**Clearing capillary blockage in the dilution refrigerator (DR):**

The symptoms of a blockage in the dilution refrigerator capillary is the same as a blocking Helium trap (section 5.11 page 5.8 of the manual), it is a simultaneous increase in the pressure on G4 and G3 and a drop in the flow rate and cooling power. If cleaning the Helium trap does not reduce the pressure and improve the operation of the DR then one has to warm up to clear the capillaries. There can be two sources for a blocked capillary either air or hydrogen from the pump oil, this note deals with the simpler, more common and less time consuming case of clearing a hydrogen blockage. In this case there is no need to get rid of the liquid helium in the main bath and the magnet stays superconducting. The procedure involves putting the mixture in the dumps, warming up the inside by turning all the heaters on and breaking the IVC vacuum, continuously checking to see if the blockage has cleared, cooling down and finally condensing and circulating. It takes between 7 and 8 hours to finish and return to normal operation. Below I will describe each of these steps in more detail.

**Returning the mixture to the dumps:**

Make sure that the QSB and valve 12 are closed (this is probably the case because of the blockage). Also, check that the following valves are open as they should be under normal operations, the circulation valve on top of the DR, valves 3, 5, 7 and the valves on both dumps.

1. Equalize the still and condenser pressures by opening valve2.
2. Stop pumping the 1K pot, when the pressure on G6 is 1 bar open valve 31 to connect the 1K pot to the main bath and close the needle valve on top of the DR.
3. Turn the heaters on the still, film and mixing chamber to maximum power. Turn on the extra heaters on the Mixing chamber (60V), 1 K pot (limit 36 V) and still (limit 15 V).
4. Close valves 8 and 8A open 1 and 1A, **open valve 9**, close valve 5 and slowly open valve 12 to bring the mixture back to the dumps using the sealed rotary pump. When the pressure is low switch to the booster and pump at full speed until all the mixture has been recovered by noting the dump pressure has returned to the original value (written above G1).

**Warming the dilution unit:**

To speed the warm up and spread the heat to all parts of the dilution unit admit up to a maximum 0.5 torr of helium exchange gas into the IVC. Monitor the temperature by the diodes on the 1 K pot, the cold plate (Lakeshore temperature monitor) and the temperature of the mixing chamber.

**Checking the capillary throughput:**

Using mixture from the dumps one can check the capillary throughput and “flush” the dilution unit. By closing valve 2 and 12 (or QSB) and open valve 5, allow the mixture into the still line, which can be seen on G2 (450 mbar). If the blockage is clear the pressure in the condenser line G3 will increase. The flow rate should be about 100 mbar/min when the dilution unit is between 15 K and 20 K (hydrogen freezes at 14 K). Repeat the above process few times.

**Cooling to 5 K:**

Turn the heaters off and wait until the temperature of the dilution unit is about 5 K. Start pumping the IVC, keep pumping for at least 5 hours.

**Cooling to 1.2, condensing and circulating:**

Refill liquid helium and nitrogen as needed. Follow the instructions in the user manual section 5.6 page 5.5 and section 5.8 page 5.6