**­Design Review:**

**DUNE Single Phase Anode Plane Assembly**

**13–14 July 2016**

**REPORT OUTLINE/WRITING ASSIGNMENTS**

1. Introduction Kettell

2. APA Technical

* 1. 2.1 Mechanical Rucinski

2.1.1 Findings

2.1.2 Comments

2.1.3 Recommendations

* 1. 2.2 Electrical/Grounding Terranova

2.1.1 Findings

2.1.2 Comments

2.1.3 Recommendations

1. Project Management & ES&H Baller

3.1 Findings

PSL has played a lead role in the APA mechanical design since 2011.

They have produced a 40% scale mechanical prototype (of the full-sized 2.3 x 6 m APA), four functional prototypes of 20% scale for the 35-ton prototype detector and a full-scale modular prototype that allows alignment during assembly.

APA construction is a major activity for PSL for the next year. Other projects such as LZ and the Photon Burst Laser System and smaller jobs during this time.

The major source of wire breakage in the 35-ton prototype was found to be due to wires that cross wire carrier board boundaries. A simple change to the solder pad placement has fixed this problem.

3.2 Comments

The APA Coordination and Management organization chart was presented. The roles and responsibilities seem to be well understood by those involved but these are not apparent to an outsider. For example, people who have advisory roles, such as Bo Yu, Michelle Stancari and Andrzej Szelc, should be shown in a separate box. The name of an ES&H Professional (or TBD since none exists at the current time) should be shown on the organization chart.

PSL is well positioned to produce 4 APAs for protoDUNE by next spring. The APA sections appear to have the required features to interface with the cold electronics and photon detection systems. The winding machine was operating in the clean room, sans APA and wires, during the tour. The clean room appears ready to receive the rest of the assembly equipment.

The technical interface between the APA and PD is currently defined by an assembly procedure. Elements of the PD were test fitted in a APA mockup at Colorado State University, demonstrating that the interface between these systems is defined for these prototypes. This however does not ensure that future design changes in one system will be accepted by the other system and properly propagated to it.

The winding machine has engineered and administrative controls to prevent injury to operators but these have not been reviewed by a ES&H professional due to the (recent) lack of such a person at PSL. A search is underway for a contract ES&H professional.

All installation and fabrication process documentation, especially for the winding machine, should be reviewed in an independent process and safety documentation should be presented. All transportation and lifting tools should be certified by an independent body.

The delayed funding for APA production in the UK creates a serious schedule risk. Procurement, construction and commissioning of a UK winding machine could easily take 6 months.

Samples and coupons from APA components should be kept to provide the possibility of doing future analyses if unanticipated effects are seen during protoDUNE operation. Consideration should be given to testing major components such as the APA frame tubing for background radioactivity prior to their use.

A preliminary suite of acceptance tests was presented. The presenters, Jonathan Asaadi & Mitch Soderberg, have significant experience from constructing and commissioning MicroBooNE that will benefit DUNE. The presence of several students and post-docs at PSL is required to perform and document these tests and repeat them at some level at CERN next year.

It would be valuable to keep a count of the number of wires in each APA that were found to a) have a catastrophic break, b) be loose, c) have an open circuit indicating a break between the solder joint and the epoxy bead and d) be successfully attached.

3.3 Recommendations

Increased attention to technical interface documentation and management is required. Mechanical and electrical drawings to define the technical interfaces between systems are needed.

Have an ES&H professional review the personnel safety controls on the winding machine as soon as possible. Consult with Mike Andrews to see if Fermilab can provide this service.

Ensure that the APA construction and transport procedures are identical in the U.S. and the UK. Define clearly the limits of the UK responsibilities to manufacture a system which has been designed in the US.

Perform a APA production readiness review with particular emphasis on winding machine operation and personnel safety.

A significant schedule and resource allowance should be made to ensure that the APA acceptance tests are fully completed and documented. Ideally these tests would be made on the second shift so as not to interfere with wire winding on the first shift.

## Appendices

1. Charge
2. Review Participants
3. Review Agenda