



September 12, 2011

To: Michael Lindgren
Head, Particle Physics Division

From: W. E. Cooper
Chair, Large Quantity Liquid Argon Cryogenic Safety Review Panel

Subject: Liquid Argon Purity Demonstration (LAPD) Recommendations

Dear Michael,

The Panel has reviewed the Liquid Argon Purity Demonstration (LAPD) in accordance with your charge of February 11, 2010. Our conclusion is that cryogenic aspects of the system, its enclosures, and associated infrastructure allow operation which is safe for people and the environment. In reaching that conclusion, we have confirmed that those requirements of the Fermilab Environmental Safety & Health Manual (FESHM) which apply to cryogenic systems have been satisfied.

The following documentation was provided to the Panel and is posted at <http://lartpc-docdb.fnal.gov:8080/cgi-bin/ShowDocument?docid=553>.

- System equipment and operation description
- Flow sheets (444897.pdf)
- Component list
- Control loop and interlock description
- PLC interlock documentation
- System procedures
- Commissioning plan
- Emergency procedures
- System expert list
- Failure mode and effects analysis (FMEA)
- What-if analysis
- PC4 enclosure oxygen deficiency hazard (ODH) analysis
- PC4 gas shed ODH analysis
- ODH system check out
- PC3 upstream ODH barrier and fan with streamers
- Condenser pressure vessel (PV) note
- Phase separator PV note
- Tank engineering note
- Molecular sieve and oxygen filter PV notes
- Liquid nitrogen (LN2) and liquid argon (LAR) piping engineering notes

Also posted at that location are:

- Status and response to issues raised during the August 26, 2011 safety panel walk-through
- Reference – LAPD controls overview

Reference – PC4 building drawings
Reference – PC4 hazard map
Reference – Piping failure rate source
Reference – Pressure vessel failure rate sources

Panel members have reviewed each of these documents and recommended changes to them to ensure FESHM requirements will be satisfied. We are pleased that those recommendations were implemented and are satisfied that the present documents satisfy FESHM requirements. They should lead to cryogenic operations which are safe for people and the environment. Vessel and piping systems follow applicable portions of FESHM chapters 5031, 5032, 5033, and 5034 (and associated sub-sections) and sound engineering practices. Vessels and piping have been properly designed, fabricated, and tested. We are satisfied that engineering notes, the “Failure Mode and Effects Analysis” (FMEA), and the “What-if Analysis” demonstrate that vessels and piping should remain safe under single component and plausible multiple component failures. The “Piping and Instrumentation Drawing” and the “Valve and Instrumentation List” are complete and accurate to the best knowledge of the Panel.

The PLC-based control and instrumentation system monitors system status and parameters, allows control of some valves, provides notifications if parameters are abnormal, and provides a secondary path for activation of some of the protective devices. Uninterruptable power has been provided to the PLC system to ensure it remains functional during power outages of one to two hours duration. We regard the PLC system as critical to the successful conduct of the purity test, but not to the safety of people or the environment. The overall cryogenic system has been designed to provide primary and sufficient protection to all piping and vessels independent of the action of the PLC system.

Oxygen deficiency hazards were evaluated in accordance with FESHM 5064. An oxygen deficiency hazard (ODH) class of 1 was assigned to PC4. Ventilation is required in the secondary egress path from PC3 to PC4 and has been provided. The gas shed for PC4 was determined to have an ODH classification of 0. The Panel is satisfied with the ODH analyses and protective measures. An exhaust ventilation blower is automatically activated by oxygen deficiency monitors upon the detection of an oxygen deficient atmosphere in PC4 and appropriate alarms are provided to initiate an evacuation of PC4. Entry to PC4 and its gas shed will be limited to authorized and properly trained personnel through the use of specially-keyed entry locks.

We have reviewed and are satisfied with system procedures, the commissioning plan, emergency procedures, and the system expert list. The emergency procedures specify actions to be taken in case of system failures, power outages, and severe weather conditions. We have been assured that actions to be taken in case of fire have been reviewed with Fire Department personnel. The expert list specifies the personnel who are necessary and qualified to execute each system procedure.

We have occasionally provided advice on issues which do not directly impact the safety of people or the environment, but which may be helpful in ensuring the success of the purity demonstration. The following comment falls into that category. We are concerned that the large number of manually operated valves in the system could lead to procedural errors, particularly if it is necessary to interrupt the standard, documented procedures. A quick way to verify the positions of all manual valves might prove useful.

The Panel made three walk-through inspections of the installation: two during early stages of the installation and one on August 26, 2011, when the installation was nearly complete. Most walk-through

findings have been addressed. The Panel considers two findings from its walk-through to be more closely related to general safety than to cryogenic safety. We suggest that PPD ES&H make a determination of actions to be taken on them. Those findings are: "Backing for racks on the upper platform should be provided to reduce the potential for falling equipment" and "A wasp patrol should be conducted around the exterior of the building".

We recommend that you authorize LAPD fill, cool down, and operation once the following items have been completed:

1. All Operational Readiness Reviews have been successfully completed and approved.
2. ODH classification signs have been posted.
3. An inspection has been made to ensure that locks have been re-keyed to limit access.
4. Emergency lighting has been provided.

Sincerely,



W. E. Cooper,
On behalf of the Panel

cc:

L. Bellantoni (Committee Coordinator, PPD Experimental ES&H Review Committee)

A. Klebaner (Head, Cryogenic Safety Subcommittee)

R. L. Schmitt

T. Tope

Review Panel Members

(W. Cooper, B. DeGraff, G. Ginther, L. Hammond, E. McHugh, R. Rabehl, J. Theilacker)