1 Venting of Parts of TRD Detector

There are four types of parts that have to be vented.

- TRD octagon container
- Honeycomb panels
- Cabling grid tubes
- Photomultiplier tube housings

1.1 Venting of the TRD Octagon Container

Starting from Bernoulli's formula describing the velocity w of a media at the outlet (cross section A) of a relatively large container under the pressure difference Δp

$$w = \sqrt{\frac{2\Delta p}{\rho}} \tag{1}$$

we get introducing the mass m_{out} that leaves the container and density ρ using

$$\Delta V = Aw\Delta t \tag{2}$$

$$w\frac{\Delta m_{out}}{\Delta V} = \rho w = \sqrt{2\rho\Delta p} \tag{3}$$

$$\frac{\rho}{A}\frac{\Delta V}{\Delta t} = \frac{1}{A}\frac{\Delta m_{out}}{\Delta t} = \sqrt{2\rho\Delta p} \tag{4}$$

$$\Delta m_{out} = \Delta t A\sqrt{2\rho\Delta p} \tag{5}$$

A flow coefficient c_d is introduced to take into account the flow resistance of the outlet. The mass m is eliminated using the gas equation (R individual gas constant, T absolute temparature)

$$p = m\frac{RT}{V} \tag{6}$$

or written with differentials

$$dp = dm\frac{RT}{V} \tag{7}$$

$$dm = V\frac{dp}{RT} \tag{8}$$

Substituting in equation (5)

$$\frac{dm_{out}}{dt} = Ac_d\sqrt{2\rho\Delta p} \tag{9}$$

$$\frac{V}{RT}\frac{dp}{dt} = Ac_d\sqrt{2\frac{p}{RT}\Delta p} \tag{10}$$

$$\frac{dp}{dt} = \frac{Ac_d}{V}\sqrt{2RTp\Delta p} \tag{11}$$

Writing p_i for the pressure inside the container and p_a for the presuure outside and making it time dependend we find

$$\frac{dp_i(t)}{dt} = \frac{Ac_d}{V}\sqrt{2RTp_i(t)(p_i(t) - p_a(t)} \tag{12}$$

The solution is made by iteration given the time curve of p_a.
The pressure drop in the payload bay during ascension (Ref.: NSTS-21000-IDD-ISS) is given by figure 1 which has been interpolated by splines.

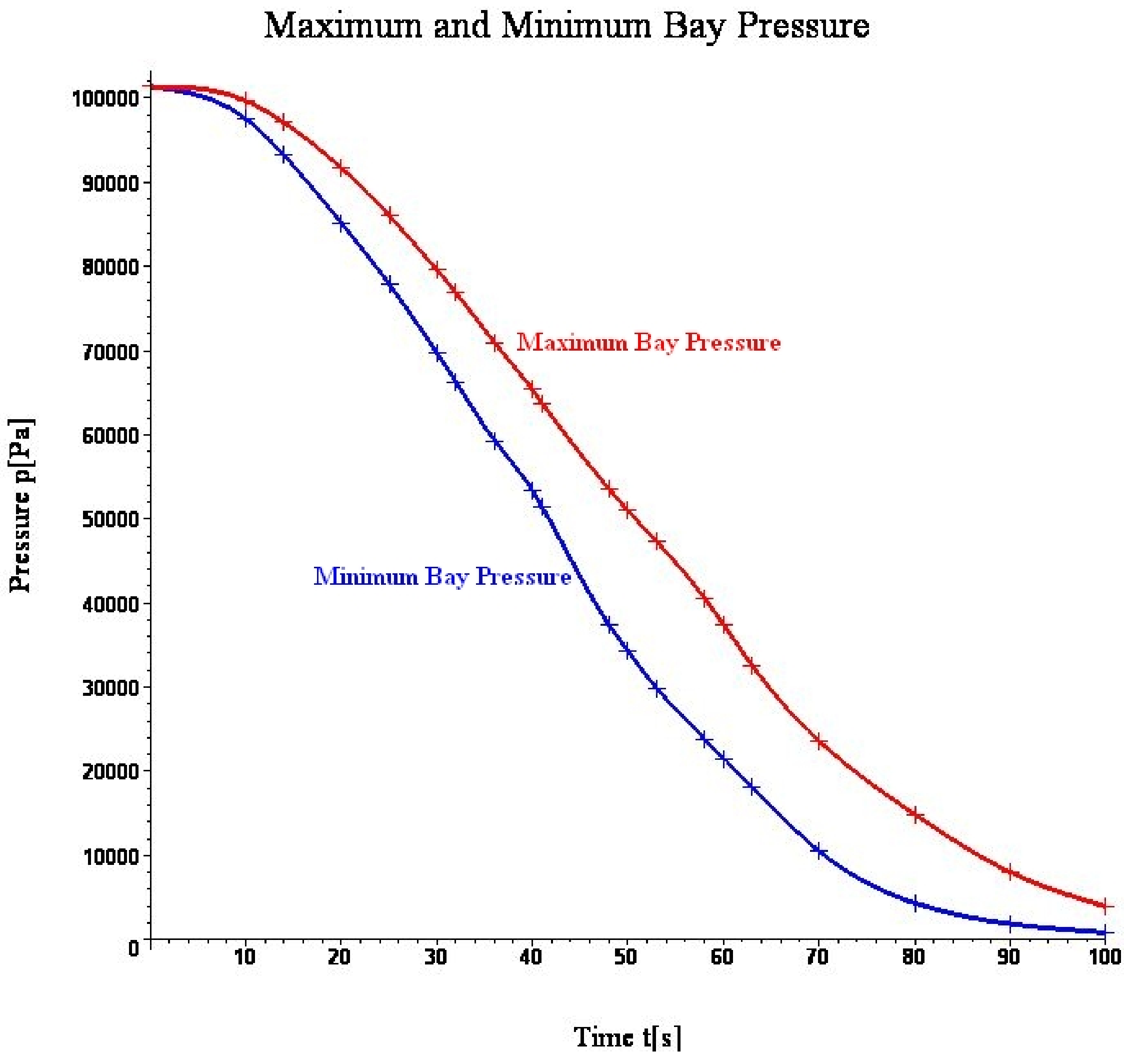


Figure 1: Maximum and minimum pressure within the payload bay of the shuttle.

The venting is done through the walls of the TRD octagon, where there are small slits above each of the TRD straw modules. These slits cover an area of totally $656 \times 100 \times 0.5\,\mathrm{mm}^3$. In addition there is a slit between the upper flange of the octagon and the upper cover all along the circumference with a height of 0.5 mm.

With the above pressure drop in the payload bay the resulting pressure drop in the volume of the octagon is shown in figure 2.

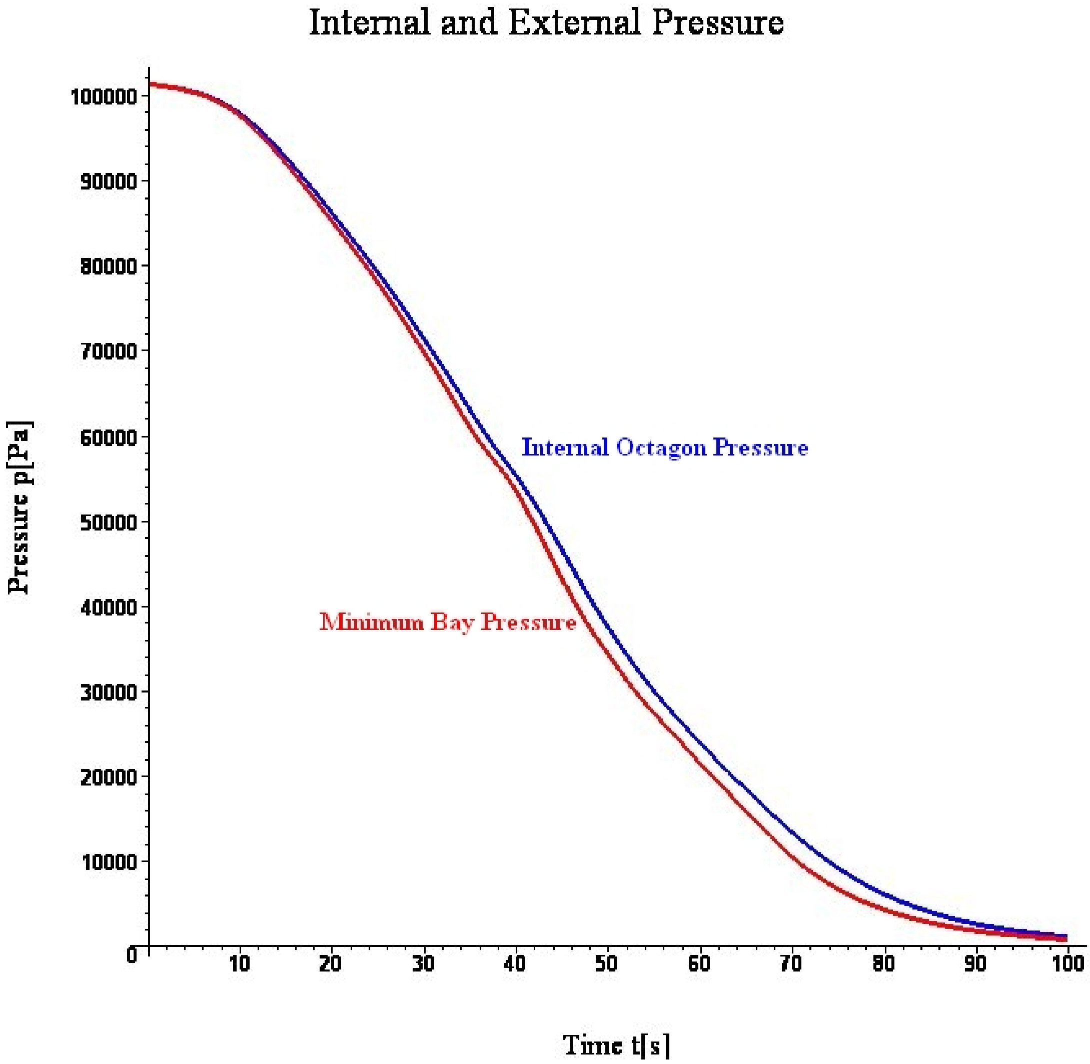


Figure 2: Pressure within the TRD octagon calculated with the minimum pressure in the payload bay.

The difference in pressure between the external pressure in the payload bay and the internal pressure in the octagon is given in figure 3.

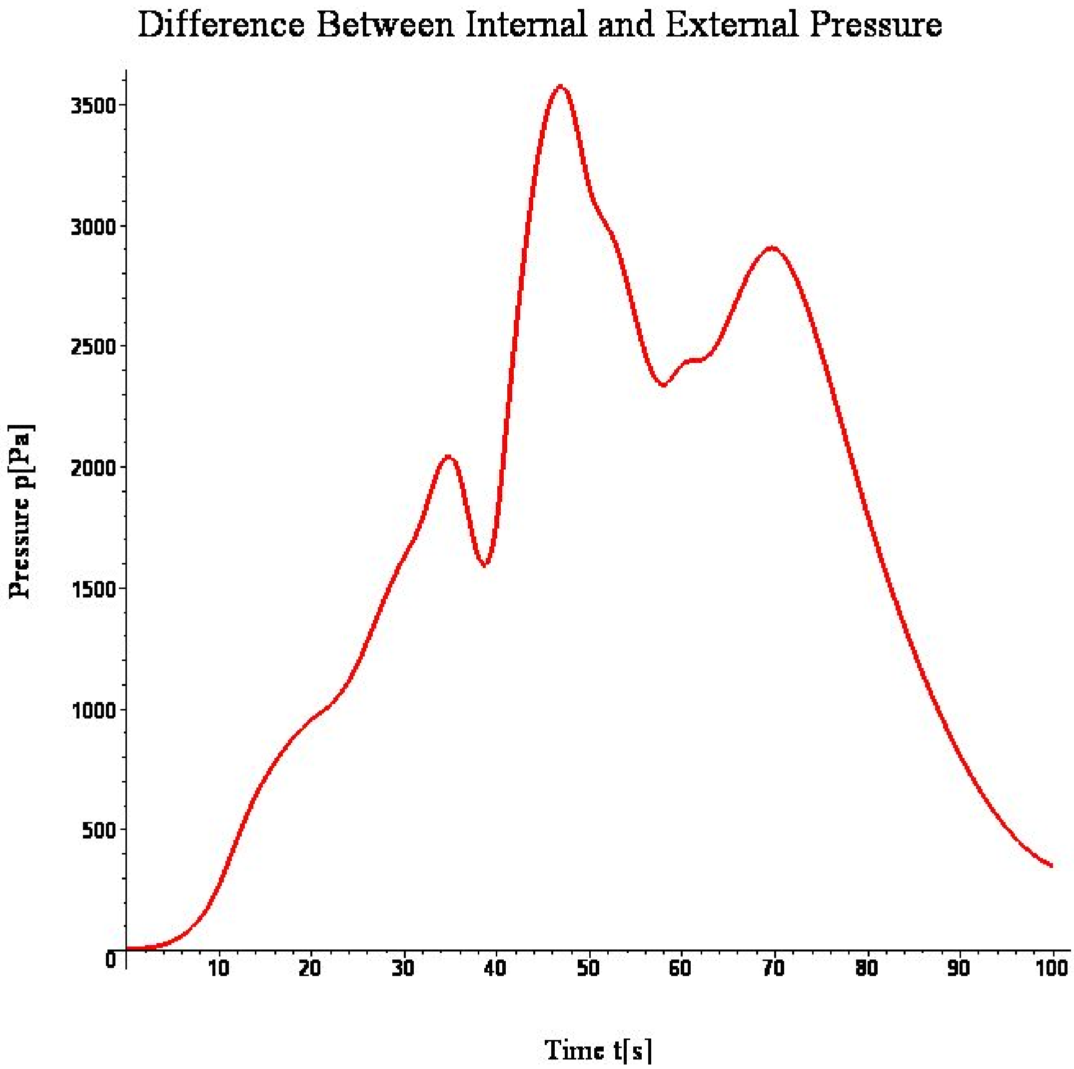


Figure 3: Pressure difference between the pressure in the payload bay and that in the TRD octagon.

1.2 Venting of Honeycomb Panels

There are three places where honeycomb panels are in use.

- TRD upper cover
- TRD lower cover
- TRD octagon side panels

The two covers have both honeycomb panels the core of which is made of honeycomb type Hexel 3/16-5056-0.0007P. It is perforated and the covers are open along the circumference. The side panels have core material made of type Hexel 1/8-5056-0.0007P. It is perforated too. The panels have holes on the outside of the octagon 1 mm in diameter to enable venting of the core.

1.3 Cabling grid tubes

The cabling grid tubes are made of carbon fibre reenforced composite material. They all have holes every 30 cm 1 mm in diameter for venting purposes.

1.4 Photomultiplier (PMT) Housing

The PMT housings have venting channels which are closed with an open pored foam to enable venting.The same is true for the PMT Connectors.

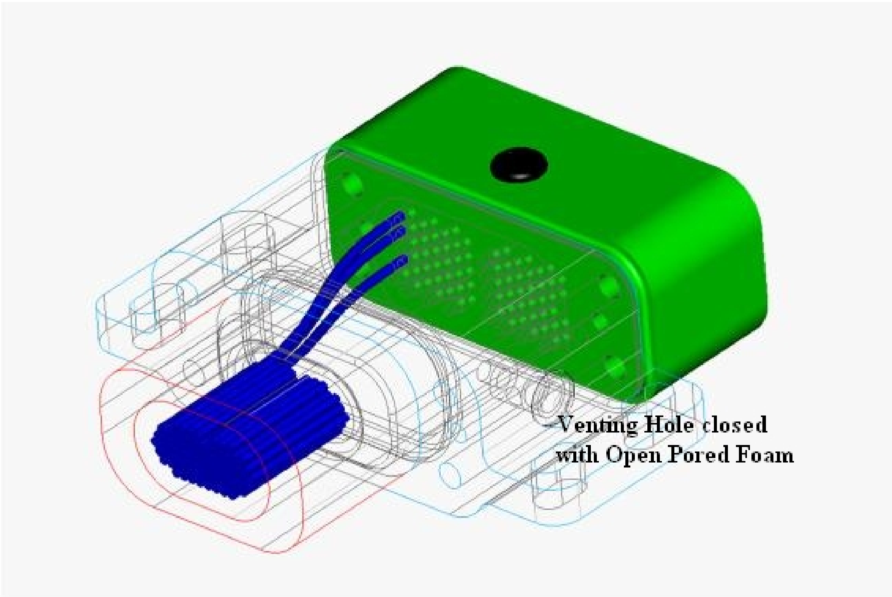


Figure 4: PMT Connector.

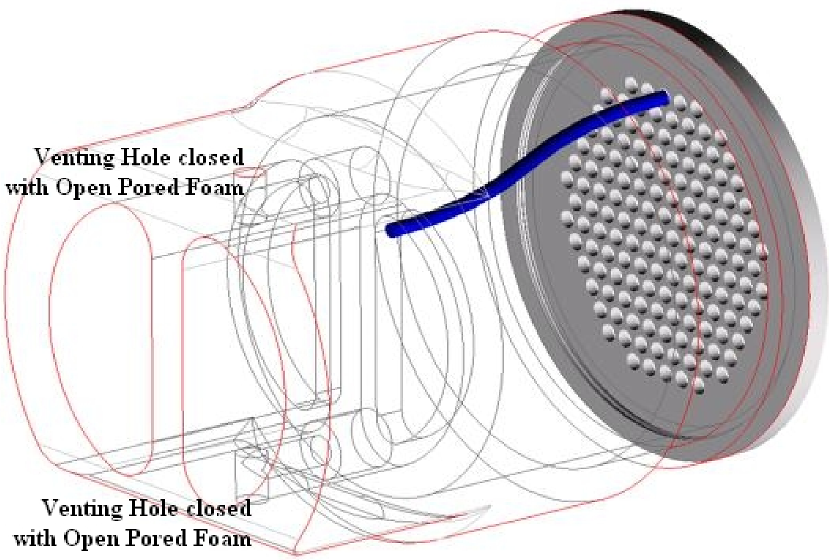
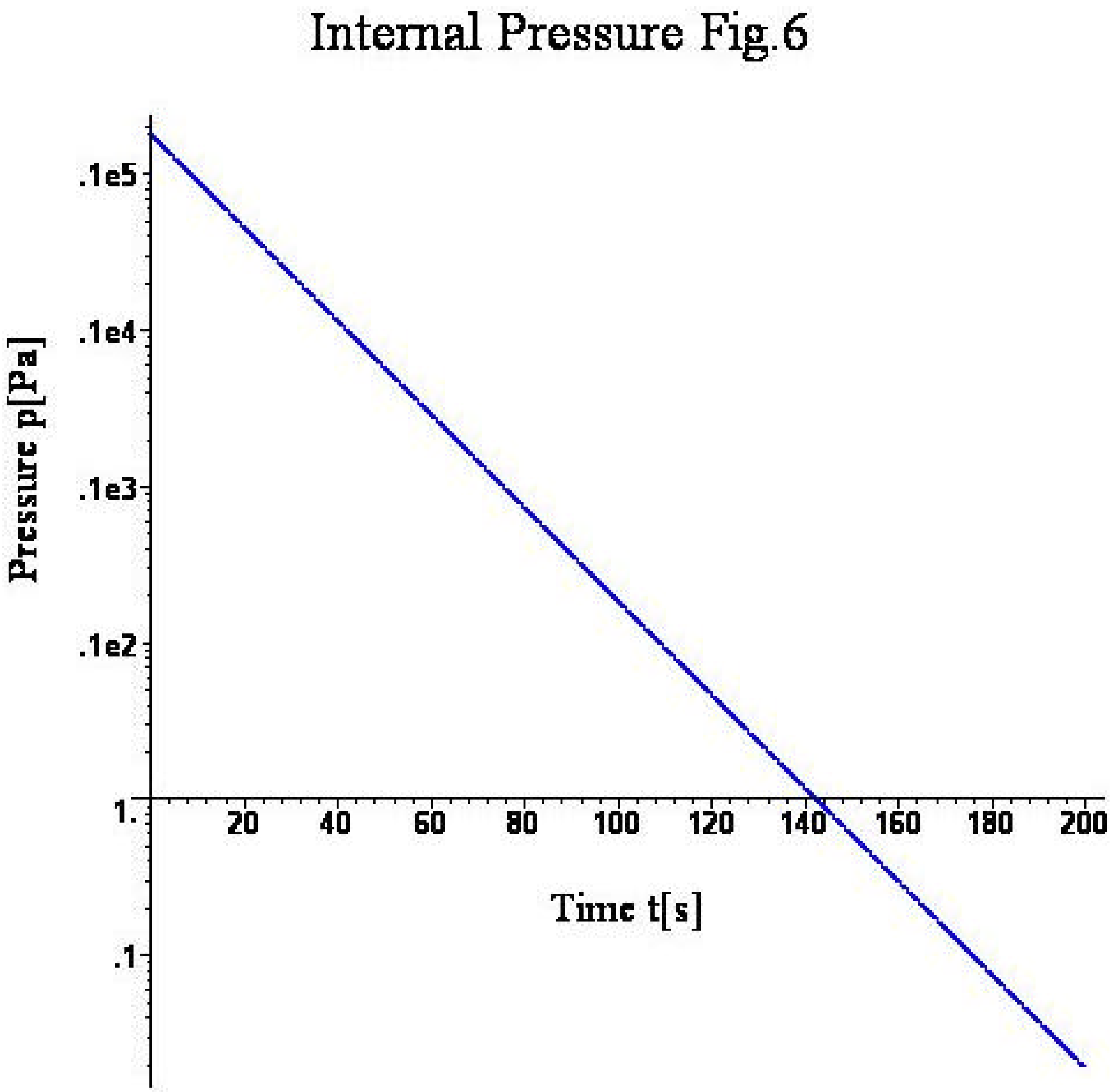


Figure 5: Photomultiplier Housing.

In case of an accident in which all of the 300 litre of STP Xenon will be released the pressure drop is shown in the next figure (6).


Internal Pressure Fig.6
Pressure p[Pa]
.1e5
.1e4
.1e3
.1e2
1.
.1
20
40
60
80
100
120
140
160
180
200
Time t[s]