE-300	ProtoDUNE CROSSING_TUBE_CABLE_SUPPORT_ASSY CROSSING_TUBE_CABLE_SUPPORT	-	J. Farrell		M.Zhao