

4.1 Bubble Chamber CF₃I Fill Procedure*Written Procedure*4.1 Bubble Chamber CF₃I Fill Procedure

This procedure covers filling of the bubble chamber inner vessel with its nominal charge of CF₃I. Obviously there is plenty of hazards and risks here, hence this is a written procedure.

- 1) Review procedure 4 "[CF₃I Handling Procedure](#)".
- 2) Ensure that the hydraulic system is filled and appropriately initialized. It should be under no pressure, with the inner vessel at a neutral bellows position, and no compressed air on the hydraulic cart.
- 3) Start the "Commissioning Tool" VI and initiate data logging every 5 seconds.
- 4) Initiate cool-down¹ to just above 0°C. This will take a while. Follow procedure 6.2 [Bubble Chamber Temperature Ramp up/down](#) until an appropriate temperature has been achieved and stabilized. If the NESLAB bath contains only water, set it to maintain a bath temperature no lower than 2°C.
- 5) Assemble the CF₃I transfer lines, vacuum pump, transfer cart, CF₃I transfer bottle, and CF₃I sample bottle. The plumbing consists of a flexible connection from the CF₃I transfer bottle to the sample bottle. The line is equipped with a tee to a vacuum gauge, an isolation valve, and a vacuum pump. The pump down port should be near the sample bottle. The cart is equipped with an electronic balance. The CF₃I transfer bottle sits on the balance. Position the transfer line so that any condensed CF₃I flows into the sample bottle. Zero the balance. Place the sample bottle in an ice-water bath.
- 6) Ensure MV-22 and the transfer bottle valve are closed. Open the plumbing to the vacuum pump and evacuate the CF₃I transfer line. Once it is evacuated, open the valve to the empty sample bottle and evacuate it. The isolate and turn off the vacuum pump. Record the vacuum pressure, wait 5 minutes, and re-check the vacuum pressure to ensure there are no leaks.
- 7) Record the mass of the transfer bottle and of the sample bottle.
- 8) Follow the "Before Handling CF₃I" section of procedure 4.
- 9) Open the transfer bottle and condense some CF₃I into the sample bottle for 5 minutes, or until 50g has been transferred.
- 10) Close the valves to both bottles and rerecord the mass of the transfer bottle.

¹ The actual temperature is not critical. It needs to be cool enough to maintain the distillation relative to the ~20°C reservoir temperature.

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- 11) While facing away from the gas stream, vent the transfer line through the pump down port.
- 12) Disconnect the sample bottle and connect the transfer line to the inner vessel plumbing. There should be a valve (MV-23), a filter, and the main Cartan valve (MV-22).
- 13) Ensure MV-22 and the transfer bottle valve are closed. Open the plumbing to the vacuum pump and evacuate the CF₃I transfer line. Once they are evacuated, open MV-23 and evacuate the filter. Once that is evacuated, isolate and turn off the vacuum pump. Record the vacuum pressure, wait 5 minutes, and re-check the vacuum pressure to ensure there are no leaks.
- 14) Open MV-22 and ensure that the vacuum does not rise significantly above the vapour pressure of water. If it does, it indicates that gas has entered the inner vessel. Close MV-22.
- 15) Compress (slightly) the chamber. Use the hydraulic piston position controls to drive the fast piston up to near its upper stop. Be very careful not to generate a pressure more than a few psi. It is only necessary to take the slack out of the system so that the bellows does not overextend when the inner vessel is pressurized with CF₃I gas.
- 16) Verify that the vacuum pump is isolated and MV-22 is closed, then slowly open the valve to the CF₃I tank to pressurize the lines. Approximately 75psi of pressure will fill the line.
- 17) Open MV-22 to initiate the distillation. Over time, one should observe the CF₃I dripping down through the water and forming a puddle in the bottom of the vessel. The mass in the tank should continually decrease. This step may take many hours.
- 18) Protect the bellows from overextension by adjusting the position of the inner vessel using the hydraulic cart piston. At the end of the distillation, position the bellows near but not at full extension.
- 19) Allow the distillation to proceed until it slows on its own at the roughly the 2-liter mark. At this point, the water level will be just below MV-22. Close MV-22

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- 20) Now iterate to complete the fill:
 - a. Estimate the volume of CF₃I required to complete the fill.
 - b. Slowly open the purge valve to the inner vessel, MV-21.
 - c. Use the hydraulic piston to lift the vessel and drive out your estimated volume of water.
 - d. Close MV-21.
 - e. Open MV-22.
 - f. Use the hydraulic piston to expand the bellows to just above full extension to create a new condensation space.
 - g. Allow the distillation to proceed until it slows on its own. Close MV-22.
- 21) On the last iteration, cross-check the mass transfer data, the CF₃I level in the vessel, and the quantity of water removed from the vessel. Make sure you're done.
- 22) Isolate the CF₃I transfer bottle.
- 23) Open MV-22. Expand the bellows to full extension
- 24) Wait for the overpressure of CF₃I in the transfer line to condense. When the pressure is minimized, close MV-22 and isolate the transfer line.
- 25) Vent the transfer line and disconnect it from both the inner vessel and the transfer bottle. Cap the transfer bottle and the inner vessel port.
- 26) Ensure the "After Handling CF₃I" section of procedure 3 was followed.
- 27) Ensure the cart is in a pressurized state and the pneumatic cylinder is not at its bottom stop. Then slowly charge the system with compressed air. Once you've established that the inner vessel is "floating" (i.e. that when all of the CF₃I is condensed the bellows is off its stop) you can run the pressure up to the nominal 200 psig.
- 28) Initiate warm up of the chamber to its operating point following procedure 2.5 "Bubble Chamber Temperature Ramp up/down".
- 29) Terminate data acquisition and backup the data by rsync'ing with the coupp2ls1 data disk.