How to Specify a Spherical Vacuum Chamber

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MADE IN USA
How to Specify a Spherical Vacuum Chamber

STEP 1: Specify the Material and Finish

MATERIAL OPTIONS:
- 304L Stainless Steel (standard)
- 316L Stainless Steel
- 6061 Aluminum

FINISH OPTIONS:

Sphere Finish Options:
- Mechanically Polished Brushed Finish (standard)
- Electropolished

Tubing Finish Options:
- Mechanically Polished Brushed Finish (standard)
- Electropolished

Flange Finish Options*
- Machined Finish (standard)
- Electropolished

*Sealing surfaces and knife edges are protected during any finishing process to ensure functionality.

Figure 1:
Spherical Example Chamber with Port Numbers, Port Orientations, Flange Types & Sizes, and 3D Cartesian Coordinate System (Isometric)
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**STEP 2: Specify the Main Body**

The **Main Body** of a spherical chamber is defined as the sphere itself (excluding all ports). In most cases, including our **Spherical Example Chamber (Figure 1)**, this sphere is fabricated using two hemispheres (Figure 2).

### Specify the Main Body Sphere

- Nominal Outer Diameter
- Nominal Wall Thickness

**Portholes** are the holes in a chamber body where tubing and flanges are eventually welded to make ports. When fabricating a sphere from two hemispheres, the first step is to machine the portholes that are located at the pole of each hemisphere. These portholes allow access for welding, so **ANCORP** recommends that chamber designers:

- Locate your largest desired portholes at the poles of your spherical chamber.
- At minimum, locate at least one porthole that is 6-inches in diameter or larger at a pole.

If possible, additional portholes are machined into the hemispheres prior to welding.

Next, the two hemispheres are welded together along the interior of the seam where they meet to form a sphere. An interior weld is preferable to an exterior weld in accordance with good vacuum practice.

Finally, any remaining portholes are machined into the sphere (Figure 3).

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**Figure 2:**
Spherical Example Chamber - Upper and Lower Hemispheres Prior to Welding with 3D Cartesian Coordinate System (Isometric)

**Figure 3:**
Spherical Example Chamber - Main Body Sphere after Welding and Machining Remaining Portholes (Isometric)
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STEP 3: Specify the Ports

The Ports of a spherical chamber are the tubulated, flanged points of access that allow vacuum hardware, instrumentation, and other components to connect to the chamber. On our Spherical Example Chamber (Figure 1), we show five ports: Ports 1, 2, 3, 4, & 5.

A) SPECIFY PORT FLANGES* (Type & Size)
Please refer to the catalog for all possible flange sizes. Representative examples are provided in Table 2 on page 6.

*Each flange size has an associated standard tube size. Unless otherwise requested, this standard tube size will be used.

B) SPECIFY PORT LOCATION AND ORIENTATION
The following features and dimensions define a port’s location and orientation on the spherical chamber (Figures 4, 5, & 6):

ORIENTATION: On a spherical chamber, we differentiate between two distinct port orientations: Standard & Offset.
- Standard (eg., Ports 1, 2, 3, 4)
  o Focal Point is the center of the Main Body sphere
- Offset (eg., Port 5)
  o Focal Point is not the center of the Main Body sphere

FOCAL POINT: A port’s Focal Point is a feature that helps define the port’s orientation and focal length.
- Locate each Focal Point in space using a 3-dimensional Cartesian coordinate system.

POLAR ANGLE: A port’s Polar Angle defines its latitudinal position along the outer surface of the spherical chamber.
- Specify each port’s Polar Angle relative to a common polar origin.

AZIMUTHAL ANGLE: A port’s Azimuthal Angle defines its longitudinal position along the outer surface of the spherical chamber.
- Specify each port’s Azimuthal Angle relative to a common azimuthal origin.

OFFSET DISTANCES: A port’s Offset Distances define how far its Focal Point is from the center of the Main Body sphere. Three Offset Distances are defined: one each along the X-Axis, Y-Axis, and Z-Axis of the Main Body sphere. Each Offset Distance is equal to the absolute value of the Focal Point coordinate along that same axis.
- Specify each port’s Offset Distances.
  o For Standard ports, the Offset Distances all equal zero.
  o For Offset ports, at least one of the Offset Distances does not equal zero.

FOCAL LENGTH: A port’s Focal Length defines the linear distance between the port’s flange face and Focal Point.
- Specify each port’s Focal Length relative to its flange face and its established Focal Point.

Table 1 on page 5 summarizes all the information needed to properly specify the ports on our Spherical Example Chamber.
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Table 1: Port Specifications for Spherical Example Chamber

<table>
<thead>
<tr>
<th>Port</th>
<th>Flange</th>
<th>Orientation</th>
<th>Focal Pt.</th>
<th>Focal Point Coordinates (X,Y,Z)</th>
<th>Polar Angle</th>
<th>Azimuthal Angle</th>
<th>Offset Distances (X,Y,Z)</th>
<th>Focal Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CF800</td>
<td>Standard</td>
<td>Point A</td>
<td>(0.000, 0.000, 0.000) in.</td>
<td>180.0°</td>
<td>0.0°</td>
<td>(0.000, 0.000, 0.000) in.</td>
<td>6.728 in.</td>
</tr>
<tr>
<td>2</td>
<td>CF600</td>
<td>Standard</td>
<td>Point A</td>
<td>(0.000, 0.000, 0.000) in.</td>
<td>0.0°</td>
<td>0.0°</td>
<td>(0.000, 0.000, 0.000) in.</td>
<td>7.145 in.</td>
</tr>
<tr>
<td>3</td>
<td>CF600</td>
<td>Standard</td>
<td>Point A</td>
<td>(0.000, 0.000, 0.000) in.</td>
<td>90.0°</td>
<td>180.0°</td>
<td>(0.000, 0.000, 0.000) in.</td>
<td>7.645 in.</td>
</tr>
<tr>
<td>4</td>
<td>CF275</td>
<td>Standard</td>
<td>Point A</td>
<td>(0.000, 0.000, 0.000) in.</td>
<td>120.0°</td>
<td>90.0°</td>
<td>(0.000, 0.000, 0.000) in.</td>
<td>8.223 in.</td>
</tr>
<tr>
<td>5</td>
<td>CF275</td>
<td>Offset</td>
<td>Point B</td>
<td>(2.000, 0.000, -1.500) in.</td>
<td>90.0°</td>
<td>270.0°</td>
<td>(2.000, 0.000, 1.500) in.</td>
<td>7.584 in.</td>
</tr>
</tbody>
</table>
Table 2: Flange Types, Sizes, Vacuum Ratings, and Temperature Ratings

<table>
<thead>
<tr>
<th>FLANGE TYPE</th>
<th>FLANGE SIZES</th>
<th>VACUUM RATING</th>
<th>TEMPERATURE RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CF - Conflat</td>
<td>133, 212, 275, 338, 450, 462, 600, 675, 800, 1000, 1200, 1325, 1400, 1450, 1650</td>
<td>1X10^{-13} Torr</td>
<td>-200°C to 450°C</td>
</tr>
<tr>
<td>WF - Wire-Sealed</td>
<td>1200, 1400, 1700, 1900, 2200, 2700</td>
<td>1X10^{-13} Torr</td>
<td>-200°C to 450°C</td>
</tr>
<tr>
<td>QF - Quick Flange</td>
<td>10, 16, 25, 40, 50, 63, 80, 100, 160, 200</td>
<td>1X10^{-8} Torr</td>
<td>-50°C to 200°C</td>
</tr>
<tr>
<td>LF - Large Flange (Clamp)</td>
<td>63, 80, 100, 160, 200, 250, 320, 400, 500</td>
<td>1X10^{-8} Torr</td>
<td>-50°C to 200°C</td>
</tr>
<tr>
<td>LFB - Large Flange (Bolt)</td>
<td>63, 80, 100, 150, 200, 250, 320, 400, 500</td>
<td>1X10^{-8} Torr</td>
<td>-50°C to 200°C</td>
</tr>
<tr>
<td>ASA</td>
<td>100, 150, 200, 300, 400, 600, 800, 1000</td>
<td>1X10^{-8} Torr</td>
<td>-20°C to 200°C</td>
</tr>
</tbody>
</table>

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