AUTHOR	DEPARTMENT	LOCATION	DATE
B. Ghiorso	Mech. Engr.	BERKELEY	01/23/06

PROGRAM-PROJECT-JOB

US - LHC COLLABORATION

LUMI PRESSURE VESSEL DESIGN SAFETY NOTE

Design Features:

- Vessel is designed to be used at up to 132 psi using a mix of 96% argon, 4% nitrogen (inert gas) with a total stored energy of less than 5000 joules without contents, less that 2600 joules with its contents, thereby placing it in the low-hazard pressure systems category (see section 7.5.1 of PUB-3000 Rev'd 1/99)
- Constructed from EDM'ed solid Type 304 stainless steel billet with resulting wall thicknesses of 0.188 inch [4.7mm] and 0.125 inch [3mm]
- Tank maximum stress is 15740 psi: safety factor on ultimate strength is 4.8 (Type 304 stainless steel tensile strength = 75400 psi).
- Top and bottom vessel components are machined with corner transition regions so welds are removed from high stress areas [see drawing] and have less than 6300 psi stress.
- Vessel cover plate fastener stress is: 10.6 in^2 x 14.7 psi x 9 atm. / 24 fasteners / .01948 in^2 (area of fastener) = 3000 psi
- Tank exterior is plasma coated with alumina (coating thickness aproximately 0.004 inches) prior to hydrostatic testing.
- All units are hydrostatically tested at 1.5 x design pressure and are stamped: "TESTED: MAX PRESSURE 132 PSI" <PRESSURE TEST NO.> on side of tank flange. Test data is appended to and filed as a revision of this engineering note.
- Pressure delivery system is limited to 132 psi by an overpressure safety valve in gas delivery system.
- Vessel will normally be used in an un-manned area.

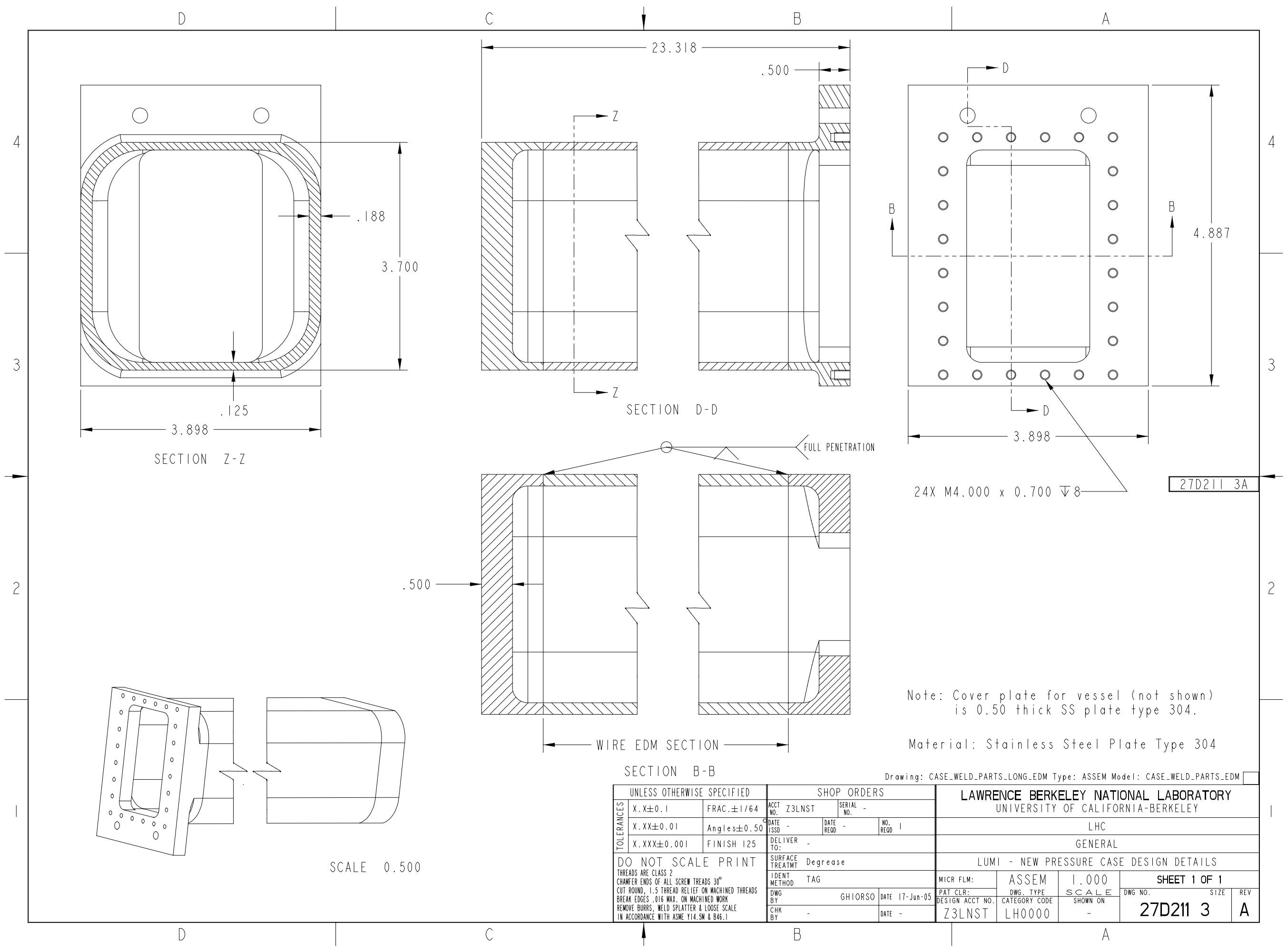
Refer to the following pages:

2) Mechanical drawing

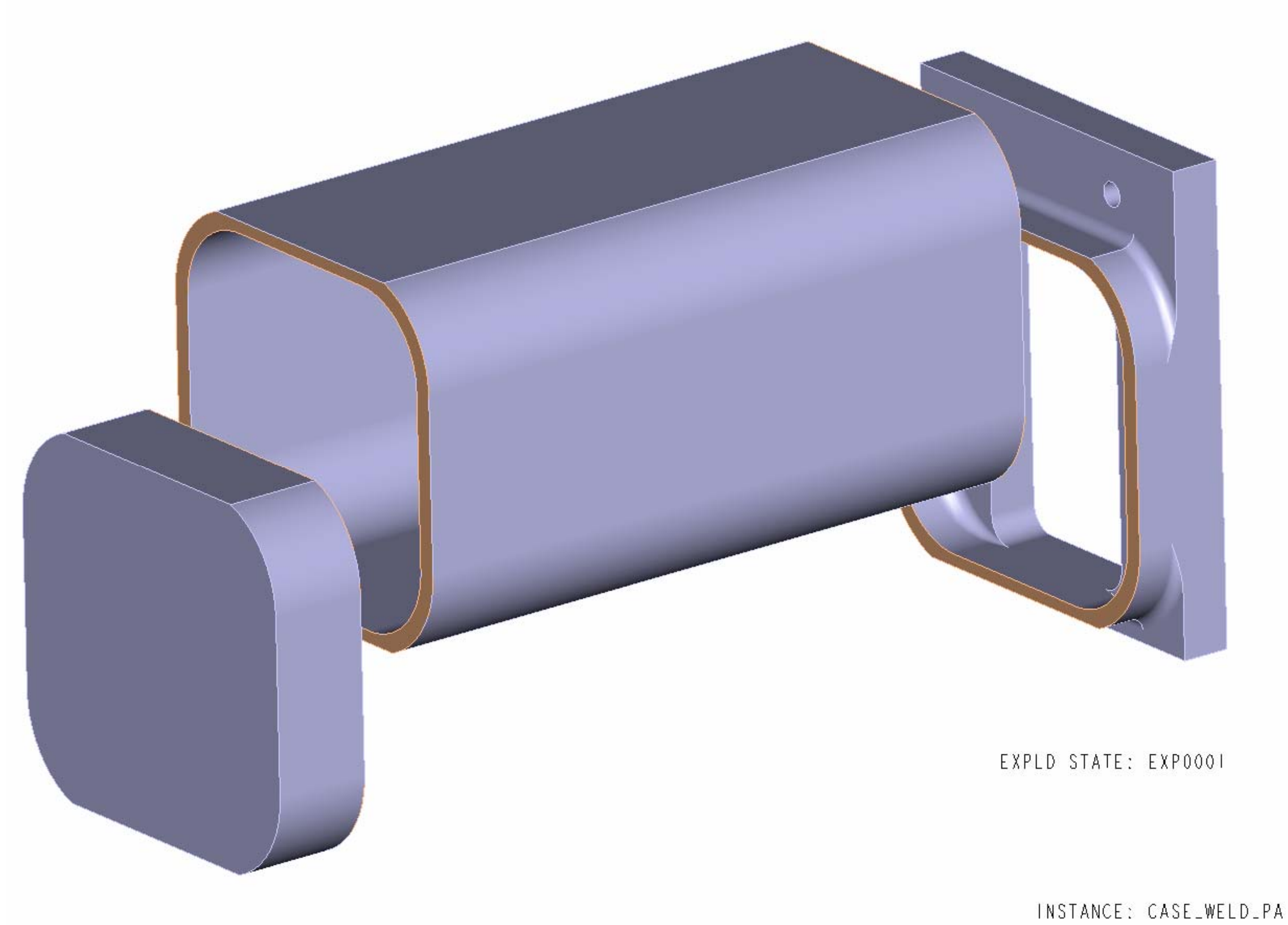
3) Pre-weld assembly exploded view showing weld seam locations

4) Stored energy calculation

5-7) Stress plots showing stress at weld seam locations as well as maximum stress in model



23.318
.500
.188
3.700
.125
3.898
SECTION Z-Z
SECTION D-D
4.887
3.898
24X M4.000 x 0.700 ↧8
27D211 3A
FULL PENETRATION
.500
WIRE EDM SECTION
SECTION B-B
SCALE 0.500
Note: Cover plate for vessel (not shown) is 0.50 thick SS plate type 304.
Material: Stainless Steel Plate Type 304
Drawing: CASE_WELD_PARTS_LONG_EDM Type: ASSEM Model: CASE_WELD_PARTS_EDM
UNLESS OTHERWISE SPECIFIED
TOLERANCES
X.X±0.1
FRAC.±1/64
X.XX±0.01
Angles±0.50°
X.XXX±0.001
FINISH 125
DO NOT SCALE PRINT
THREADS ARE CLASS 2
CHAMFER ENDS OF ALL SCREW TREADS 30°
CUT ROUND, 1.5 THREAD RELIEF ON MACHINED THREADS
BREAK EDGES .016 MAX. ON MACHINED WORK
REMOVE BURRS, WELD SPLATTER & LOOSE SCALE
IN ACCORDANCE WITH ASME Y14.5M & B46.1
SHOP ORDERS
ACCT NO. Z3LNST
SERIAL NO. -
DATE ISSD -
DATE REQD -
NO. REQD 1
DELIVER TO: -
SURFACE TREATMT Degrease
IDENT METHOD TAG
DWG BY GHIORSO
DATE 17-Jun-05
CHK BY -
DATE -
LAWRENCE BERKELEY NATIONAL LABORATORY
UNIVERSITY OF CALIFORNIA-BERKELEY
LHC
GENERAL
LUMI - NEW PRESSURE CASE DESIGN DETAILS
MICR FLM:
ASSEM
DWG. TYPE
1.000
SCALE
SHEET 1 OF 1
PAT CLR:
DESIGN ACCT NO. Z3LNST
CATEGORY CODE LH0000
SHOWN ON -
DWG NO. 27D211
SIZE 3
REV A



Pressure vessel components

Appendix E (LBNL PUB 3000)
STORED ENERGY OF A PRESSURED GAS VESSEL

Although the pressure section of this publication is not intended to be a primer on pressure calculation, the following formula is used sufficiently frequently, but is obscure enough, that it has been included.

When a gas is compressed, energy is stored in it. If the energy is released in an unfavorable way, it will cause damage. Stored energies in excess of 100 kJ are considered high hazard. Sometimes it is helpful to think of stored energy in terms of grams of TNT. One gram of TNT contains 4.62 kJ of energy.

Volume of vessel: $Vh := 283 \cdot in^3$ $\quad Vh = 0.004638\ m^3$

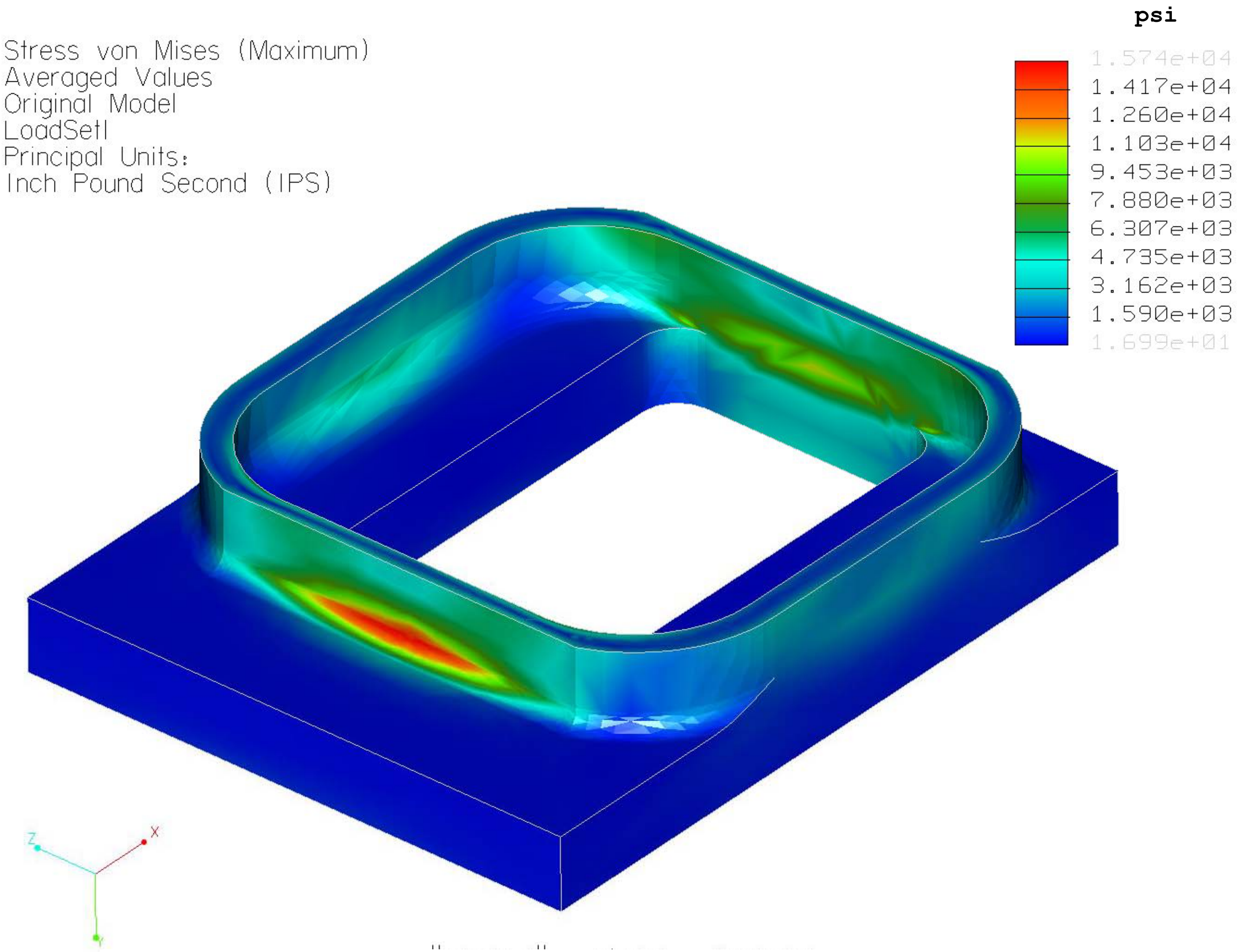
Absolute pressure of vessel: $Ph := 147 \cdot psi$ $\quad Ph = 1.01353 \times 10^6\ Pa$

Pressure to which vessel would drop if burst: $P1 := 14.7 \cdot psi$ $\quad P1 = 1.01353 \times 10^5\ Pa$

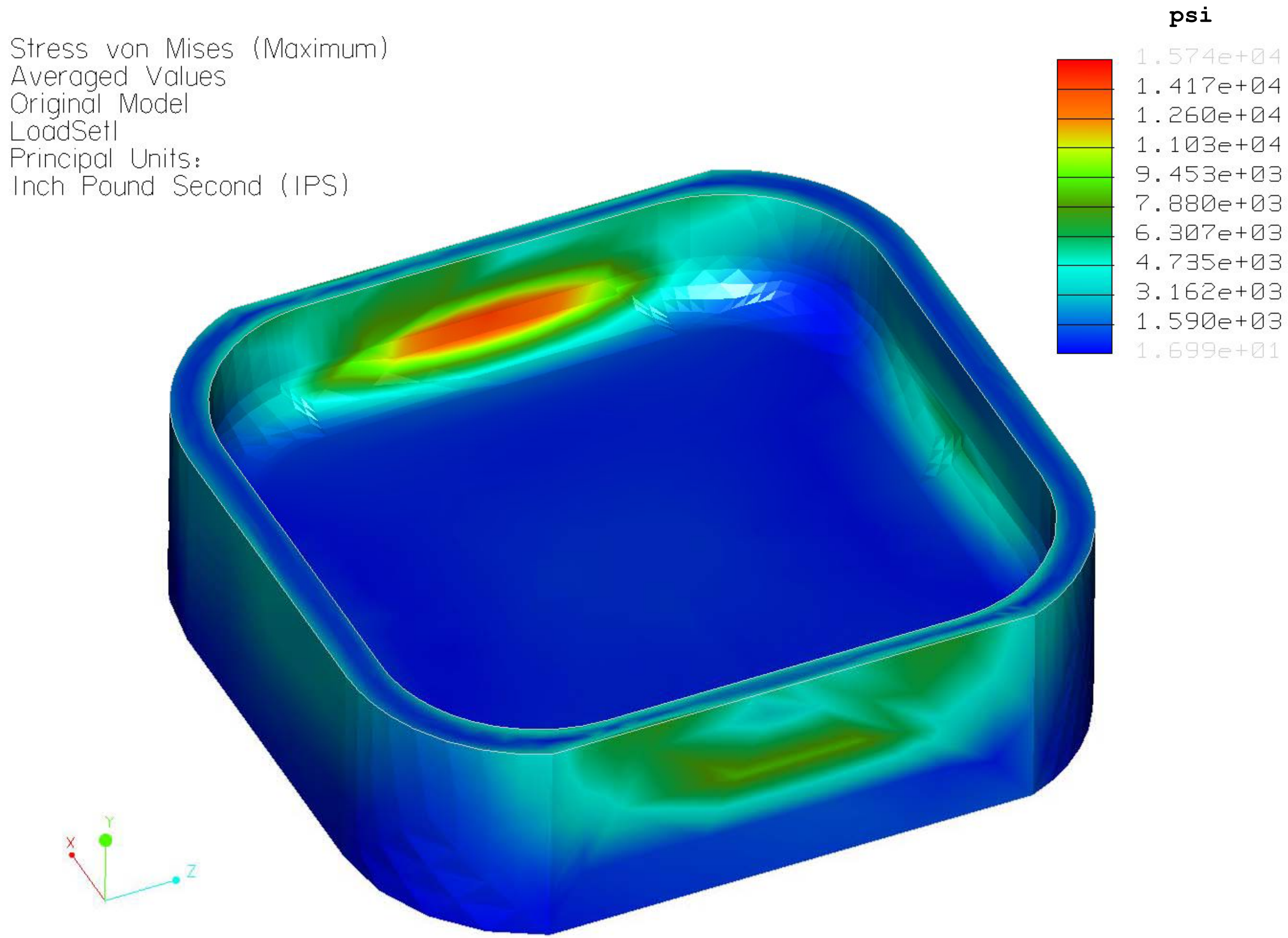
γ = The adiabatic exponent or ratio of specific heats, Cp/Cv. The value is 1.666 for monatomic gases such as argon and helium; 1.4 for diatomic gases such as nitrogen, oxygen, hydrogen, and air; and variable for polyatomic gases such as methane, water, and carbon dioxide but generally very nearly 1.3.

$\gamma := 1.66667$ (argon)

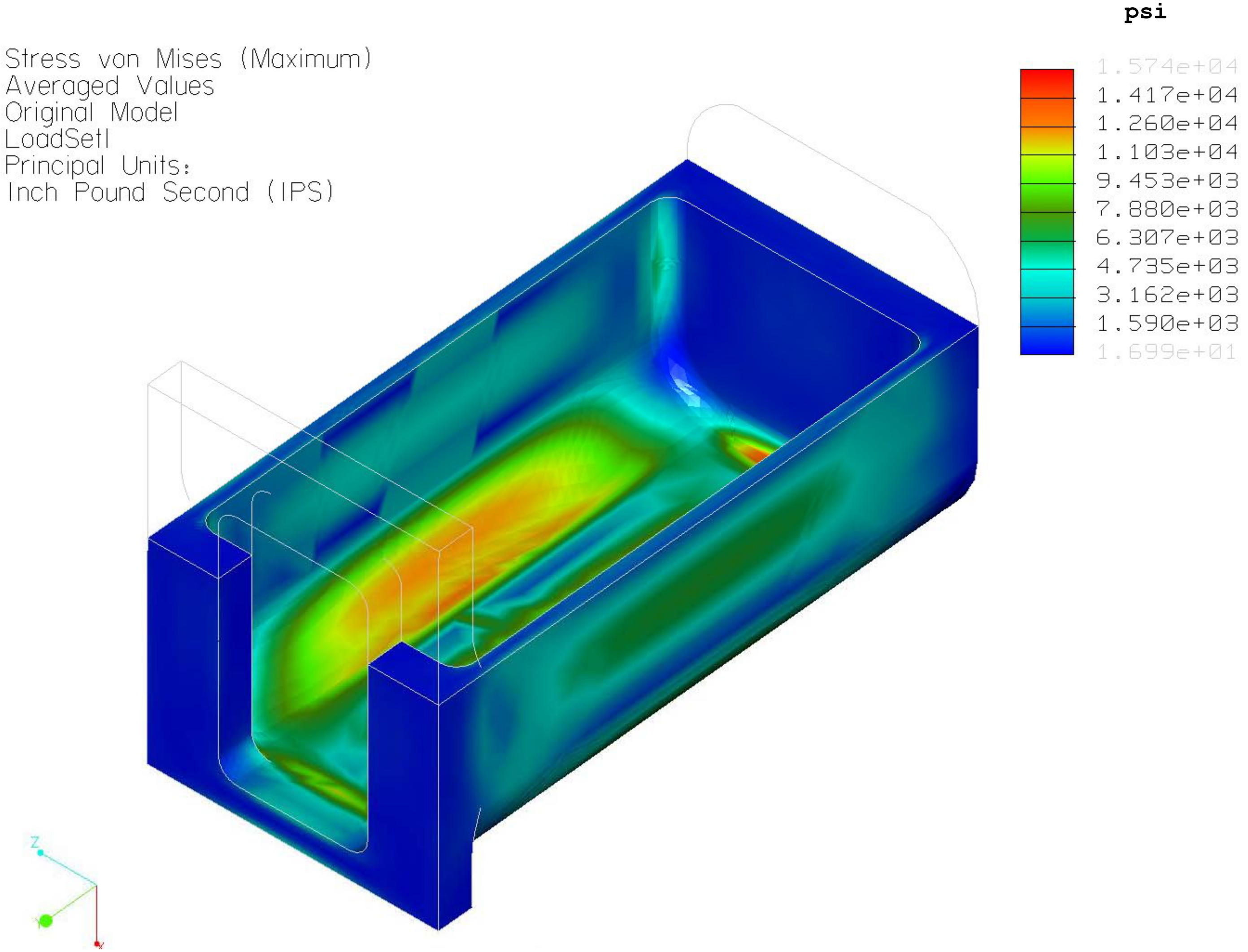
$$\frac{Ph \cdot Vh}{\gamma - 1} \cdot \left[1 - \left(\frac{P1}{Ph} \right)^{\frac{\gamma - 1}{\gamma}} \right] = 4243.59\ N \cdot m$$ (joules)



Pressure vessel top at 132 psi showing weld seam stress < 6300 psi



Pressure vessel bottom at 132 psi showing weld seam stress < 6300 psi



Pressure vessel interior view at 132 psi showing maximum stress < 16000 psi