Commissioning Plan for the Liquid Argon Purity Demonstrator

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I. INTRODUCTION

This document describes the commissioning and run plan for the Liquid Argon Purity Demonstrator (LAPD). It describes both the process for determining the stability of the system as well as the planned tests for each phase of the process.

There are three primary measurement systems in LAPD; *i*) resistive thermal devices (RTD) that measure temperature gradients in the vessel, *ii*) oxygen sampling tubes that sample the concentration of O_2 in the gas at various depths in the vessel, and *iii*) purity monitors used to determine the electron lifetime in the liquid. The RTDs and purity monitors are located in two locations, the center of the vessel and near the outer wall of the vessel.

All calculations of concentrations and durations of the various stages are described in

`http://lartpc-docdb.fnal.gov:8080/cgi-bin/ShowDocument?docid=627.`

II. TESTING OF PLC DEVICES

The testing and verification of the PLC devices will be done before any argon is placed into the system. Dan Markley and his group will verify that the devices are performing as expected.

III. GASEOUS ARGON PURGE

The first phase of operation is the purge using gaseous argon. The gas will come from the vaporization of liquid argon in dewars obtained from the stockroom. During the initial input of argon, we expect the argon to act as a piston to push the atmosphere out of the vessel as the argon is heavier than atmosphere. We will vaporize 11 liters per hour, which produces 314 cubic feet of gas per hour, for a rate of rise in the tank of 4 feet per hour. After the initial piston purge, we will continue to flush the interior of the tank with five more volume exchanges of argon gas. We expect to run in this configuration for at least 30 hours. Terry Tope will be present during the first 8 hours of the purge. After 8 hours we will evaluate the performance of the system and if no problems are observed we will run unattended for the remaining time. If there are problems, the plan is for another engineer to take over monitoring the system. Calculations for the pressure in the vessel during this phase show that it is not possible to exceed safety limits.

We will take measurements of the oxygen concentration at various depths in the vessel every two minutes during this phase in order to measure the effectiveness of the purge. We will also measure the concentration of water in gas coming out of the vessel. These measurements will be compared to ANSYS models of the purge to verify the accuracy of the simulations. In addition to the water and oxygen concentration measurements, we will measure the temperature of the gas in at various depths in the vessel using the RTD translation devices. Those measurements will be taken every 15 minutes and will be compared to the results of the ANSYS models as well.

IV. GASEOUS ARGON CIRCULATION

The expected oxygen concentration at the end of the purge phase is 261 parts per million (ppm). The next phase is the recirculation of the gaseous argon to force the gas through the filtration system. The recirculation will continue until we reach a concentration of 50 ppm. The gas will be circulated at a rate of 5 ft^3/minute, with one volume exchange every 2.6 hours.

During this phase we will be pulling gas from the tank and forcing it through the filtration system. Because we are sampling the gas during this phase we will also be introducing additional gas into the system to keep a positive pressure. We plan to run shifts during this phase until the system is stable. We define a stable system as one where a constant pressure inside the primary vessel is maintained during the recirculation. If at any point we are unsure of the system's performance we can turn off the recirculation with no risk to the personnel, equipment or the goals of the project. This phase can last indefinitely until we are satisfied that purity goals have been met to proceed to the next phase or until the logistics are in place for liquid filling.

V. LIQUID ARGON FILLING

After the oxygen concentration goals for the gas circulation phase have been met, we will begin putting liquid argon into the system. This phase will be attended during the entire filling process. We plan to initially fill to a depth of 5 feet. We expect to let the tank vent overnight after the fill and the vessel will not be attended during this time.

VI. TURNING ON REFRIGERATION

This stage is the most delicate in terms of meeting the project goals as a mistake could cause air to be pulled into the vessel which would ruin the efforts of the previous phases. The project's engineers will be on shift until stable pressure control is established. If problems arise the plan is to turn off the nitrogen at the source and allow the tank to vent. After the stable pressure control is established we will staff shifts to observe the system for 24 hours.

VII. TURNING ON THE PUMP

This phase is also delicate as we attempt to establish pressure control with the added heat input from the pump. The project's engineers will be on shift until stable pressure control is established. If the engineers are not comfortable with the system operation at anytime we will turn off the pump and return to the previous stable operating condition. After the stable pressure control is established we will staff shifts to observe the system for 24 hours.

VIII. STABLE RUNNING

During this phase of the program we plan to leave the system unattended. The PLC is configured to alert the relevant experts through text messages if any problems are detected.

IX. SHIFT DETAILS

We envision shifts to occur in three time intervals, *i*) 8:00 am to 4:00 pm (day shift), *ii*) 4:00 pm to 12:00 am (swing shift), and *iii*) 12:00 am to 8:00 am (night shift). Day shifts will be staffed at PC4. The swing shift will start with a walk-through of PC4 with the day shift person and then will be staffed from the shifter's FNAL office. The shifter will monitor the system remotely. The night shift will start with a walk-through of PC4 by both the swing and night shifter and then will be staffed from the shifter's FNAL office. We are staffing the swing and night shifts from on-site locations, but not at PC4, out of safety concerns for the shifters. Specifically, if a shifter were to have an accident in PC4 during one of these shifts it is unlikely that another person would arrive to help until the start of the next shift. Running these shifts from areas with fewer hazards and more people around seems to be a prudent plan, especially as the system can be monitored remotely. We will have several web-cams broadcasting views of the system for visual inspections throughout the shifts and the monitoring system can also be accessed remotely.