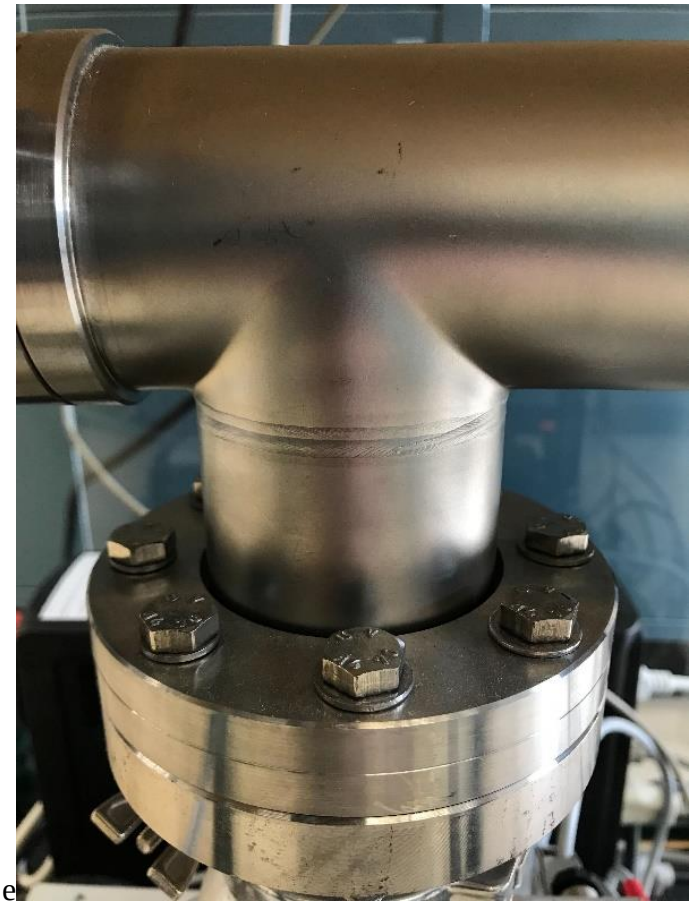
READ FIRST: Make sure the vacuum system is free of leak before RGA operation, otherwise high level of O_2 in the system could be very damaging to the RGA detection part.

When opening the vacuum system to ambient pressures through the PEEK capillary tube, open up the sampling valve slowly, and in steps, to avoid a sudden pressure surge in the vacuum. Sudden pressure surges can destroy the turbomolecular pump.

Users of this document acknowledge that it is simply a guide. Equipment described involves the use of 110 V power and users acknowledge the risks associated with such work.

1. Place the vacuum station on a flat and stable surface. **Running on a tilted surface or having shocks during operation could seriously damage the lifetime of the turbo pump**.

2. Connect the inlet of turbo pump onto the center leg of the RGA Probe manifold (Part **6a** in part list), both flanges should be DN63 CF (4.50" OD)



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Instruction for CF flange installation:

https://www.lesker.com/newweb/flanges/flanges_technicalnotes_conflat_1.cfm

https://www.youtube.com/watch?v=wR4axVaKAMw

* Make sure the surfaces of flange and copper gasket are clean before installation.

** Torque wrench is recommended but not necessary. When using a regular wrench, do not overtighten otherwise the flange can be damaged.

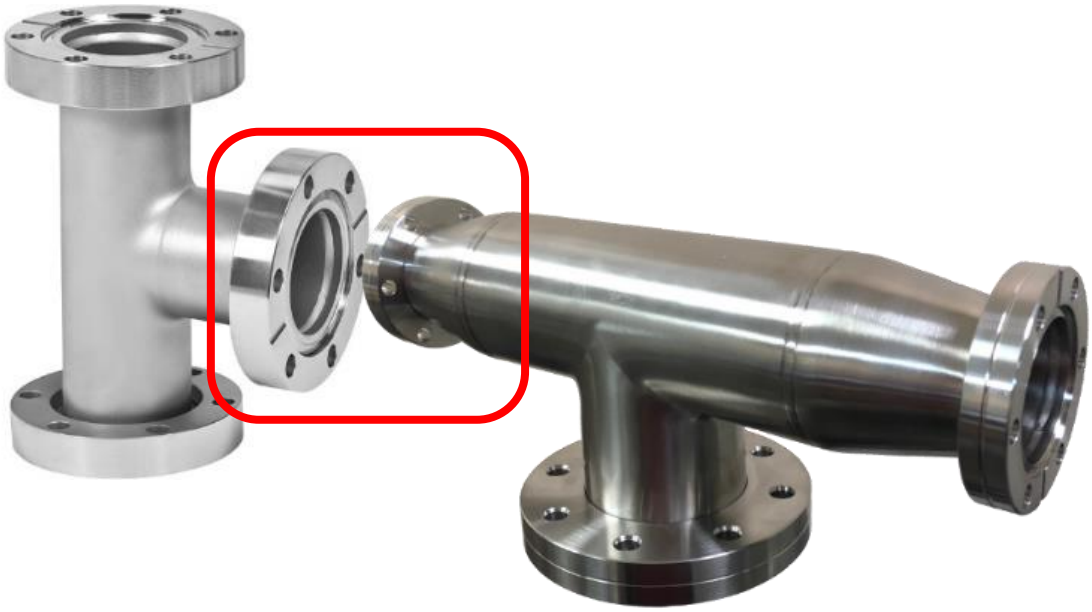
*** Copper gasket is only for single use.

3. Connect the RGA onto the right side of the RGA Probe manifold, both flanges should be DN40 CF (2.75" OD; DN63 CF in the picture, just for reference)

More detailed instruction on RGA installation is in Extorr manual:

https://www.extorr.com/products/residual-gas-analyzer/manual/

4. Connect the center leg of the Stainless Steel DN 40 CF tee (Part **6c** in part list) onto the left side of the RGA Probe manifold, both flanges should be DN40 CF (2.75" OD)



5. Connect the vacuum gauge and the inlet valve (Part **6b** in part list) onto the Stainless Steel DN 40 CF tee. Connect the vacuum gauge to the vacuum station using the provided electronics cable.

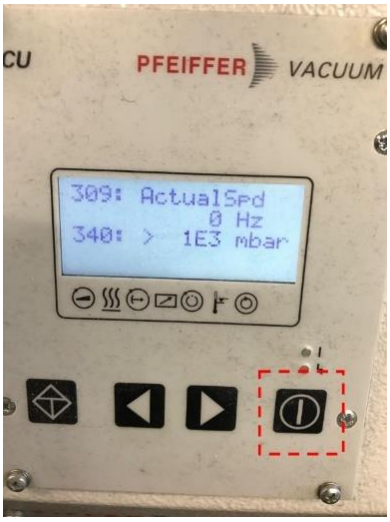
Connection on the gauge side (fixed by a screw)


Connection on the DCU side (fingertight)

6. Place the uninterruptible power supply (UPS) by the pump station. Connect the UPS to a main outlet and switch on the UPS, this should enable the UPS to start charging. If the UPS is functional, plug the pump station, RGA, and computer into the UPS. Use of the UPS protects the system from sudden power surges, as well as short periods of unexpected power loss, during which time the turbostation can maintain its vacuum level. The UPS also facilitates placing the entire system on a cart that can be moved around to desired locations and using a different wall power outlet, without loss of power.

Be advised that only the left side plugs labelled “SURGE + BATTERY” provide uninterrupted power supply. It is recommended to connect the pump station and computer to surge + power portion of the UPS (left side in above photo).

7. With all parts securely connected, and the bellows sealed valve on the inlet closed, switch on the pump station following the instructions in its manual. The diaphragm pump will be first switched on to bring the pressure down to ~10^{-2} mbar, the turbo pump will then switch on and lower the pressure to ~10^{-7} mbar. It can take several hours to bring down the pressure to the final value, but can take more time (overnight to 1-2 days) to completely pump down for the first time after installation because of the air and moisture that needs to be removed. **Consult Pfeiffer manual for more details and instructions on how to operate pump station.**

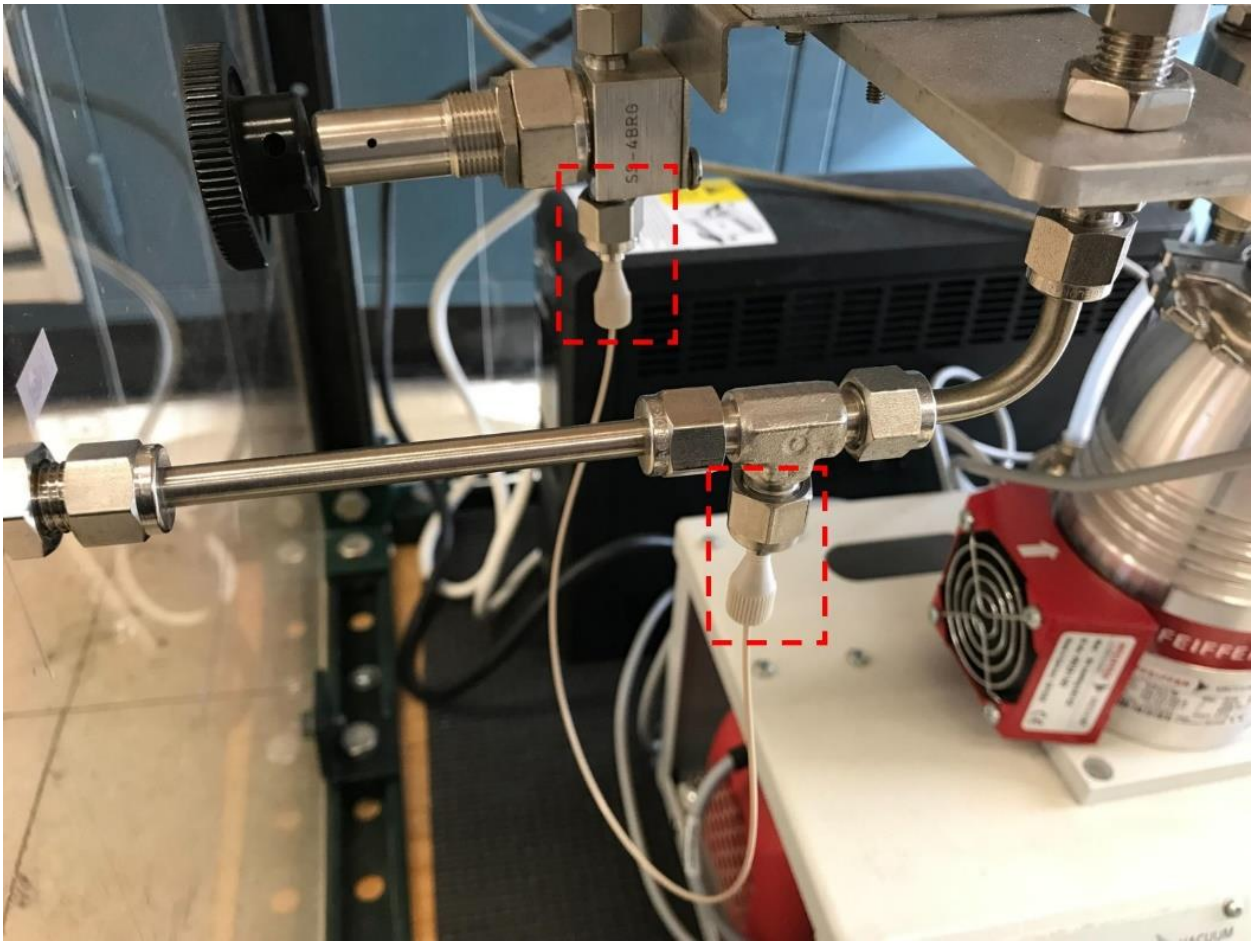


8. With the bellows sealed valve on the inlet closed, the performance of the vacuum station, and the leak tightness of the overall manifold can be tested. Under normal condition, without any significant leak in the system, the turbo pump should be able to reach a speed of 1500 Hz and the pressure should be ~10^{-7} mBar or lower. If the RGA is configured and operational, a stream of helium can be used to leak test the flanges while the m/z=4 signal in the Extorr software is tracked. Point the tube with flowing helium towards the suspected leaking flange, and this will give a rise in the helium signal if it is leaking (the vacuum system is pulling in surrounding air at the point of a leak). Commercially available DN 40 CF and DN 63 CF flanges typically have test hole on the flange body for more accessible leak testing.

Useful video of vacuum leak test: https://www.youtube.com/watch?v=O0TEfvJMcM8

* **Make sure a high level of vacuum is reached before turning on the filament of RGA**. Based on recommendations from the manufacturer, the RGA requires a minimal pressure of 10^{-3} mBar for normal operation with a Pirani gauge (Extorr XT Series RGA instruction manual, pp 9). The filament can become quickly oxidized, resulting in a significant reduction in its lifetime when exposed to higher pressures/ significant amount of O_2.

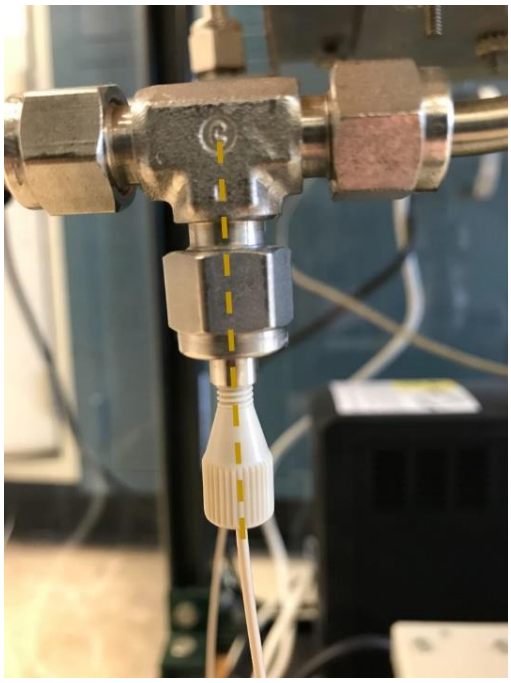
9. After confirming that both the pump station and RGA are functional, and the absence of any significant leaks, the ambient pressure inlet portion of the system can be installed. A 1/16" OD PEEK capillary tube (Part **5b** in part list) is used to connect the center leg of a 1/4" stainless steel tee (Part **4a** in part list) with the inlet valve, using a 1/4" tube to 10-32 thread, 1/16" OD tubing adapter (Part **4c** in part list), and a 10-32 fingertight PEEK fitting (Part **4d** in part list) on both sides. The length and internal diameter of the PEEK tube will affect the pressure drop across the tubing, and thus, the base pressure of the vacuum system. Different gases will also influence the pressure drop; adjust the length and ID of the PEEK tube based on your application.



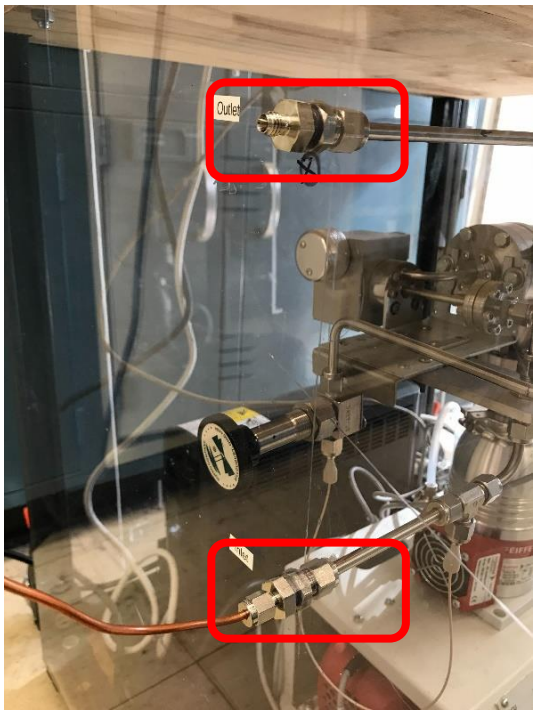
Instruction for Swagelok fitting installation:

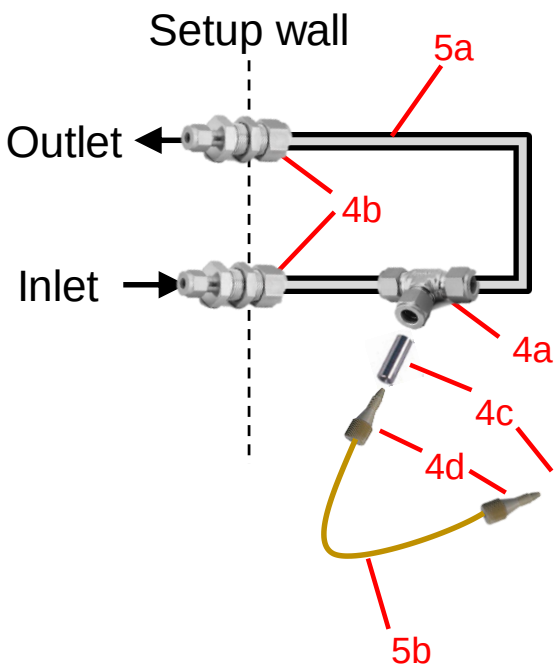
https://northerncal.swagelok.com/blog/bid/88199/skill-tube-fitting-assembly-one-inch-and-under

* When connecting the PEEK tube onto the Swagelok tee, make sure the tubing goes in to the center of the tee for optimal sampling. See figure below.



10. If a portable RGA system is being built, fix the two 1/4” to 1/8” stainless steel bulkhead reducing union (Part **4b** in part list) onto the wall of the portable station, and connect them to both sides of the 1/4" stainless steel tee. The 1/8” side of the bulkhead unions serve as inlet and outlet ports of the ambient portion of the system.





Instruction for RGA operation

1. Set up file name, mass table, scanning parameters (if necessary to change from default setting) in the RGA software

2. Make sure sample gas flow goes through the inlet/outlet (avoid air entering the vacuum system)

3. **Slowly open up the inlet valve to avoid sudden increase in pressure in the vacuum system**. This can be checked by monitoring the pressure reading displayed on the vacuum station screen. Both the high level of O_2 and a sudden increase in pressure are damaging to the RGA. Also it is recommended to turn on the filament AFTER introducing the inlet flow.

* It is advisable to record the pressure before and after valve is opened every time before a measurement

4. Turn on the filament of RGA by clicking the light bulb bottom and hit "Go" in the software, and this will also start data recording.

* Usually it will take ~30 min to 1 hr for the baseline to stabilize, so plan the time accordingly

5. After the measurement is finished, close the inlet valve (do not overtighten as this will cause leak) and turn off the filament. Leave the vacuum station running (it is supposed to be kept running).

6. **Be sure to consult RGA manufacturer manual** for additional operation details and best practices: https://www.extorr.com/products/residual-gas-analyzer/manual/