UITF SF6 gas transfer Tech Note

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Overview: The UITF high voltage power supply tank is normally filled with **60psi of SF6**. Without this insulating gas, the Glassman High voltage 450kV power supply would arc to the walls of the tank and the high voltage socket connection for output to our electron gun would track internally. This document covers the facts about the volumes and weights of the SF6, the Glassman Tank, and the aluminum storage cylinders.

All SF6 transfers are performed using the DILO D-320-R006 B143R01 Gas transfer and recovery unit. The manual that describes the operation of the unit and a copy of this tech note are kept in the side storage pocket of the DILO cart. They are also available in pdf form at: https://wiki.jlab.org/ciswiki/index.php/SF6_Inventory_and_Handling_Procedures

There are important facts you should know about the Glassman tank and SF6 volume:

1. The volume of the UITF High Voltage tank is 25 cubic feet.
2. **Aluminum Cylinders hold 75lbs of SF6. They have an empty weight of 49.5lbs, which means that when filled with SF6 to their normal maximum volume, the cylinder will weigh 125lbs.**
3. 60 psi of SF6 in the Glassman tank has a gaseous weight of 47lbs, so one full aluminum cylinder will have enough SF6 for filling the Glassman Tank.
4. A full cylinder is 125lbs, but there is still a small gas pocket above to keep the cylinder from overfilling. If you were to keep filling the cylinder, it would reach a maximum weight of 130lbs and would be filled to a solid liquid state. We must NEVER overfill a cylinder and lock that volume into a cylinder. This is the only hazardous situation that can occur in our process because locking a liquid in a fixed confined volume can create tremendous hydrostatic pressures as the temperature of the liquid changes, which could rupture the burst disk. If you have overfilled a cylinder, you must immediately transfer some of the SF6 to the second cylinder or back into the Glassman Tank. See page 24 of the user manual for cylinder consolidation procedure or page 22 of the manual for filling equipment with SF6.
5. We are not permitted to refill cylinders that come from our gas supplier. Refilling a cylinder without the owners permission is a violation of 49 CFR 173.301(e). Only the labeled aluminum cylinders owned by JLAB and mounted on the cart are authorized for recovery and cylinder consolidation.
6. The N150 aluminum gas cylinders must be re-certified by a credited testing agency 5 years after the original manufacturing hydrostatic test date stamped on the crown of the cylinder and every 5 years after as required by 49CFR180.209

Facts that I want to emphasize from the DILO manual:

1. The Black hoses have self-sealing DN8 connectors and only need hand tightening to make a clean connection.
2. Hoses should be stored with <3psi pressure or under vacuum. You can always press the inner valve of a DN8 fitting to release excess gas if you are unsure of the pressure. After doing this, you have contaminated the hose, so you must evacuate the hose using the procedure of page 13 of the DILO manual.
3. **Never connect a hose that has >3psi to the vacuum pump connection.**

The following procedures can be used as a supplemental guidance to the DILO manual and specifically addresses the Gas removal and Filling of the UITF Glassman Tank

Removal of Air prior to filling with SF6:

1. It is assumed that work has been performed on the internals of the Glassman tank and you have just closed it up and sealed the gaskets.
2. A good first step is to hook up the Nitrogen system to the instrumentation port of the Glassman tank and let the tank fill to about 10psi where you would then leak check the fittings that have been opened for maintenance with "snoop" soapy water. If there are leaks, re-tighten or vent and check the gaskets. If there are no leaks, we want to vent the tank to near 1psi and refill to 10psi with nitrogen 2 or three times to remove all "air" from the tank. We are doing this because Nitrogen mixed with SF6 is not as bad as Oxygen mixed with SF6.
3. Once you have vented and backfilled several times with Nitrogen, you should vent down to 0 psi (barely a whisper of nitrogen remaining) and then connect the bottom DN8 fitting of the tank to the dry scroll pump (Jlab pump) and run the pump to evacuate to a 29" Hg vacuum reading on the local gauge.
4. The Glassman tank is now empty of all gas (Nitrogen, oxygen, etc.) and ready to backfill with SF6. Disconnect the black hose at the DN8 fitting while the unit is under vacuum and the line will be clean for the next step.

Filling the Glassman Tank with SF6:

1. Verify you have 47lbs of SF6 available in one or both aluminum cylinders. This is a weight measurement. (recall an empty cylinder weighs 49.5lbs, so a cylinder that weighs 96.5lbs will have the exact amount of gas present to fill the Glassman tank).
2. Take the main valve on the DILO cart to the "Filling of SF6" position and follow steps as outlined in the DILO manual page 14, which explains how to adjust the regulator, attach the fill hose and perform the fill.
3. When the Glassman tank is filled to 60psi, weigh the cylinder and record the weight in the inventory book with date and time.

Removing SF6 from Glassman Tank and storing in Cylinders:

1. Ensure you have a cylinder that can hold the volume of the gas when liquefied. This will be 47lbs of product, so a cylinder should weigh less than 78lbs in order to fit within one cylinder without over filling. If absolutely necessary, you may have to distribute the contents among both cylinders.
2. You must set up to weigh the cylinder as it is filled to ensure you have not over filled.
3. If you are unsure of the state of the gas in a transfer hose, make sure the transfer hose is clean by venting it to less than 3psi and evacuating it with the DILO vacuum pump.
4. The gas purifying filter should be used during this step to ensure the SF6 from the Glassman tank is filtered to remove impurities before it is compressed into the aluminum cylinder(s). This requires both hoses with DN8 fittings, which would go from the bottom of the Glassman tank to the Filter, and then from the filter to the SF6 recovery port of the DILO cart.
5. We now follow the steps on page 12 of the DILO instruction manual to recover the SF6.
6. During recovery, you will hear the compressors change from "parallel operation" mode to "series operation" mode when the pressure falls to approximately 5 to 10 psig. This allows one compressor to be used to obtain a vacuum on the system while the second compressor will still provide up to 725psi discharge to liquefy the SF6 for storage in the Aluminum cylinders. This series operation is much slower than the parallel operation mode.
7. When the Tank pressure gauge reaches 0 psig, we have recovered 38lbs of SF6, but we still have another 9 lbs of SF6 remaining in the Glassman tank that we need to recover.
8. Once the tank has gone sub-atmospheric (<0 psig), we can enhance the recovery speed by placing the dry scroll pump in series with the DILO system. You can take the short black DN8 line from the bottom of the Glassman tank to the suction of the scroll pump. You will then take the discharge of the scroll pump to the SF6 recovery port using the poly line coiled on the Glassman tank. You will notice that this poly line has the appropriate fittings to mate with the vacuum pump discharge and the SF6 recovery port. Before making this connection, you should realize that the last operation we performed with this scroll pump was pumping Nitrogen. In order to clean the pump, you will close the valve at the bottom of the Glassman tank. You will than start the scroll pump and it will be pumping on the black inlet hose and discharging through the poly hose. You will take this poly hose to the DILO Air Evacuation port and use the small vacuum pump to draw suction on the entire line plus Scroll pump. Once the line is evacuated, it can be moved to the SF6 recovery port of the DILO cart. You need to turn off the Scroll pump whenever the scroll pump does not have a discharge path. Failure to do this will cause the Scroll pump to grind to a halt on overpressure.
9. With the compressors started again and the poly line connected, you can open the valves and start up the scroll pump. This will be of great assistance in removing the remaining 9lbs of SF6 remaining in the Glassman tank.
10. Once the Glassman tank reads 29" Hg vacuum, you can turn off the compressors and close all valves. You will then disconnect the scroll pump and all hoses. You will backfill the Glassman tank with Nitrogen (or air) using the instrumentation port valve. We generally prefer Nitrogen because it will introduce no water to the system, but we realize that if work is to be performed

on the Glassman tank, we will eventually open it to air. In this case a purge of Nitrogen is appropriate. The nitrogen source should be regulated so it cannot overpressurize the system. Set the discharge to 60psi or lower. In the event we had a higher pressure connection, we are still protected because the system relief valve has a much higher Cv rating than the ¼" fill tubing of the instrumentation port. Still, we do not want to "test" the relief valve setpoint of 75 psig.

Keep the following in mind during all operations:

1. SF6 is an expensive gas.
2. SF6 is a powerful greenhouse gas.
3. We want to make all transfers maintaining the highest purity.
4. If you run into a step of a procedure and you are unsure of the purity in a hose, it is better to vent this small amount of SF6 and then evacuate the hose with the vacuum pump than it is to contaminate a large volume of SF6.