6 inch ID pipe with flanges   1040 cold rolled steel   1000 psi pressure

12 bolts around flange   1/2-20 UNF Grade 8   threaded into flange

application factor of safety $N_{AFS} = 2$ to prevent blow-by

$$F_{TOTAL} = (pressure)\frac{\pi}{4}(D_{BORE})^2 = 28,274 \text{ lbf}$$

$$F_{BOLT} = F_{TOTAL}/12 \text{ bolts } = 2356 \text{ lbf}$$

$$P_i = N_{AFS} F_{BOLT} = 4712 \text{ lbf}$$

pre-load torque

Norton Table 15-11 $k_i = 0.21$

$$T_i = k_i P_i d = 494.8 \text{ in.lbf} = 41.2 \text{ ft.lbf}$$ Norton Eq. 15.23d

1/2-20 UNF Grade 8   Norton Table 15-2 and 15-6
d = 0.50 in
d_r = 0.4350 in
A_t = 0.1600 in^2
p = 1/20 in = 0.05 in
S_{PR} = 120 ksi
S_{UT} = 150 ksi

tension in bolt

$\sigma' = P_i / A_t = 29.46$ ksi

$N_{PR} = S_{PR} / \sigma' = 4.07$

strip one thread in bolt $w_i = 0.80$ Norton Table 15-5

$A_S = \pi\, d_r\, p\, w_i = 0.05467$ in^2 Norton Eq 15.8a

shear area for three threads $A_{3S} = 0.1640$ in^2

$\tau = P_i / A_{3S} = 28.73$ ksi

$\sigma' = \sqrt{3}\, \tau = 49.77$ ksi

$N_{3S\_BOLT} = S_{UT} / \sigma' = 3.01$

strip one thread in flange (nut) $w_o = 0.88$ Norton Table 15-5

$A_S = \pi\, d\, p\, w_o = 0.06911$ in^2 Norton Eq 15.8b

shear area for three threads $A_{3S} = 0.2073$ in^2

$\tau = P_i / A_{3S} = 22.73$ ksi

$\sigma' = \sqrt{3}\, \tau = 39.37$ ksi

Norton Table A-9   1040 cold-rolled $S_{UT} = 85$ ksi

$N_{3S\_FLANGE} = S_{UT} / \sigma' = 2.16$

this is very close to N_{AFS}

RECOMMEND
use coarse threads OR drill through second flange and use Grade 8 nuts $N_{3S\_NUT} > N_{3S\_BOLT}$

1/2-13 UNC Grade 8   Norton Table 15-2, 15-5 15-6
d = 0.50 in
d_r = 0.4001 in
A_t = 0.1419 in^2
p = 1/13 in = 0.07692 in

tension in bolt

$$\sigma' = P_i / A_t = 33.21 \text{ ksi}$$

$$N_{PR} = S_{PR} / \sigma' = 3.61$$

strip three threads in bolt $w_i = 0.80$ Norton Table 15-5

$$A_{3S} = 3 \pi d_r p w_i = 0.2321 \text{ in}^2 \qquad \text{Norton Eq 15.8a}$$

$$\tau = P_i / A_{3S} = 20.31 \text{ ksi}$$

$$N_{3S\_BOLT} = \frac{S_{UT}}{\sqrt{3} \, \tau} = 4.26$$

strip three threads in nut $w_o = 0.88$ Norton Table 15-5

$$A_{3S} = 3 \pi d p w_o = 0.3189 \text{ in}^2 \qquad \text{Norton Eq 15.8b}$$

$$\tau = P_i / A_{3S} = 14.77 \text{ ksi}$$

$$N_{3S\_BOLT} = \frac{S_{UT}}{\sqrt{3} \, \tau} = 5.86$$