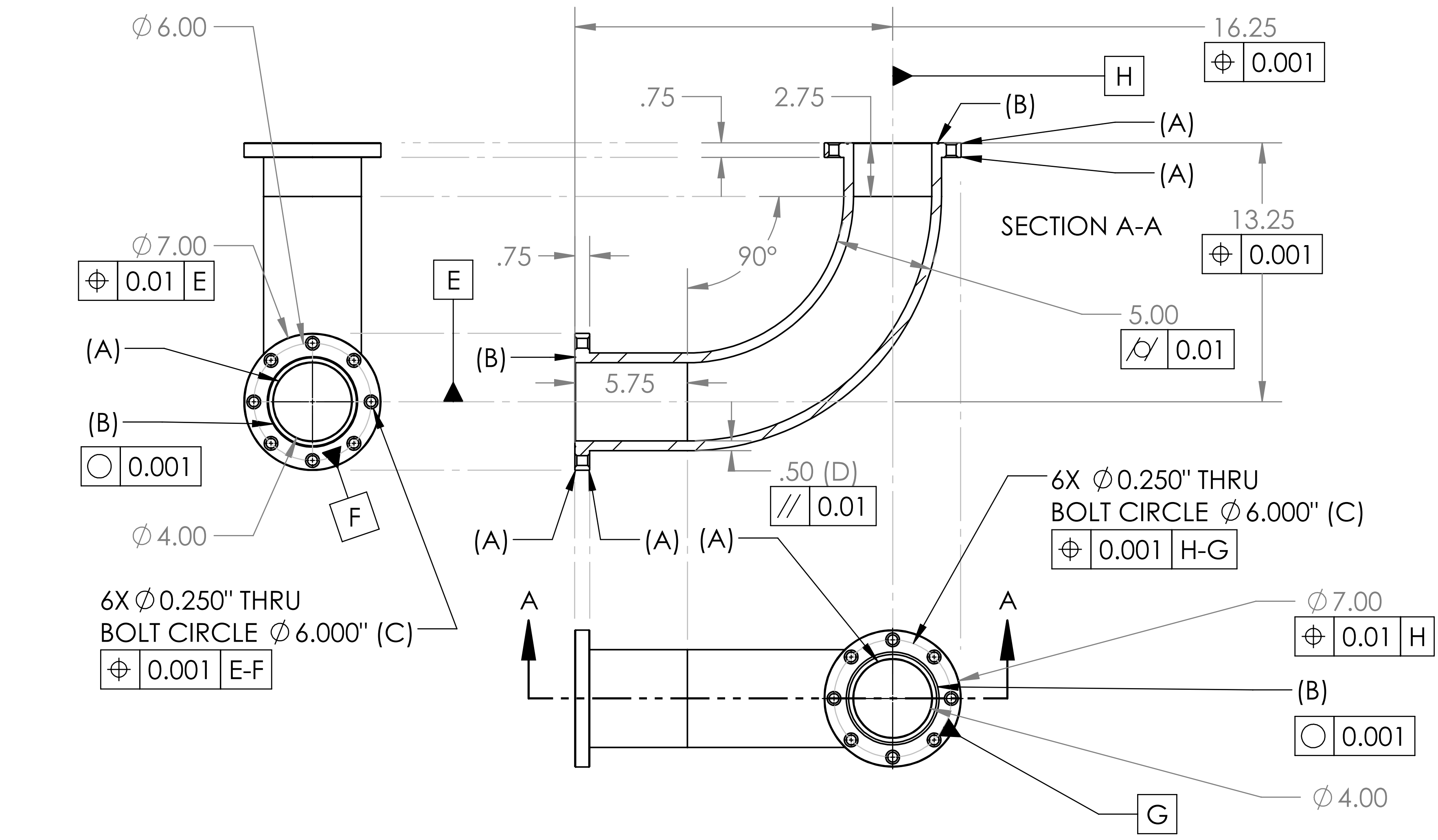

UNLESS OTHERWISE SPECIFIED:	
DIMENSIONS ARE IN INCHES TOLERANCES:	
LINEAR: ± 0.001" ANGULAR (MACHINED): ± 0.001° ANGULAR (BENT): ± 0.1°	
GEOMETRIC TOLERANCING INTERPRETED PER ASME Y14.5-2009	
MATERIAL ASTM A106 GRADE B	
FINISH FLANGES - AS MACHINED OTHER - AS FABRICATED	
DO NOT SCALE DRAWING	

	NAME	DATE
DRAWN	ALAN L.	07/31/2025
CHECKED	N/A	N/A
ENG APPR.	N/A	N/A
MFG APPR.	N/A	N/A
Q.A.	N/A	N/A

COMMENTS:
(A) - 1/32" x 45° CHAMFER
(B) - 1/16" W x 1/16" DEEP x R4.625" CIRCULAR CX GASKET GROOVE CONCENTRIC WITH DATUM E OR H
(C) - 0.100" X 45° CHAMFER
(D) WALL THICKNESS UNIFORM

NEXT ASSY	USED ON
APPLICATION	

TITLE:

4" FLANGED PIPE 90° ELBOW

SIZE	DWG. NO.	REV
A	1	001

SCALE: 1:8 | WEIGHT: 56.96 LB | SHEET 1 OF 1

Project: 4” Flanged Pipe 90° Elbow
Engineer: Alan C. Longfellow
Date: 31 July 2025
Calculation Type: Internal Pressure, Hoop Stress Verification
References: ASME B31.3, Lamé equations

Given:

- Pipe ID = 4.000 in
- Wall thickness (t) = 0.500 in
- Max design internal pressure (P_{inner}) = 5.000 ksi
- External pressure (P_{outer}) = STP = 0.0147 ksi
- Safety factor (FS) = 1.5

Material:

- ASTM A106 Grade B
- Yield strength (σ_y) = 35.0 ksi

Calculated geometry:

- $r_{\text{inner}} = 2.000\,\text{in}$
- $r_{\text{outer}} = 2.500\,\text{in}$
- $r_{\text{mean}} = 0.5 \cdot (2.000\,\text{in} + 2.500\,\text{in}) = 2.250\,\text{in}$

Lamé equation for hoop stress σ_θ in a thick-walled vessel ($r_{\text{outer}}\,/\,t\ <\ 10$):

$$\sigma_\theta = \frac{P_{\text{inner}} r_{\text{inner}}^2 - P_{\text{outer}} r_{\text{outer}}^2}{r_{\text{outer}}^2 - r_{\text{inner}}^2} - \frac{r_{\text{inner}}^2 r_{\text{outer}}^2 \left(P_{\text{inner}} - P_{\text{outer}}\right)}{\left(r_{\text{outer}}^2 - r_{\text{inner}}^2\right) r_{\text{mean}}^2}$$

Solution for hoop stress:

$$\sigma_\theta = \frac{(5.000\,\text{ksi}) \cdot (2.000\,\text{in})^2 - (0.0147\,\text{ksi}) \cdot (2.500\,\text{in})^2}{(2.500\,\text{in})^2 - (2.000\,\text{in})^2} -$$

$$\frac{(2.000\,\text{in})^2 \cdot (2.500\,\text{in})^2 \cdot (5.000\,\text{ksi} - 0.0147\,\text{ksi})}{((2.500\,\text{in})^2 - (2.000\,\text{in})^2) \cdot (2.250\,\text{in})^2} = 19.790\,\text{ksi}$$

Safety factor verification:

$$\sigma_{\max} = \frac{\sigma_y}{\text{FS}} = \frac{35.0\,\text{ksi}}{1.5} = 23.333\,\text{ksi}$$

$$\frac{\sigma_\theta}{\sigma_{\max}} = \frac{23.333\,\text{ksi}}{19.790\,\text{ksi}} = 117.9\%\ \text{FS}, \quad \textbf{ACCEPTABLE}$$