LBNF Final Design Review Charge

Far Detector Cryogenic Systems

20-22 September 2022

***The bold-blue-highlighted text was revised after the review presentations, at the request of the review committee, and approved by the LBNF-DUNE Review Office and cryogenics team**

The committee is requested to review the LBNF Far Detector Cryogenic Reference Design, a documentation package. The documentation serves as the complete technical specification for suppliers of the system.

Background

A Preliminary Design Review (PDR) of the LBNF Cryogenic Systems was held July 2019. The final report including comments and the responses to those recommendations are found in this EDMS folder (public). The same review team has agreed to participate in this Final Design Review.

The Reference Design documentation for this Final Design Review is found at this link. The file *List of Documents for Acquisition* provides the summary listing of the contents of the Reference Design package.

The cryogenic systems are divided into portions, determined by function, geographical layout or a combination of both, with portions assigned to different LBNF-DUNE collaboration partners; a table showing the assignments is in Appendix A. The supplier of the portions provided by the LBNF Project will be selected through competitive bid administered by the host lab. **Other portions are provided by participating LBNF-DUNE collaboration partners as In-Kind contributions; these may be supplied by competitive bid, by internal fabrication, or a combination of both, according to the collaboration partner preference and expertise*.** All suppliers of the cryogenic systems, whether through the LBNF Project or through In-Kind contributions, are instructed by the Reference Design to provide final design & layout, materials purchase, fabrication, testing, delivery, installation and requisite documentation for each stage.

This review

The committee is asked to respond to the following questions:

1. Have recommendations from the Preliminary Design Review been addressed to this committee's satisfaction?
2. Are the Reference Design materials complete, functioning as complete technical specification **appropriate for a commercial tender of the DOE supplied equipment, and providing sufficient**

information for collaboration partners to deliver their scope*? Please provide a response for each of the top-level items in the List of Documents for Acquisition (as applicable):

a. Statement of Work / Specifications
b. Interface Matrix
c. Process Flow Diagram / P&IDs
d. 3D Envelopes
e. 2D Drawings / Isometrics

3. What are the relevant Lessons Learned from the similar cryogenics system acquisition (design – fabrication – installation) – for example the acquisition performed for the Neutrino Platform detectors (the two ProtoDUNE systems at CERN and the two SBN systems at Fermilab)? Have these lessons been incorporated into this acquisition for the LBNF/DUNE Far Detector cryogenics?

Review Findings:
The committee should present its findings, comments and recommendations in a final written report by *(proposed deadline)* 01 November 2022.

Appendix A – Summary of Scope

All committed contributions.

*Switzerland contribution is via CERN.

Scope Assignment

Item	FD-1	FD-2
Cryostat (Part of FS Integration)	CERN	CERN
Cryogenics Systems Integration	DOE	DOE
Nitrogen System (Refrigeration + LN2 Storage + distribution) – Engineering / Manufacturing / Installation / Commissioning	DOE	DOE
Argon Receiving Facilities (surface)	DOE + CERN	DOE + CERN
Argon condensers system – Engineering / Manufacturing	Switzerland*	Brazil
Argon distribution	DOE	DOE
Argon purification and regeneration – Engineering / Manufacturing	Brazil	Brazil
LAr circulation – Engineering / Manufacturing	Brazil	Brazil
GAr boil-off and pressure control	DOE	DOE
Process Controls	DOE	DOE
Internal Cryogenics – Engineering / Manufacturing (Part of FS Integration)	Poland	Poland
Installation of In-Kind Contributions (IKC)	DOE	DOE
Collect safety docs and obtain safety approval	DOE	DOE
Purge and cool down	DOE	DOE
LAr procurement and LAr fill (**only LAr for FD-2, not labor)	DOE	DOE**