

Operation of the PRad Target

Revision 1
Chris Keith, 2/18/16

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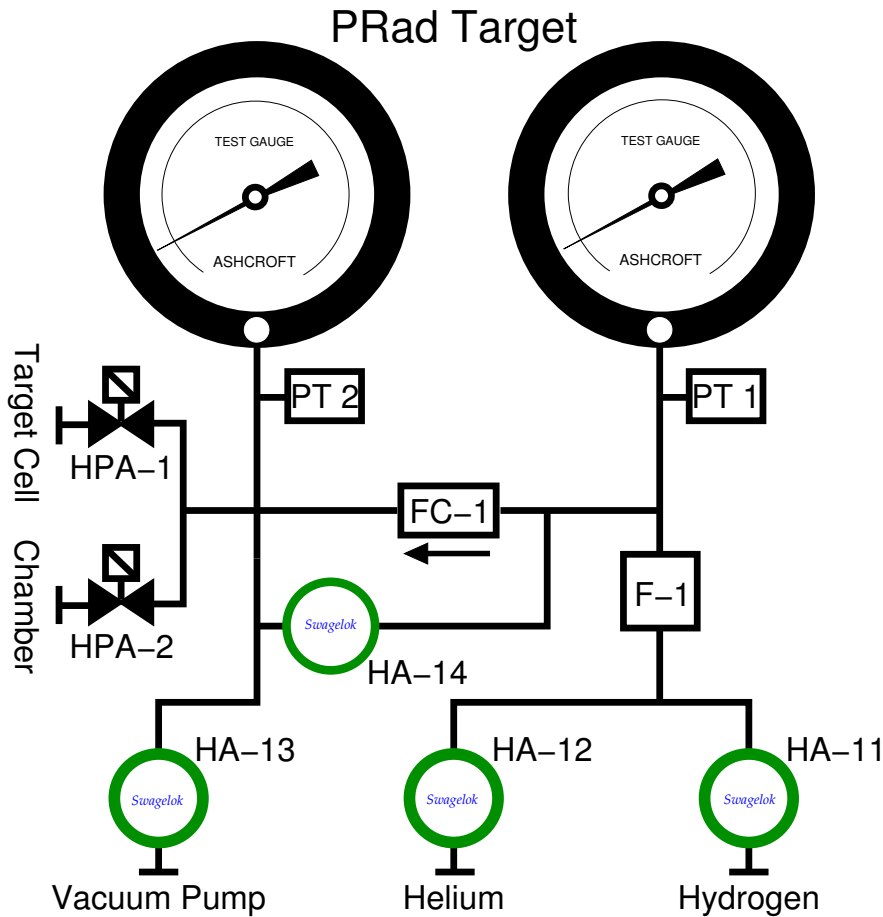


Figure 1: The gas panel for the PRad target.

1. Pre-operation checklist

1. Approximately 24 hours before the cool down, the vacuum chamber should be evacuated. Open the scattering chamber gate valve (use the button to override the vacuum switch); turn on the vacuum pumps. When chamber vacuum is less than 10 torr, close the override switch.
2. Check that the gas lines from the gas panel are properly connected to the target cell and target chamber at HPA-1 and HPA-2;
3. Check all piping connections between the gas panel and the hydrogen and inert gas inlet valves HA-11 and HA-12.
4. Confirm all pump exhausts are connected to the Hall B vent header;
5. Check that the vent header is being purged with an inert gas (nitrogen);
6. Check that the Aeroquip coolant lines are connected to the pulse tube refrigerator (PTR) and its compressor;
7. Check that the heater and thermometer cables are properly connected between the target and the Lake Shore 335 and 218 electronics;
8. Check that all readbacks and controls are functioning with the control computer;
9. Check that the water cooling lines are connected to the compressors;
10. Check that the compressor pressure gauges read 200 ± 5 psig;
11. If necessary perform a pump and purge procedure on the gas panel and target system (see Appendix);
12. Confirm that a hydrogen cylinder is properly connected to the PRad target supply line and has sufficient pressure for operating the target. A standard T-size cylinder at full pressure (2800 psi) will last about 6 days of continuous operation.
13. Confirm the following:
 - All gas panel valves CLOSED
 - Flow controller at ZERO
 - Upstream and downstream chamber gate valves CLOSED
 - Compressor for pulse tube refrigerator OFF
 - Chillers OFF
 - Foreline valves behind all chamber turbo pumps CLOSED
 - All vacuum pumps OFF

2. Evacuating the target chamber

In addition to the windowless hydrogen gas cell, the PRad target system also contains very thin carbon and aluminum foils. To prevent damaging these foils, it is imperative that the target chamber is evacuated VERY slowly from atmospheric pressure.

1. Confirm that the target chamber is at atmospheric pressure.
2. Confirm all gas panel valves are CLOSED, the upstream and downstream gate valves on the chamber are CLOSED, and the foreline valves for the chamber, upstream and downstream turbos are CLOSED.
3. OPEN the Chamber inlet valve HPA-2.
4. Turn ON gas panel pump P-001.
5. SLOWLY OPEN HA-13 to evacuate the chamber. Monitor the pressure at pressure gauge PT-2. A reasonable pumping rate is about 1 psi per minute.
6. When the chamber pressure < 1 torr, turn ON the forepumps for the turbos.
7. After one minute, OPEN the foreline valves.
8. When the chamber pressure < 100 mtorr, turn ON the turbo pumps.
9. CLOSE HA-13. Turn off the gas panel pump.

The chamber is now evacuated. It should quickly reach a pressure < 1e-3 torr

3. Pump and purge the gas panel

Two persons are recommended this procedure, one at the PRAD gas panel and the second at the Hall B gas pad. Use cell phones for communication.

1. Confirm all gas panel valves are closed;
2. OPEN hydrogen supply valve HA-09;
3. At the Hall B gas pad, confirm:
 - a. hydrogen cylinder valve HA-01 is CLOSED.
 - b. Hydrogen regulator valve HA-02 is OPEN
 - c. Hydrogen supply valve HA-04 is OPEN.
 - d. Hydrogen pump out valve HA-03 is CLOSED
 - e. Hydrogen regulator knob PRV-2 is engaged (ie open it a bit)
4. Enter a value of 1 slpm into the flow controller FC-1. This will cause it to OPEN.
5. OPEN gas panel valve HA-14.
6. Turn ON gas panel pump P-001, and OPEN gas panel valve HA-13 to start pumping on the system.
7. When the gas panel pump reaches <1 torr, CLOSE HA-13.
8. At the Hall B gas shed, CLOSE HA-02, OPEN cylinder valve HA-01, and set the regulator pressure to 15 psig (30 psia).
9. OPEN HA-02 to pressurize the hydrogen lines and PRad gas panel to 30 psia, then CLOSE it.
10. OPEN HA-13 until the gas panel pump reaches <1 torr, then CLOSE it.
11. REPEAT steps 9 and 10 for a total of five times.
12. OPEN HA-02 to pressurize the system to 30 psia. Leave it OPEN.
13. CLOSE HA-14 and set the flow controller FC-1 to ZERO.
14. TURN OFF the gas panel vacuum pump.

The gas panel is now filled with pure hydrogen gas.

4. Cooling the target

This procedure assumes that the hydrogen lines and gas panel have been pumped and purged using the procedure described in Section 3, and the target chamber has been evacuated per Section 1.

- 1) Confirm all gas panel valves are CLOSED, and the flow controller is set for ZERO.
- 2) Confirm the turbo pumps are running.
- 3) Turn ON the gas panel pump, and open HA-13 until PI-2 read less than 2 psia.
- 4) CLOSE HA-13 and turn OFF the pump.
- 5) OPEN HPA-1 and enter 0.2 slpm (200 sccm) in the flow controller to start gas flowing through the target cell. The flow of gas through the cell hastens the cooling process.
- 6) Turn ON the pulse tube refrigerator and load a set point of 25.0 K into the Lake Shore 336 temperature controller. The pulse tube should reach this temperature in about five to six six hours.
- 7) Enter the appropriate flow control setting to reach the desired target thickness.

5. Changing hydrogen cylinders

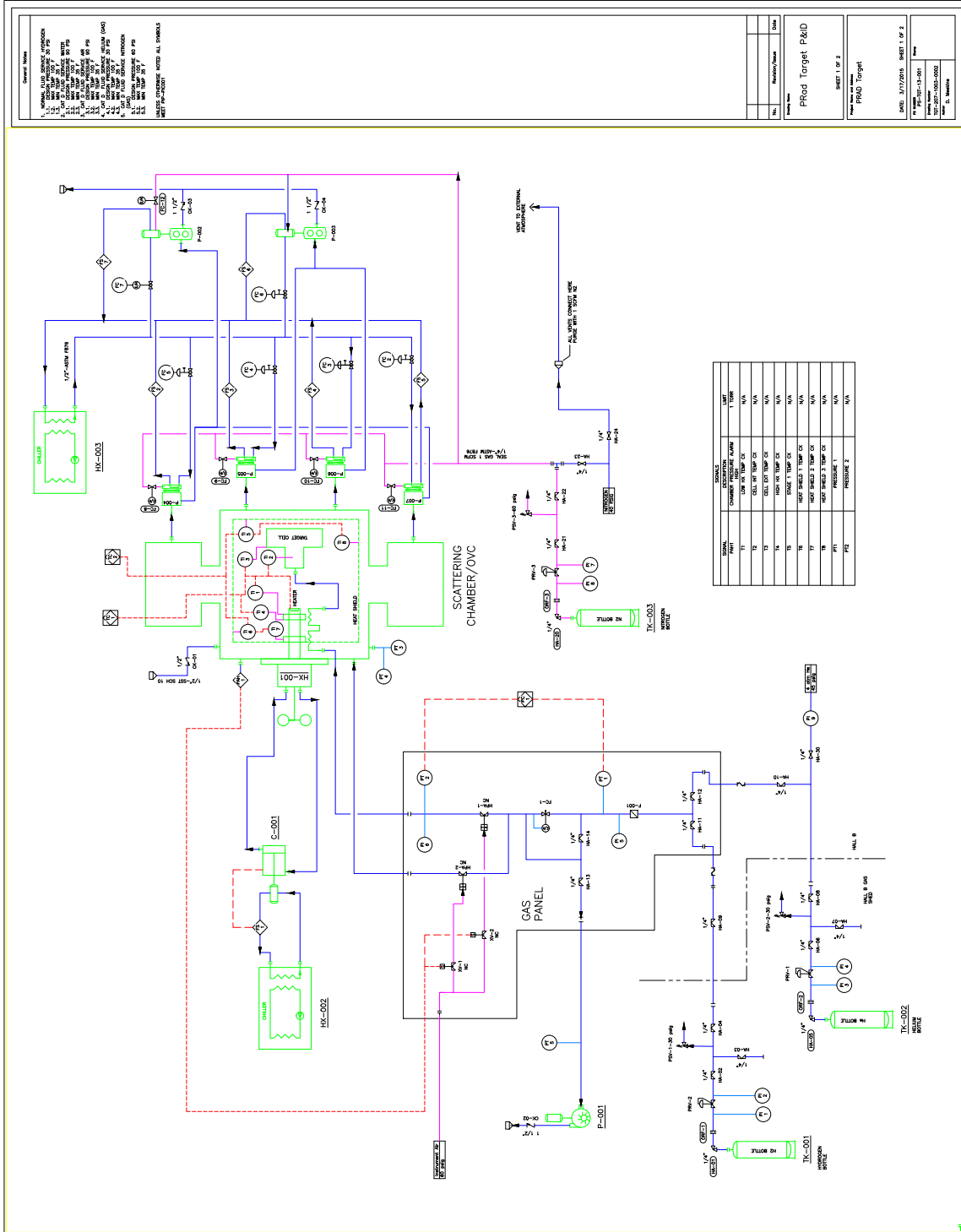
A full, standard-size hydrogen cylinder should be sufficient for about 6 days of continuous target operation. This procedure assumes that one cylinder is close to empty and a second, full cylinder is at hand.

- 1) At the target gas panel or control computer, set the flow controller FC-1 to ZERO.
- 2) At the Hall B gas pad, CLOSE supply valve HA-08.
- 3) CLOSE the valve on the empty gas cylinder, HA-01.
- 4) Using a nonsparking wrench, disconnect the hydrogen supply regulator PRV-1 from the empty cylinder and connect it to the fresh one.
- 5) Connect a small vacuum pump to the pump out valve HA-07, and turn the pump ON.
- 6) OPEN HA-07 to pump out the hydrogen line between HA-08 and HA-01.
- 7) CLOSE HA-07 and OPEN HA-01.
- 8) CLOSE HA-01 and OPEN HA-07.
- 9) Repeat steps 8 & 9 for a total of five times.
- 10) CLOSE HA-07 and turn the vacuum pump OFF.
- 11) OPEN HA-01. Confirm that the regulator is set for about 15 psig (30 psia). A
- 12) OPEN HA-08. The hydrogen line is again charged. Reset the flow controller FC-1 to its previous value.

6. Shutting the target OFF

- 1) At the target gas panel, set the flow controller FC-1 to ZERO.
- 2) CLOSE both HPA-1 and HPA-2.
- 3) Turn OFF the pulse tube refrigerator and turn OFF the temperature controller's heater.
- 4) At the Hall B gas pad, close hydrogen cylinder valve HA-01.
- 5) Return to Hall B and turn OFF the turbo pumps, close the foreline valves, and turn OFF the fore pumps.
- 6) Turn ON the gas panel pump P-001.
- 7) OPEN HA-11, HA-13, and HA-14 to evacuate hydrogen from the supply line.
- 8) When the gas panel pump reaches <100 mtorr, CLOSE HA-13 and turn the pump OFF.
- 9) Connect a source of dry inert gas such as nitrogen, argon, or helium at HA-12.
- 10) OPEN HA-12 and fill the gas panel and hydrogen supply line with the gas to a pressure of 1-2 psig (16-17 psia). CLOSE HA-12.
- 11) If desired, the target chamber can be filled with a small amount of inert gas to hasten its warm up. Steps 1-10 must be completed before doing this.
 - a) OPEN HPA-2. The gas trapped inside the gas panel will bleed into the chamber, raising its pressure.
 - b) OPEN HA-12 and bleed the chamber up to a pressure of about 10-20 torr.
 - c) CLOSE HA-12 and HPA-2.
- 12) When all the target thermometers indicate 0C or warmer, the target can be bled up to atmosphere. It is recommended to use a dry, inert gas for this procedure, such as nitrogen or argon. Follow steps a), b) and c) in 11) above. Fill the chamber with 0 psig (15 psia) of inert gas. Check valve CK-01 will prevent the chamber pressure from exceeding about 1 psig.

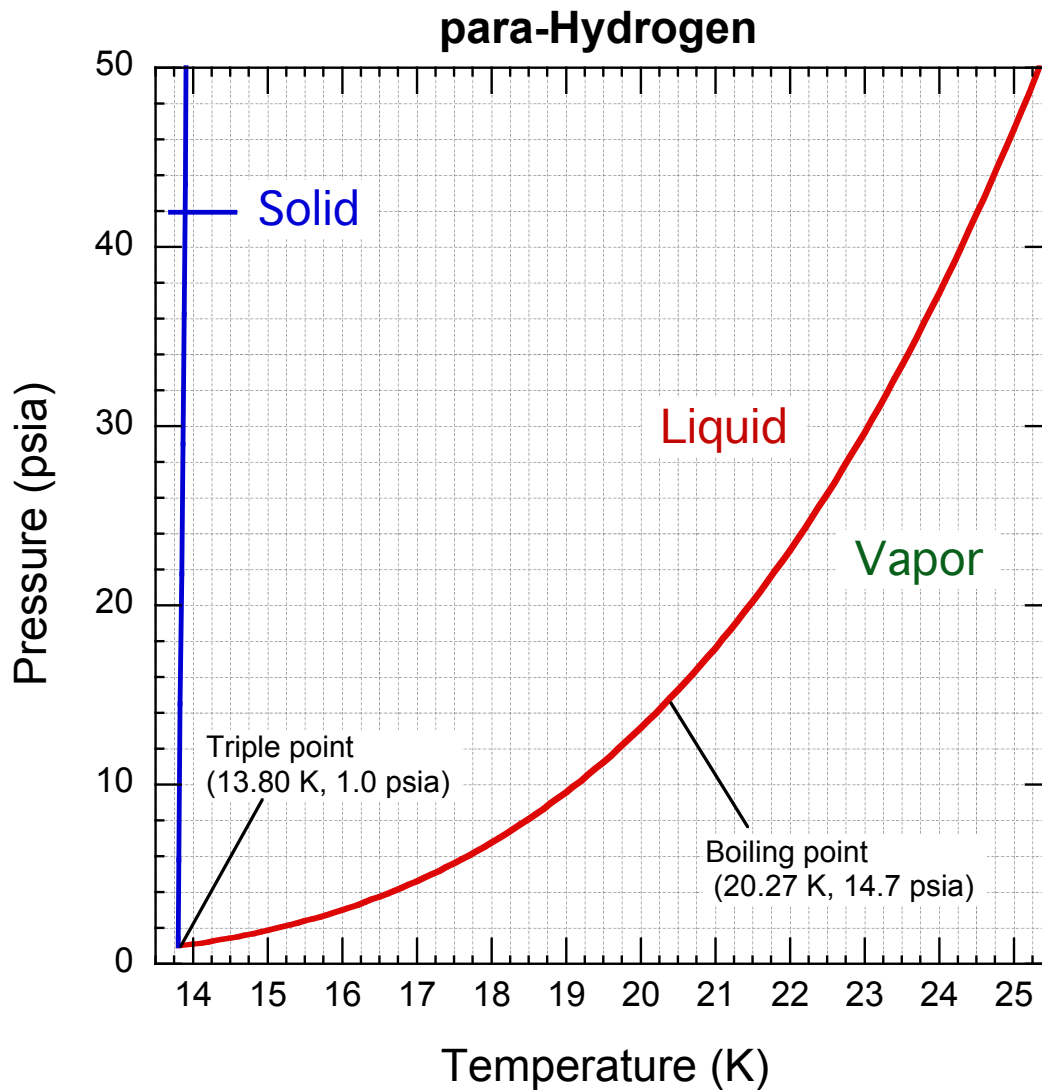
A1. PRad Target P&I Diagram



A2. Hydrogen vapor pressure curve

Source: National Institute of Standards, Thermophysical Properties of Fluid Systems

<http://webbook.nist.gov/chemistry/fluid/>



A3. List of qualified personnel

Additional personnel can be added to this list by: Chris Keith.

James Brock
Chris Carlin
Chris Keith
James Maxwell
Dave Meekins
Josh Pierce