Contribution ID: **593** Type: **Contributed Oral**

C3Or4C-08: Overview and status of the Long-Baseline Neutrino Facility Far Detectors cryogenics system

Wednesday 12 July 2023 18:00 (15 minutes)

The Sanford Underground Research Facility (SURF) will host the Far Detectors of the Deep Underground Neutrino Experiment (DUNE), an international multi-kiloton Long-Baseline neutrino experiment that will be installed about a mile underground in Lead, SD. Detectors will be located inside four cryostats filled with almost 70,000 metric tons of ultrapure liquid argon, with a level of impurities lower than 100 parts per trillion of oxygen equivalent contamination. The cryogenics infrastructure supporting this experiment is provided by the Long-Baseline Neutrino Facility (LBNF). This contribution presents modes of operation, layout and main features of the LBNF Far Detectors cryogenics system, which is composed of the following subsystems: argon receiving facilities, nitrogen system, argon distribution system, argon purification and regeneration systems, argon circulation system, argon condensers system, internal cryogenics, miscellaneous items, and process controls.

The argon receiving facilities include the equipment to receive the argon in liquid phase on the surface, vaporize it and transfer it underground as a gas.

The nitrogen system provides cryogenic refrigeration and is composed of a refrigeration system, liquid nitrogen buffer tanks and liquid and gaseous nitrogen distribution pipes to and from the argon condensers and other users.

The argon distribution system distributes liquid and gaseous argon to and from the purification system and the condensers and the cryostats.

The argon purification and regeneration system purifies gaseous and liquid argon to the level required by the experiment using molecular sieve and copper beds. The media requires activation prior to its use and periodic regeneration cycles throughout the life of the experiment to release the impurities that are being removed from the argon and trapped inside the media.

The argon circulation system consists of two sets of pumps to circulate the bulk of the liquid and the recondensed argon through the purification system and back to the cryostat.

The argon condensers system consists of condensers and nitrogen and argon phase separators to recondense the boil-off argon from the cryostat and deliver the purified argon back to the cryostat.

The internal cryogenics comprises the liquid and gaseous argon distribution inside each cryostat for the commissioning, cool down, fill and steady state operations of the cryostats and detectors.

The miscellaneous items consist mainly of the cryostat boil-off, pressure control systems and some other ancillary equipment.

The process controls provide the means to monitor and operate the systems. They include Programmable Logic Controller (PLC) cabinets, wiring, Human-Machine Interface (HMI), programming, and Oxygen Deficiency Hazard (ODH) hardware and software.

An international engineering team is designing these systems and will manufacture, install, test, commission, and qualify them. This contribution describes the main features, performance, functional requirements and modes of operation of the LBNF Far Detectors cryogenics system. It also presents the status of the design, along with present and future needs to support the DUNE experiment.

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Session Classification: C3Or4C: Large Scale V: Transfer Lines and Distribution Systems