I. Cylinders

Required thickness of the inner shell under 10 bar of pressure per ASME B&PV Code, UG-27:

\[ t = \frac{P \cdot r}{Sa \cdot E - 0.6P} \]

\[ t = 0.017 \text{ in} \]

The inner tube has 0.12 wall, so it's adequate for an internal pressure of 10 bar. The outer shell has 0.25 wall and it is more than adequate for a 1 bar load, external pressure.

II. Welds (End Flanges to Cylinders)

\[ h = 0.1 \text{ in}, \text{fillet weld size} \]

Since the vacuum space between the cylinders is small, the dominant weld load would be shear. The outer cylinder is quite stiff to prevent any significant edge rotation.

For conservatism, let the full force due to the 10 bar internal pressure be carried by the inner weld in tension. The shear on the weld is:

\[ A := \pi \left( \frac{ds}{2} \right)^2 \quad \text{--> Area under pressure (ds = seal dia)} \]

\[ C := \pi \cdot d1 \quad \text{--> Weld length} \]

\[ Aw := 0.707 \cdot h \cdot C \quad F := P \cdot A \]

\[ Sw := \frac{F}{Aw} \quad \text{--> shear on the weld} \]

\[ Sw = 3.046 \times 10^3 \text{ psi} \]

Note: This is much less than 18,800 psi! And of course the outer weld also shares the load, thus the weld stress is even lower.
III. Cover Flange Penetrations:

(Refer to UG-34, and Fig. UG-34j, ASME Code; Assume a self-energizing gasket such as an O-ring):

\[
\begin{align*}
\text{hg} & := 0.594\text{-in} \\
\text{c} & := 0.3 \\
W & := F \\
W & = 2.875 \times 10^3 \text{lbf}
\end{align*}
\]

Required thickness:

\[
\text{tf} := ds\sqrt{\frac{c \cdot P}{Sa \cdot E}} + \frac{1.9 \cdot W \cdot (hg)}{Sa \cdot (E) \cdot ds^3}
\]

\[
\text{tf} = 0.306\text{in}
\]

The cover flange is 0.5 in thick, so it's ok. There are several penetrations but the removed material is replaced by a stiff feedthru, etc. and thus, the flange strength is not adversely affected. Assumption: Welds (no dimension shown) are as strong as the parent metal.

IV. O-ring Seals

As the flange thickness is more than the required thickness, the thru-thickness deformation should be insignificant and the O-ring, which is generally considered as a self-energizing and self-sealing gasket, should be ok.