Tube Analysis

Static Load Case: Weight of Actuator

Three stresses we are concerned with are shear stress due to torsion, normal stress due to bending, and shear stress due to bending

In [1]:
```
import numpy as np
import pandas as pd
import pint
u = pint.UnitRegistry()
```

Define Parameters of Interest

In [2]:
```
#Parameters
h3 = (11*u.inch) #in
Factuator = 10*u.lbf #lbf
```

Calculate Stresses

In [3]:
```
r2 = (1*u.inch) #in
r1 = r2 - np.array([.065, .083, .095])*u.inch #in
A = (np.pi)*(r2**2 - r1**2) #in^2
bending_shear = (4*Factuator/A)*((r2**2 + r1*r2 + r1**2)/(r2**2 + r1**2)) #psi
bending_shear = bending_shear.to('megapascal')

bending_normal = 4*r2*h3*Factuator/(np.pi*(r2**4 - r1**4)) #psi
bending_normal = bending_normal.to('megapascal')

torsion_shear = 2*h3*Factuator*r2/(np.pi*(r2**4 - r1**4)) #psi
torsion_shear = torsion_shear.to('megapascal')

print('For thicknesses of .065", .083", and .095"')
print('Max Shear Stress in Bending: {}'.format(bending_shear))
print('Max Normal Stress in Bending: {}'.format(bending_normal))
print('Max Shear Stress in Torsion: {}\n'.format(torsion_shear))

yield_stress = 240*u.megapascal
print('Yield Stress: {}'.format(yield_stress))
shear_yield_stress = .55*yield_stress
print('Shear Yield Stress: {}\n'.format(shear_yield_stress))
bending_shear_sf = shear_yield_stress/bending_shear
bending_normal_sf = yield_stress/bending_normal
torsion_shear_sf = shear_yield_stress/torsion_shear
print('Safety factor for shear stress in bending: {}'.format(bending_shear_sf))
print('Safety factor for normal stress bending: {}'.format(bending_normal_sf))
print('Safety factor for shear stress in torsion: {}'.format(torsion_shear_sf))
```

```
For thicknesses of .065", .083", and .095"
Max Shear Stress in Bending: [1.04616352 0.82656703 0.72641188] megapascal
Max Normal Stress in Bending: [4.09643185 3.29681046 2.93335438] megapascal
Max Shear Stress in Torsion: [2.04821592 1.64840523 1.46667719] megapascal

Yield Stress: 240 megapascal
Shear Yield Stress: 132.0 megapascal

Safety factor for shear stress in bending: [126.17530336 159.69666803 181.71509012] dimen
sionless
Safety factor for normal stress bending: [58.58757299 72.79763374 81.81759477] dimensionl
ess
Safety factor for shear stress in torsion: [64.44633029 80.07739711 89.99935425] dimensio
nless
```