Summary of HD-Ice meeting:

Subject: ODH due to cryogens used by HD-Ice target

List of Cryogens:

**Liquid Helium** which is kept in 3 separate “containers”.

Storage or Fill Dewar: Capacity 1000 liters – kept at 2 PSIG

Buffer Dewar: Capacity 500 liters – kept at 2 PSIG

IBC: 50 liters

**Liquid Nitrogen** which is kept in 1 dewar – capacity 100 liters

IBC gets its helium from the buffer dewar. Buffer dewar is **not** shut off during operation.

Buffer dewar is filled from the storage dewar, which takes about 2 hrs. After filling the buffer dewar, the storage dewar is shut off.

The loss of Helium from relief valve is 1% of the dewar capacity – The total helium loss from the two dewars is 15 liters or 11400 liters of gas through the relief valve. Once the pressure inside the dewar drops, no more gas can escape. (How long does it take for the pressure inside the dewar to be the same pressure in the cave?)

Loss of Helium due to shear in the transfer tubes between storage dewar and buffer dewar and buffer dewar and IBC. Storage dewar has 1/4” diameter transfer line. Buffer dewar has 1/8” diameter transfer line. As in the case of relief valve, once the dewar’s pressure reaches the ambient pressure, no more helium comes out though there will be helium evaporating at some rate. (How long does it take for the pressure inside the dewar to be the same pressure in the cave?).

HD-Ice also uses 100 liters of liquid nitrogen which is equivalent to 70000 liters of gas. The nitrogen dewar is at 200 PSI. The transfer line is 1/4” in diameter.

Calculation:

1. Velocity of the fluid escaping the through the transfer line, if this line is sheared off completely

ΔP = ρ/2 (v22-v12)

ΔP is the pressure differential between the dewar and the cave = 2 PSI

ρ is the density of the fluid 125 g/l

v2 is the velocity of Helium venting out

v1 is velocity of Helium in the dewar = 0

This give v2 = 40 m/s

1. Volumetric flow

Q = A2 \* [ (2/ρ) \* (ΔP/(1-(A2/A1)2 ) ]1/2

A1 is the area of the neck of the dewar = 6.3 cm (assumed 5” diameter for the neck)

A2 is the area of the transfer line = 0.063 cm

This gives a flow of 0.1 l/s = 12.5 g/s of Helium from the storage dewar. In reality, the pressure will keep droppin until the pressures in the dewar and cave equalize and He will not vent but only evaporate. So, 12.5 g/s can be taken as the maximum. Even though the buffer dewar is smaller, we will assume the same rate of Helium venting for that dewar for a total of 25 g/s.

I will refine the calculation with discharge rate constantsd, if I can find them or figure out how to arrive at them.