BELOW-THE-HOOK LIFTING DEVICE
Engineering Note Cover Page

Lifting Device Numbers: 173A

FNAL Site No/ _____ (If applicable) Div. Specific No. MD-196 (If applicable) Asset No. _____ (If applicable)

ASME B30.20 Group: (check one)
- [X] Group I Structural and Mechanical Lifting Devices
- [ ] Group II Vacuum Lifting Devices
- [ ] Group III Magnets, Close Proximity Operated
- [ ] Group IV Magnets, Remote Operated

Device Name or Description: GAS CYLINDER LIFTING FIXTURE

Device was (check all applicable)
- [ ] Purchased from a Commercial Lifting Device Manufacturer. Mfg Name _____
- [X] Designed and Built at Fermilab
- [ ] Designed by Fermilab and Built by a Vendor. Assy drawing number _____
- [ ] Provided by a User or other Laboratory
- [ ] Other: Describe _____

Engineering Note Prepared by: Mike Zuckaboot Date: 28 July 2009

Engineering Note Reviewed by: ANG LEE Date: 4 Aug 2009

Lifting Device Data:

Capacity: 1200 #

Fixture Weight: 100 #

Service: [X] normal [ ] heavy [ ] severe (refer to B30.20 for definitions)

Duty Cycle _____ 8, 16 or 24 hour rating (applicable to groups III, and IV)

Inspections Frequency: EACH USE

Rated Load Test by FNAL (if applicable) Date: 24 FEB 2010 Load: 2000 #

[ ] Check if Load Test was by Vendor and attach the certificate

Satisfactory Load Test Witnessed by: TIM GRIFFIN

Signature (of Load Test Witness): 5108

Notes or Special Information:

BELOW-THE-HOOK LIFTING DEVICE
Engineering Note Cover Page

Lifting Device Numbers: 173B

FNAL Site No/ _____ (If applicable) Div. Specific No. MD ~~196~~ B (If applicable) Asset No. _____ (If applicable)

ASME B30.20 Group: (check one)
- [X] Group I Structural and Mechanical Lifting Devices
- [ ] Group II Vacuum Lifting Devices
- [ ] Group III Magnets, Close Proximity Operated
- [ ] Group IV Magnets, Remote Operated

Device Name or Description: GAS CYLINDER LIFTING FIXTURE

Device was (check all applicable)
- [ ] Purchased from a Commercial Lifting Device Manufacturer. Mfg Name _____
- [X] Designed and Built at Fermilab
- [ ] Designed by Fermilab and Built by a Vendor. Assy drawing number _____
- [ ] Provided by a User or other Laboratory
- [ ] Other: Describe _____

Engineering Note Prepared by Mike Zuckerbrot Date 28 July 2009

Engineering Note Reviewed by Aug LEE Date 4 AUG 2009

Lifting Device Data:

Capacity 1200 #

Fixture Weight 100 #

Service: [X] normal [ ] heavy [ ] severe (refer to B30.20 for definitions)

Duty Cycle _____ 8, 16 or 24 hour rating (applicable to groups III, and IV)

Inspections Frequency EACH USE

Rated Load Test by FNAL (if applicable) Date 24 FEB 2010 Load 2000 #

[ ] Check if Load Test was by Vendor and attach the certificate

Satisfactory Load Test Witnessed by: TIM GRIFFIN

Signature (of Load Test Witness) [signature] 5108

Notes or Special Information:

5022TA

BELOW-THE-HOOK LIFTING DEVICE
Engineering Note Cover Page

Lifting Device Numbers: 173 C

FNAL Site No/ _____ (If applicable) Div. Specific No. 173-C (If applicable) Asset No. _____ (If applicable)

ASME B30.20 Group: (check one)
- [X] Group I Structural and Mechanical Lifting Devices
- [ ] Group II Vacuum Lifting Devices
- [ ] Group III Magnets, Close Proximity Operated
- [ ] Group IV Magnets, Remote Operated

Device Name or Description: 4 GAS CYLINDER LIFT CART

Device was (check all applicable)
- [ ] Purchased from a Commercial Lifting Device Manufacturer. Mfg Name _____
- [X] Designed and Built at Fermilab
- [ ] Designed by Fermilab and Built by a Vendor. Assy drawing number _____
- [ ] Provided by a User or other Laboratory
- [ ] Other: Describe _____

Engineering Note Prepared by Mark Zuckerbrot Date 10 July 09

Engineering Note Reviewed by Angel SE Date 4 Aug 09

Lifting Device Data:

Capacity 1200

Fixture Weight 100

Service: [X] normal [ ] heavy [ ] severe (refer to B30.20 for definitions)

Duty Cycle _____ 8, 16 or 24 hour rating (applicable to groups III, and IV)

Inspections Frequency Each USE

Rated Load Test by FNAL (if applicable) Date 2/26/10 Load 2000 #

[ ] Check if Load Test was by Vendor and attach the certificate

Satisfactory Load Test Witnessed by: John Voirin

Signature (of Load Test Witness) John Voirin

Notes or Special Information:

Fermilab

Particle Physics Division

Mechanical Department Engineering Note

Number: MD-ENG-196 Date: 28 July 2009

Project Internal Reference:

Project:

Title: Gas Cylinder Lifting Fixture

Author(s): Mike Zuckerbrot

Reviewer(s): Anghel Aug 4, 2009

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

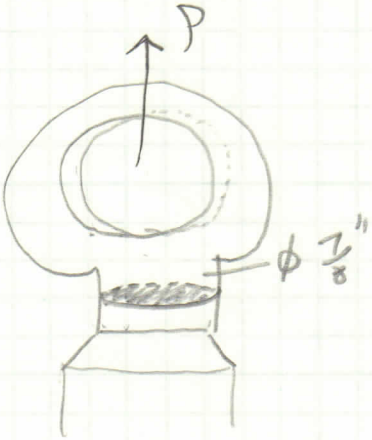
Discussion

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

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

→ Assume each tank = 300 lbs

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



Eye

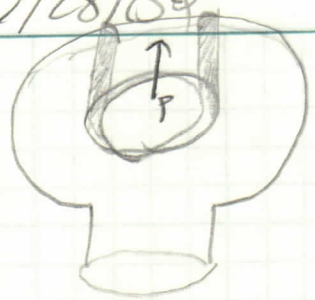
- Tensile stress

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

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

Tanks	σ_{Total} (psi)
2	998
4	1997

< 10 ksi ok



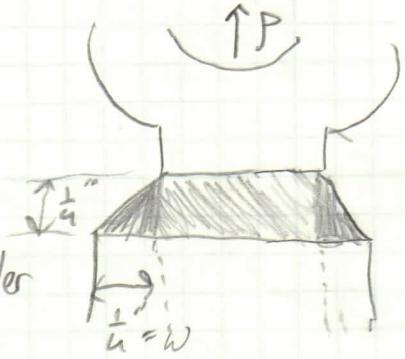
- Shear Stress

$\tau_{max} = \frac{1}{3} F_y = 10 \text{ ksi}$; $\tau = \frac{P}{A}$

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

Tanks	τ_{Total} (psi)
2	4999
4	998

$<$ 10 ksi ok



- Eye weld stress

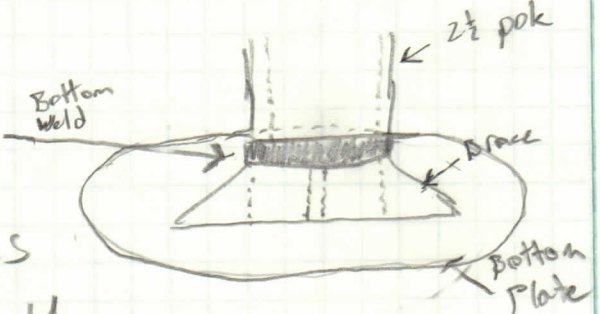
$\tau_{max} = \tau_y(.3)$ → assume E60xx filler

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

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

Tanks	τ_{Total} (psi)
2	1235
4	2469

$<$ 18 ksi ok

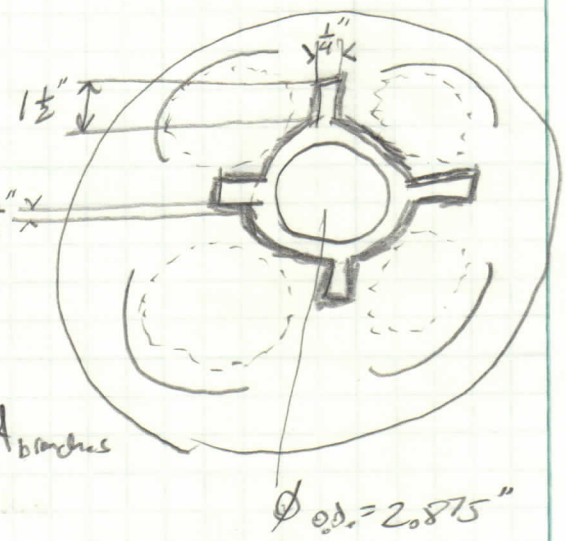


- Bottom weld stress

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

$\tau_{Bottom\ Weld} < \tau_{eye\ Weld} < 18 \text{ ksi}$ 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

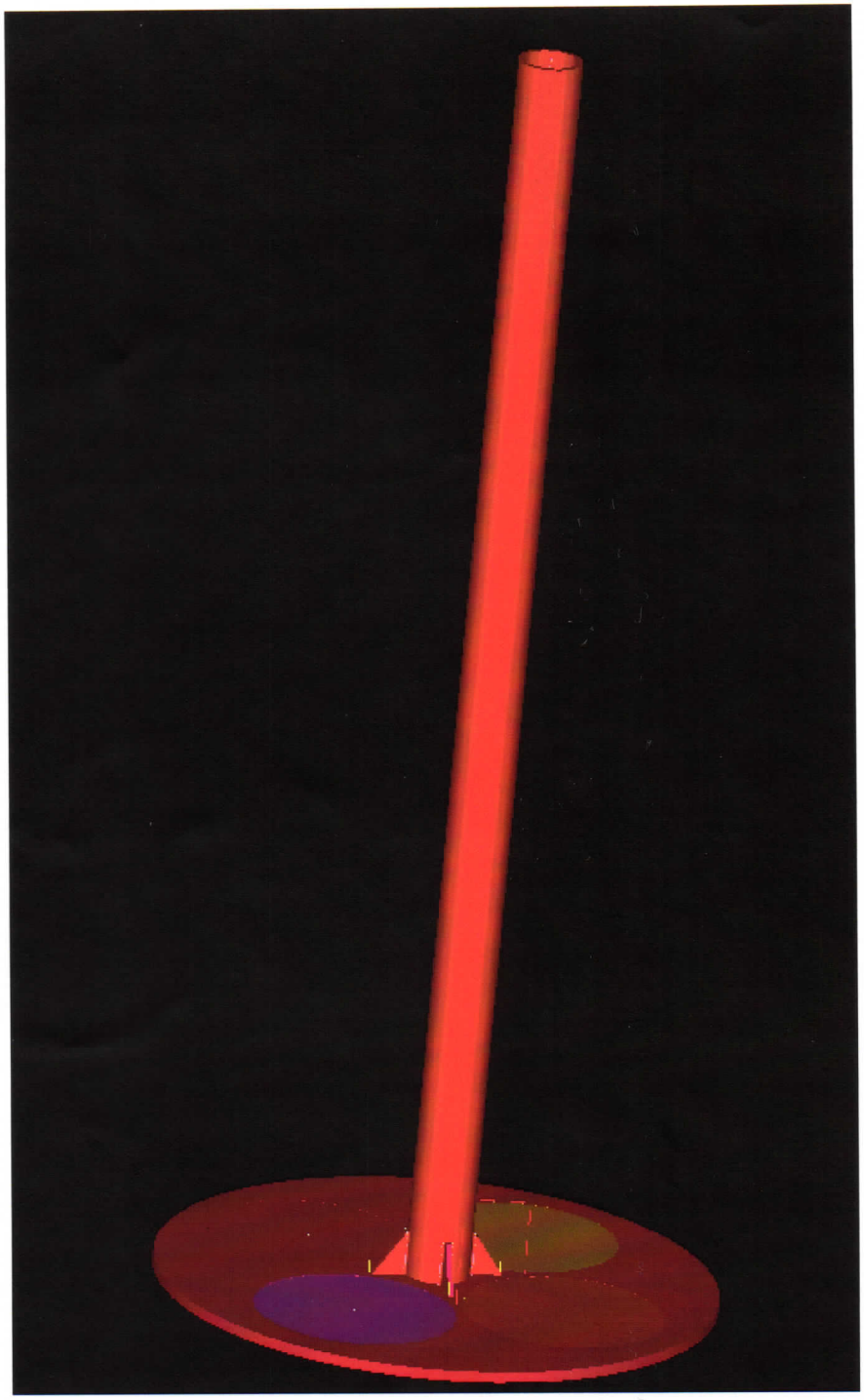


Figure: Equivalent fixture modeled in I-DEAS

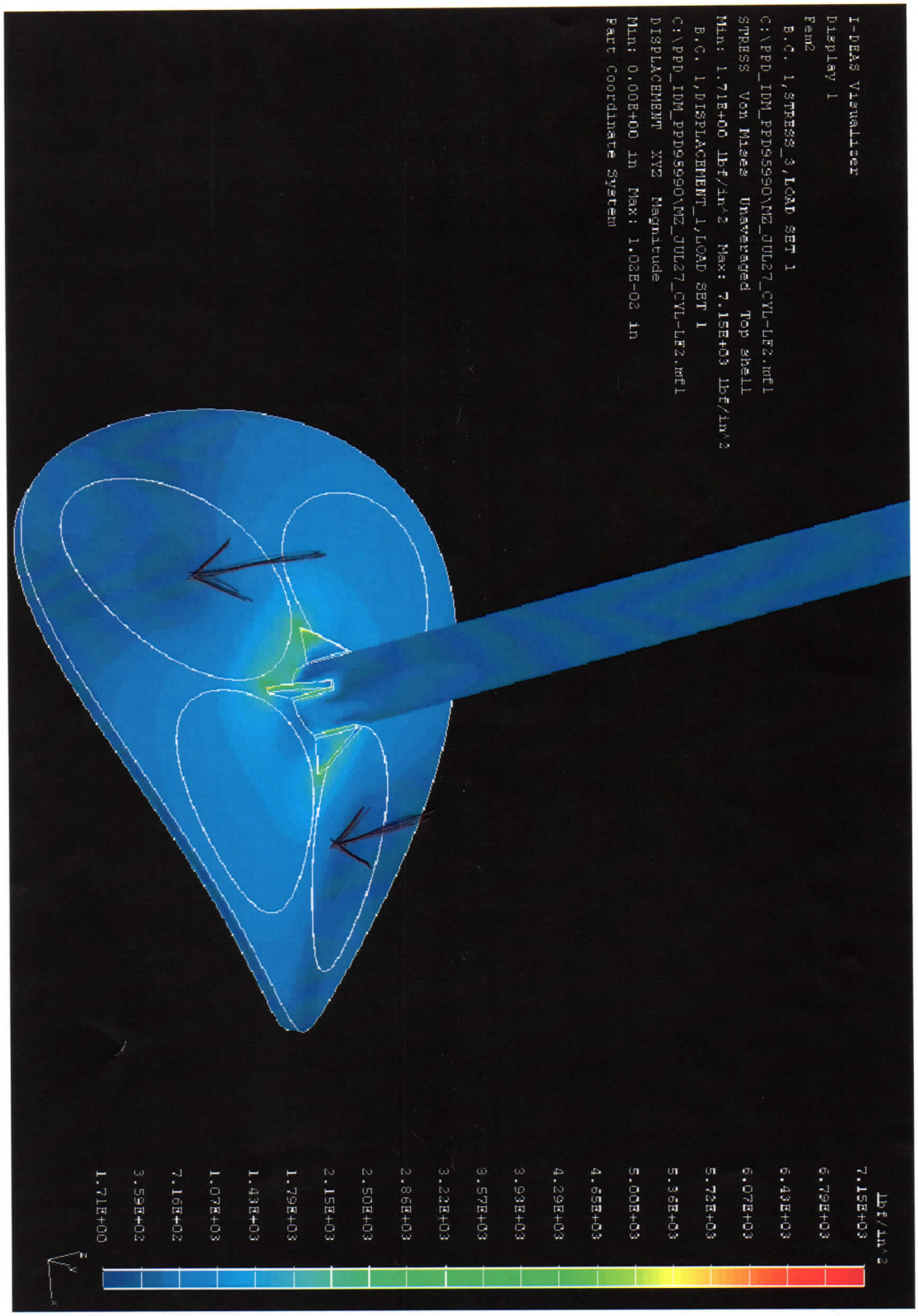


Figure: FEA with 2-300lb gas cylinders present; max stress is 7150 psi at very localized points where the corners of the brace meet the bottom plate (welds, Fmax = 18ksi).

* Tanks always opposite each other when only 2 present

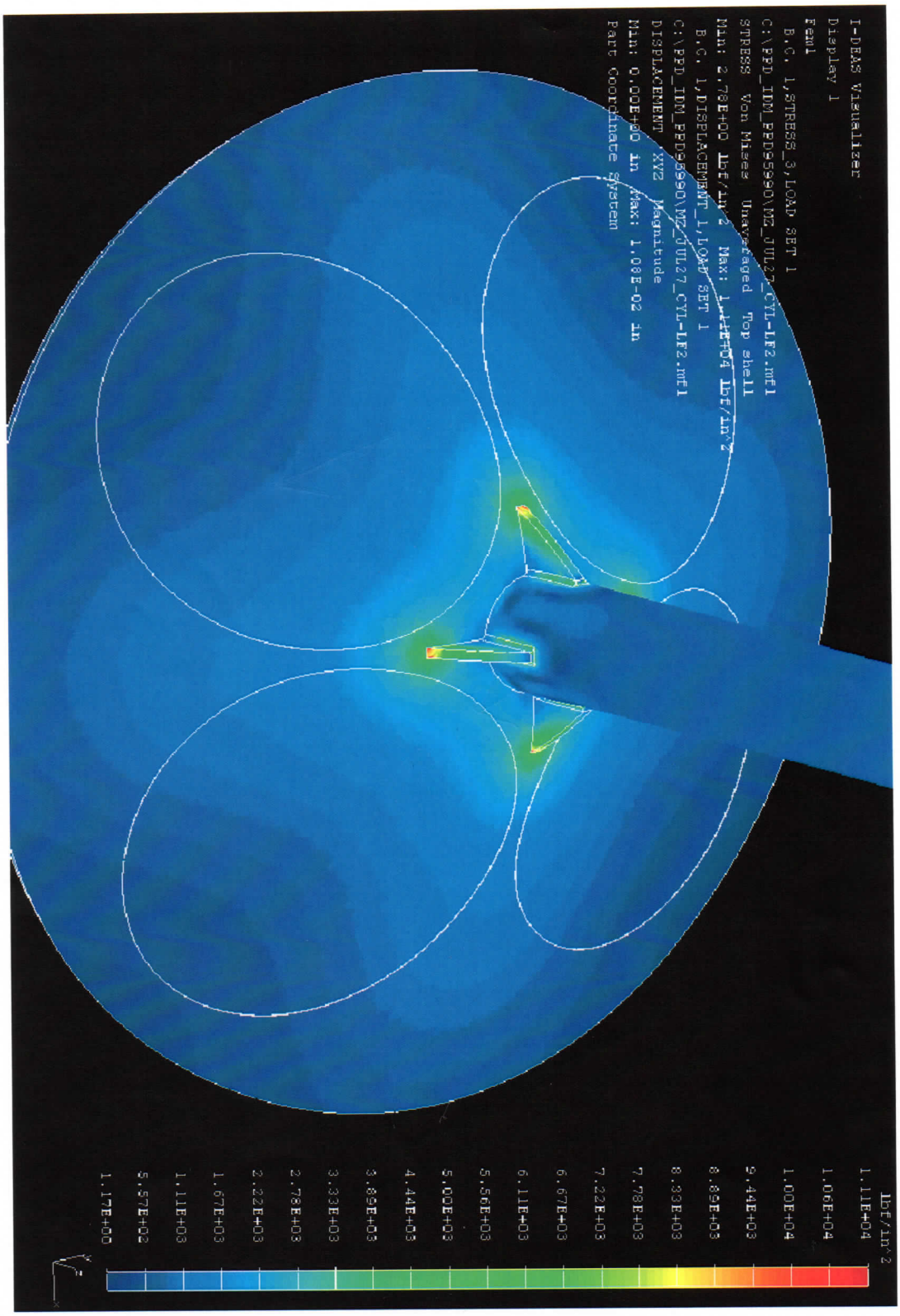


Figure: FEA with 4-300 lb cylinders presents; max stress is 11100 psi at very localized points where the corners of the brace meet the bottom plate (welds, Fmax = 18ksi).