Fermilab

Particle Physics Division

Mechanical Department Engineering Note

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Project Internal Reference:

Project:

Title: Gas Cylinder Lifting Fixture

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Key Words: Lifting fixture, gas cylinder

Applicable Codes:

Abstract Summary:

The following note analyzes the capacity of a gas cylinder lifting fixture; considering loading with either two or four cylinders present.

Picture: Actual gas cylinder lifting fixture for analysis

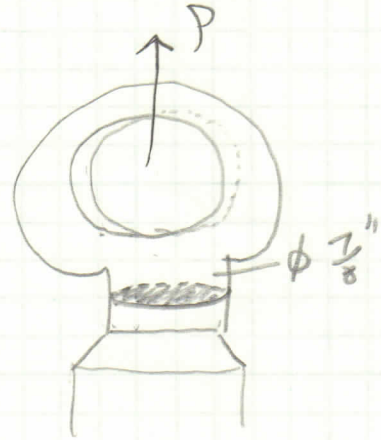
Discussion

- $\sigma_y = 30$ ksi
- Will consider loading with 2 and 4 tanks
- Assume Standard type K cylinder size filled with water

→ 9.25" × 60" ; weights 135 lbs
(d) (h)
Water capacity = 110 lbs

→ Assume each tank = 300 lbs

Tanks	P_{Total} (#)
2	600
4	1200



Eye

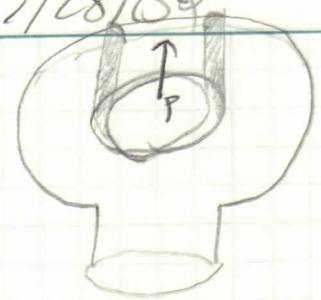
- Tensile stress

$\sigma_{max} = \frac{1}{3}\sigma_y = 10$ ksi

$\sigma = \frac{P}{A}$; $A = \frac{1}{4}\pi(\frac{7}{8})^2 = .601 \text{ in}^2$

Tanks	σ_{Total} (psi)
2	998
4	1997

< 10 ksi ok



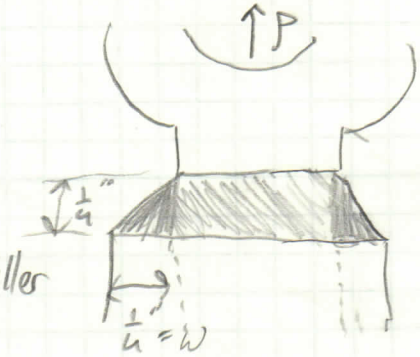
- shear stress

$\sigma_{max} = \frac{1}{3} F_y = 10$ ksi ; $\sigma = \frac{P}{A}$

$A = 2\left[\frac{1}{4}\pi\left(\frac{7}{8}\right)^2\right] = 1.203 \text{ in}^2$

Tanks	σ_{Total} (psi)
2	499
4	998

< 10 ksi ok



- Eye weld stress

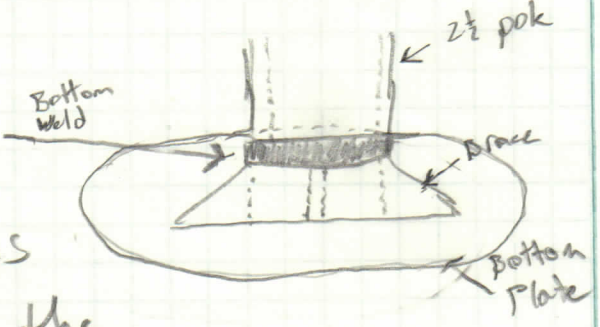
$\sigma_{max} = \sigma_y(.3)$ → assume E60xx filler

$= (60 \text{ ksi})(.3) = 18$ ksi

Throat Area $= (.707)\left(\frac{1}{4}\right) \times \overset{\text{length}}{\pi\left(\frac{7}{8}\right)} = .486 \text{ in}^2$

Tanks	σ_{Total} (psi)
2	1235
4	2469

< 18 ksi ok

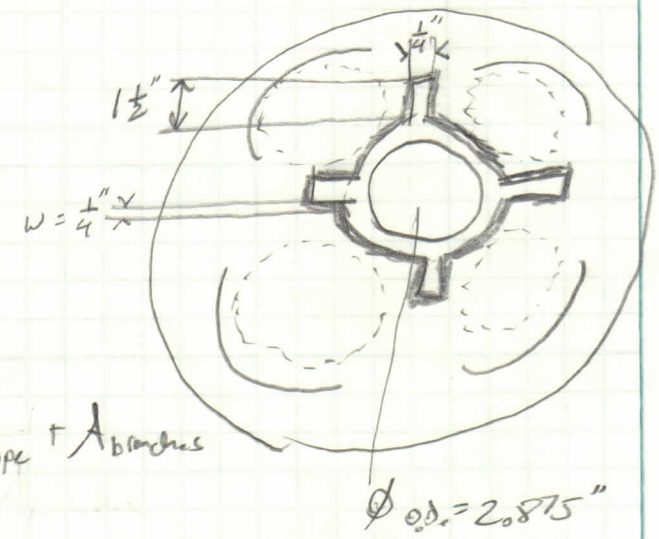


- Bottom weld stress

→ The bottom weld has greater area than the eye weld, therefore

$\sigma_{Bottom\ Weld} < \sigma_{Eye\ Weld} < 18$ ksi ok

Bottom Plate



- Weld stress

$\sigma_{max} = (.3) F_y = 18\ ksi$

$\sigma = \frac{P}{A}$; $A_{Total} = A_{pipe} + A_{branches}$

$A_{pipe} = .707 \pi d w = .707 \pi (2.875) \frac{1}{4} = 1.6\ in^2$

$A_{branches} = .707 (\frac{1}{4})(1\frac{1}{2}) \times (8\ sides) = 2.121$

$A_{Total} = 1.6 + 2.121 = 3.721\ in^2$

Tanks	σ_{Total} (psi)
2	161
4	322

< 18 ksi ok

- Bending stresses on the Bottom Plate are considered in the FEA seen on the next pages

FEA

Tanks	max δ (in)	Max σ (localized at intersection of brace corners and plate) (psi)
2	.0102	7,150
4	.0108	11,100

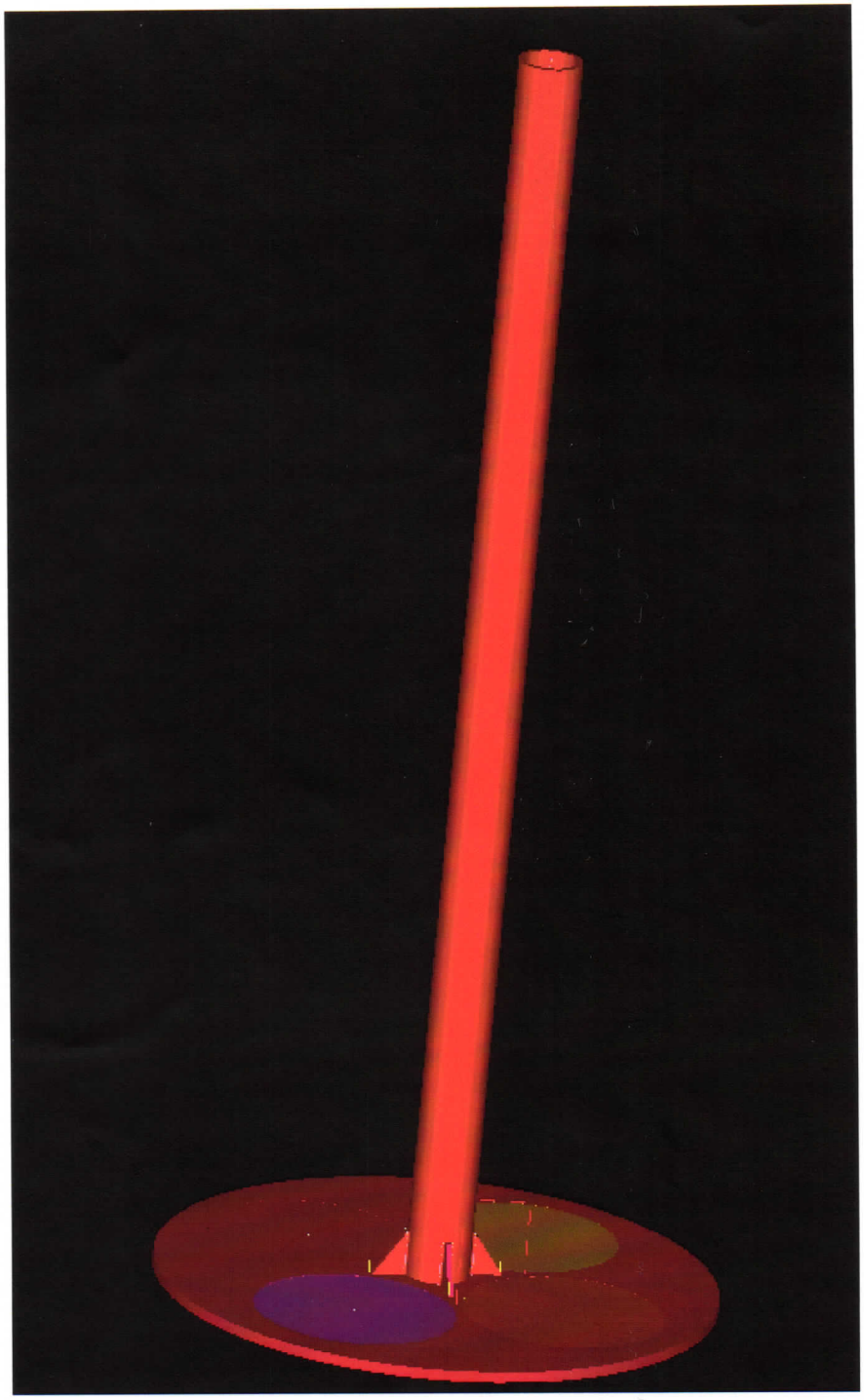


Figure: Equivalent fixture modeled in I-DEAS

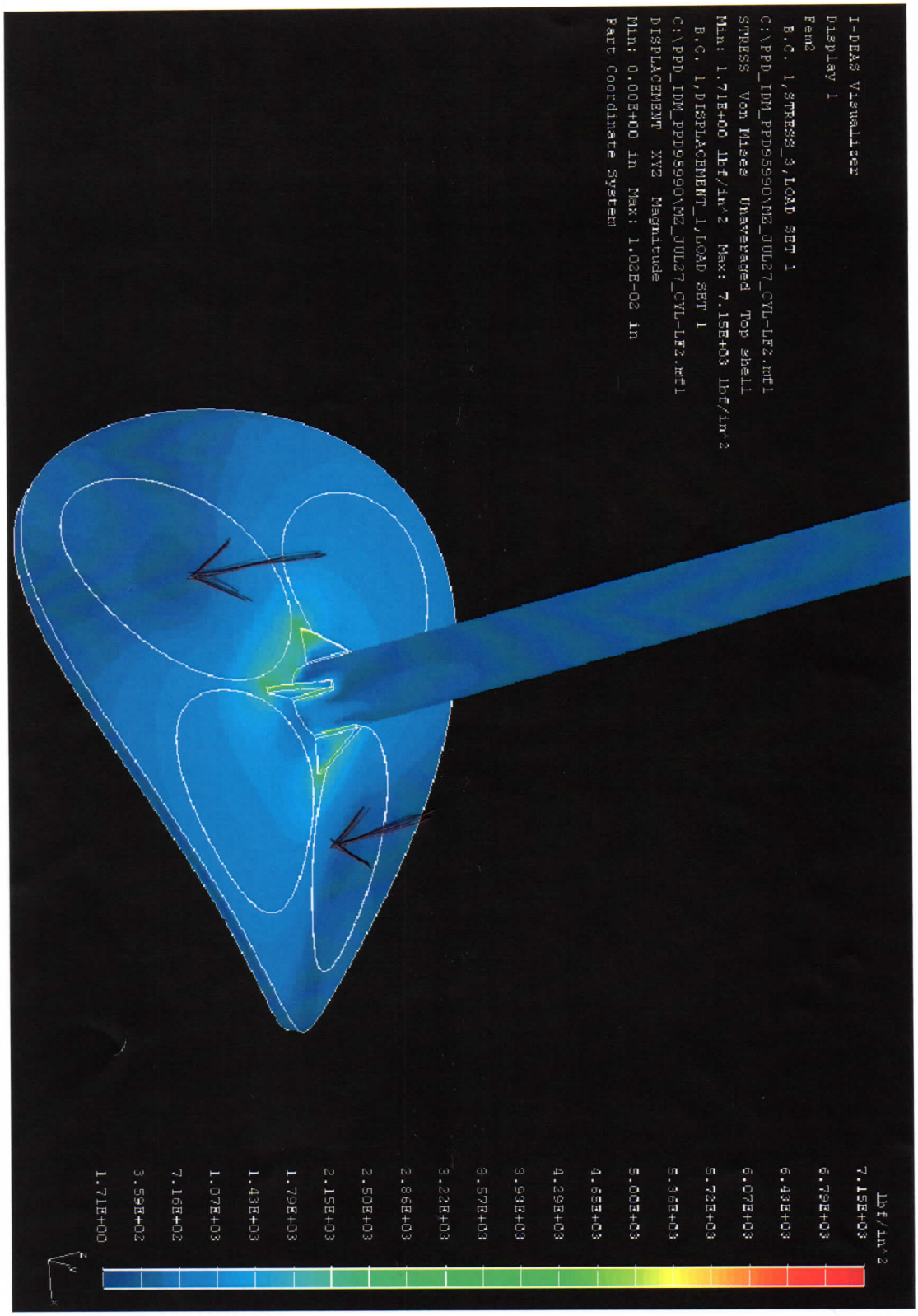


Figure: FEA with 2-300lb gas cylinders present; max stress is 7150 psi at very localized points where the corners of the brace meet the bottom plate (welds, Fmax = 18ksi).

* Tanks always opposite each other when only 2 present

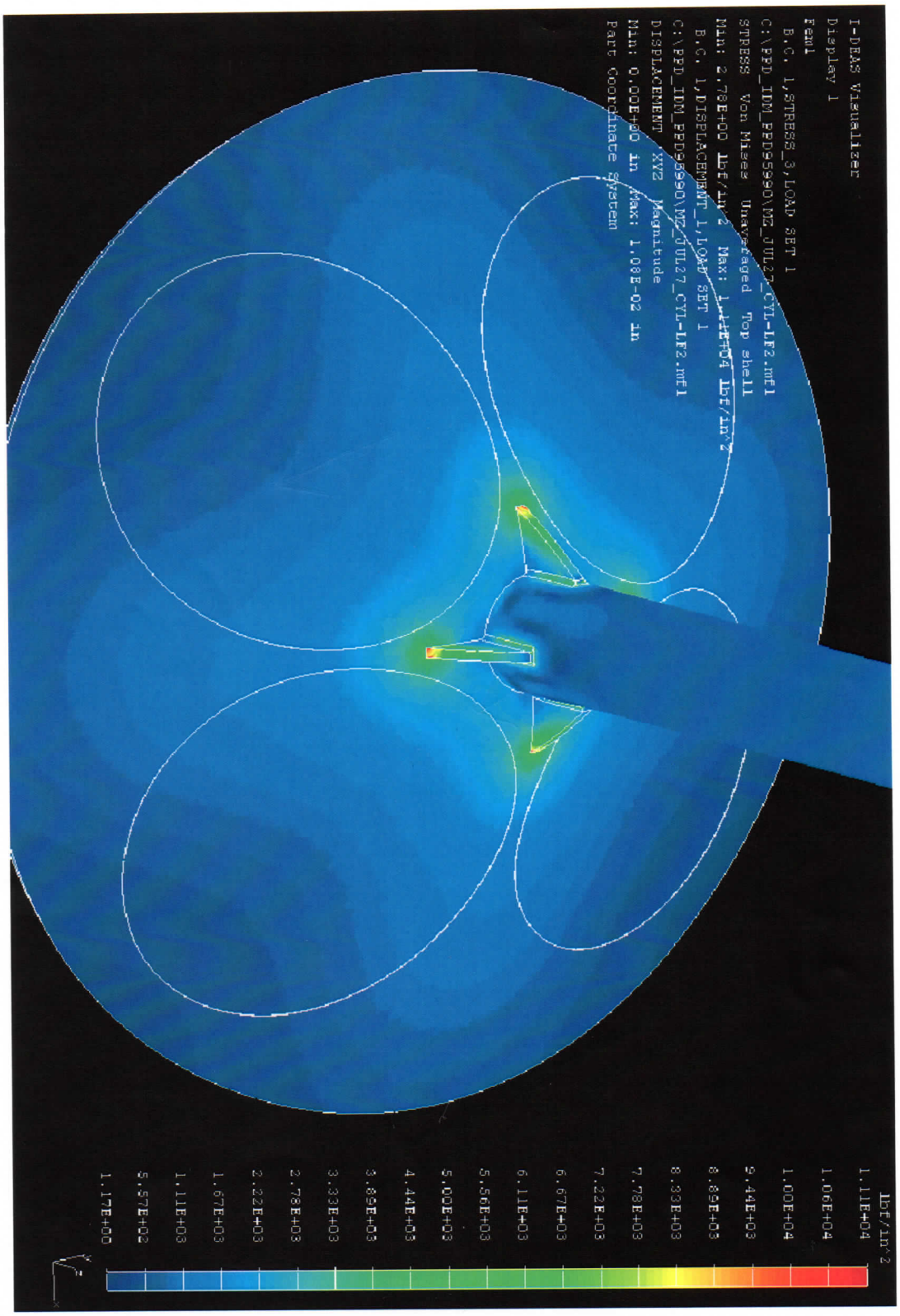


Figure: FEA with 4-300 lb cylinders presents; max stress is 11100 psi at very localized points where the corners of the brace meet the bottom plate (welds, Fmax = 18ksi).