LAr Filter Regeneration Procedure

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General steps:

1. Preheat the LAr filter to 175 – 180°C with ultra high purity Ar gas at 160 slpm (∼6.7 scfm on the flowmeter). It takes about 3 hours. You can start with 55 V and bump it to 100 – 110 V after 20 minutes. You can stop preheating when the bottom thermocouple reaches ∼155°C.
2. Use 1 – 2% H_2 balanced with Ar to regenerate the LAr filter. Keep the temperature between 175 and 225°C. With the flowrate of 80 slpm (∼3.3 scfm on the flowmeter), we expect to use 5 gas bottles, each takes a bit less than an hour. You can keep the voltage between 55 – 75 V.
3. Cool down the system with ultra high purity Ar gas. This take ∼80 minutes and you will sort of uniformly ramp down the voltage from 65 V to 20 V.

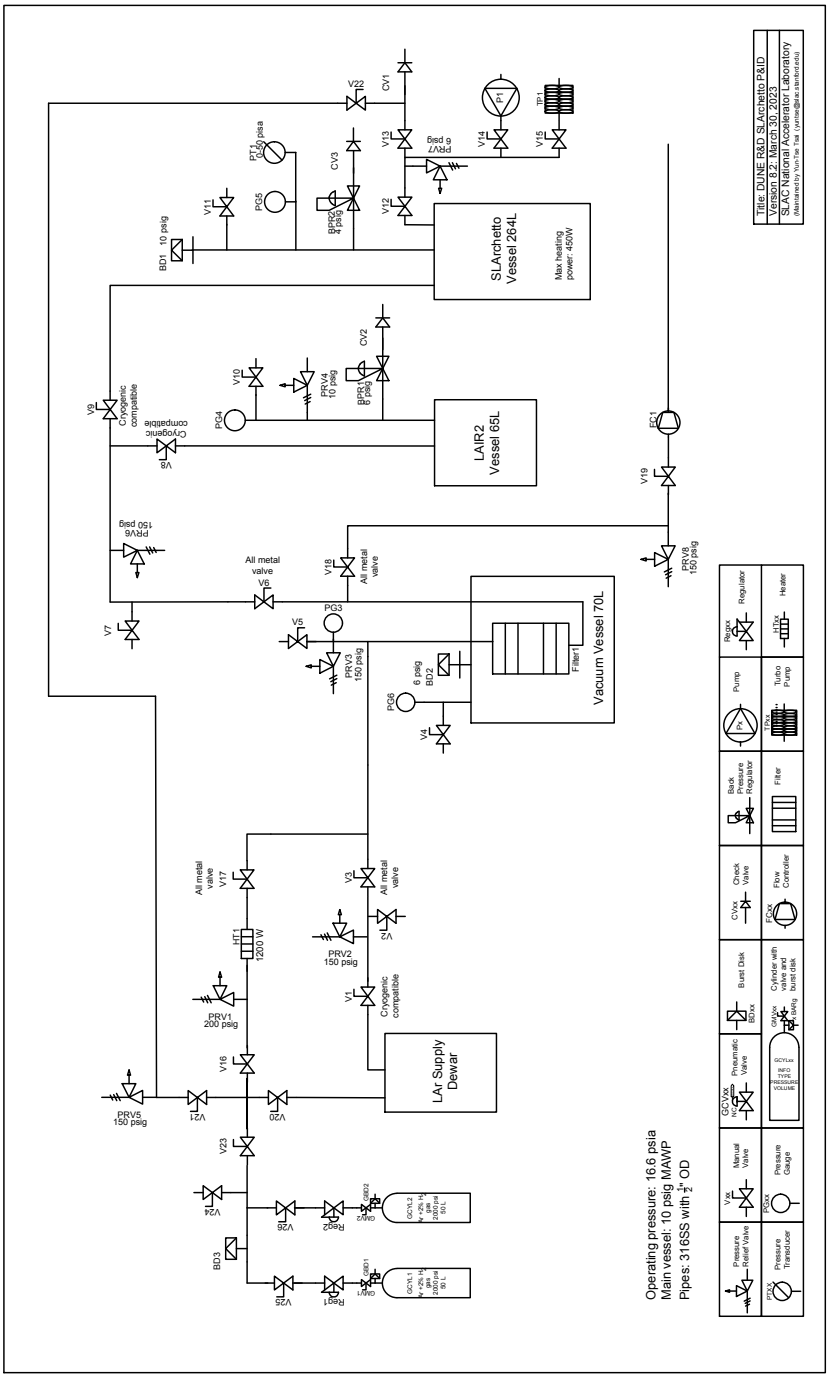
Time to stop regeneration:

- Humidity plateaus. Better plateaus at 0%.
- 5 hours of 2% H_2 gas at 80 slpm (∼3.3 scfm on the flowmeter).
- Temperature in the LAr filter does not rise anymore.

Notes:

- All the doors of the LNTF hut have to be open, the intake fan has to be turned on, and oxygen deficiency sensor and monitor (ODM) have to be checked.
- V3, V5, V6, V16/V17, V18/V19 isolate the LAr filter. During the regeneration, V3, V5, and V6 should be always closed. V17 and V18 are metal valves, which we will just finger tight all the time. We will rely on V16 and V19 to isolate the LAr filter, instead of V17 and V18.
- The gas flows from the gas bottle, Reg1/2, V25/V26, V23, V16, HT1, V17, into the LAr filter, and vents from V18, V19, FC1.
- The vacuum vessel surrounding the LAr filter should be evacuated from V4 all the time. The pressure can be read from PG6.
- Control V9 and V18 carefully to avoid compromising the LAr filter; V9 is the gas inlet and V18 is the exhausting valve.
- The torque for V9 is 25 foot-pound.
- The torque for V18 is 21.7 foot-pound, 3/4" socket. Need different torque wrenches for V9 and V18 typically.
- The gas flow has to be greater than 2 scfm (marked on the flowmeter) to prevent the heater from getting too hot.
- We should always keep the gas flow (Ar or 2%H_2+Ar) between 2 and 6.7 scfm (marked on the flowmeter).

- Maintain the catalyst temperature between about 175°C and 225°C.
- Do NOT exceed 225°C, even though 250°C may be tolerated.
- If seeing smoke or smelling something unusual, shut down the variac power supply (heater) and investigate.


Title: DUNE R&D SLArchetto P&ID
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SLAC National Accelerator Laboratory
Instrument Vortex Test Cryomagnet Laboratory
SLArchetto Vessel 264L
Max heating power- 450W
LAIR2 Vessel 65L
Vacuum Vessel 70L
LAr Supply Dewar
Operating pressure: 16.6 psia
Main vessel: 10 psig MAWP
Pipes: 316SS with 1/2" OD

Figure 1: P&ID

Checklist	What to Do and Detailed Description
Preparation	
3 bottle of ultra high purity Ar gas (TBC)	
5 bottles of Ar+2%H_2 gas (TBC)	
Remove the cold insulation foam from the tubes close to the LAr filter regeneration line	
Heater, tubes connecting the heater and the LAr filter wrapped with a few layers of aluminum foils for thermal insulation	
V4 connected to the scroll pump	Prepare to evacuate the vacuum vessel
V4 open, scroll pump on	Evacuate the vacuum vessel
V3, V5, V6, V7, V8, V9, V10, V11, V12, v18 closed	
Exhausting gas line connected and humidity meter hooked	
All the doors of the LNTF hut open	
Intake fan on	The emergency button is yellow
Oxygen deficiency sensor in place, oxygen deficiency monitor green	
Preheating with Ar gas	
V3, V5, V6, V7, V8, V9, V10, V11, V12, V18 closed	
PG6 at 0 psi	
Variac power supply off. Voltage set at 0	
Heater plugged in to the variac power supply	
Ar gas bottle connected to Reg1 and V7/V8 line	
GMV1 opened, Reg1 increased, V7 opened, air purged	Purge the air in the connection tube
V7 closed	Finish purging
V8, V9 opened	
PG3 at 5 – 15 psig, V18 opened	
Gas flow ∼6.7 scfm, stable	
Variac power supply on, increase the voltage	Turn on the heater
Humidity plateaued at 0% for $>$ 10 minutes	Molecular sieves regenerated
Preheated for $>$ 2 hours	
TC0, 1, 2, 3 at 175 – 180°C, or TC3 $>$ 155°C	
Variac power supply off. Voltage set at 0	Turn off the heater

V8, V9, V18 closed	
GMV1 and Reg1 closed	
Regenerating copper sieves	
Ar+2%H_2 gas bottle connected to Reg1 and V7/V8 line	
GMV1 opened, Reg1 increased, V7 opened, air purged	Purge the air in the connection tube
V7 closed	Finish purging
V8, V9 opened	
PG3 at 5 – 15 psig, V18 opened	
Gas flow between 50 and 160 slpm (Ar), or between 2.2 and 6.7 scfm (marked as Air). Preferably at 3.5 scfm Air	
Variac power supply on, increase the voltage	Turn on the heater
Should the temperature exceed 225°C anywhere in the bed, switch to H_2-free gas until the hot zone cools back down to 200 – 210°C, then resume feeding the H_2 gas mixture	
The temperature of the all catalyst bed is stable or subsiding	
Humidity plateaued at 0% for $>$ 10 minutes	Copper sieves regenerated
Variac power supply off. Voltage set at 0	Turn off the heater
V8, V9, V18 closed	
GMV1 and Reg1 closed	
Completion; cooling down	
Variac power supply off. Voltage set at 65 V	
Ultra high purity Ar gas bottle connected to Reg1 and V7/V8 line	
GMV1 opened, Reg1 increased, V7 opened, air purged	Purge the air in the connection tube
V7 closed	Finish purging
V8, V9 opened	
PG3 at 5 – 10 psig, V18 opened	
Gas flow ∼6.7 scfm, stable	
Variac power supply on, decrease the voltage	Turn on the heater
Variac power supply off. Voltage set at 0	Turn off the heater
V8, V9, V18 closed	
GMV1 and Reg1 closed	