
Failure Testing of Stainless Steel Explosive Containment Vessels

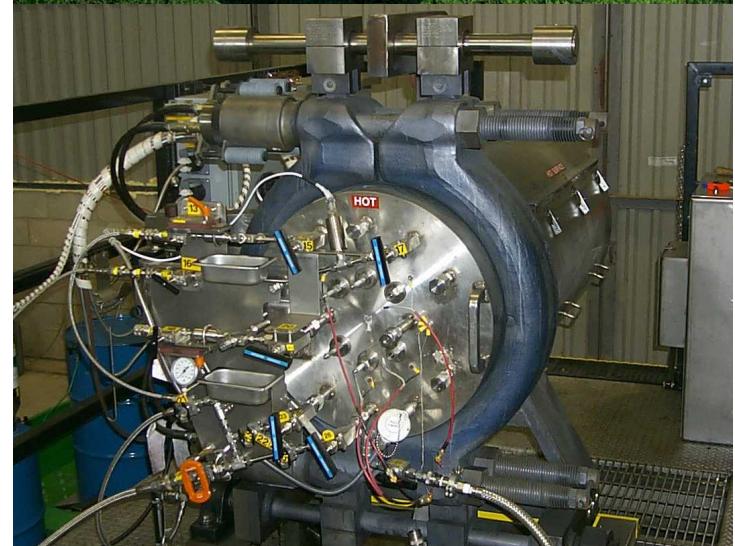
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Sponsored by US Army Project Manager for Non-stockpile Chemical Materiel



Background

- Sandia designed the Explosive Destruction System for PMNSCM to destroy recovered, explosively configured chemical munitions.
- The system uses explosive shaped charges to open the munitions and detonate or deflagrate the bursters.
- EDS explosive containment vessels are made of 316 stainless steel for compatibility with subsequent process steps.
- We are using subscale vessels to evaluate the vessel response at loads much greater than the rated capacity.
- Scaling laws allow extrapolation to larger vessels.





Test Description

- Vessel 1
 - Static burst test
 - Burst pressure = 13,400 psi
 - Hoop strain = 14.7% at 13,100 psi
- Vessel 2
 - 6 repetitions at 138 grams
 - Increasing explosive weight until failure
 - 28 gram increments to 352 grams
 - 12.4% hoop strain prior to failure
- Vessel 3
 - Initial test at 324 grams
 - Repeated detonations at 296 until failure
 - 17.1% hoop strain at failure

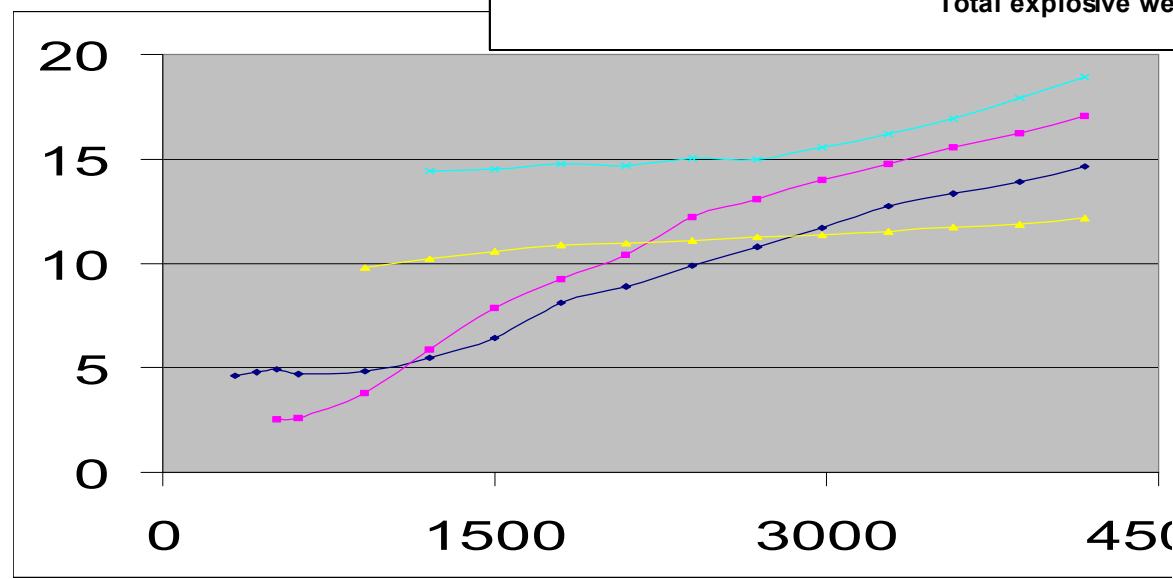
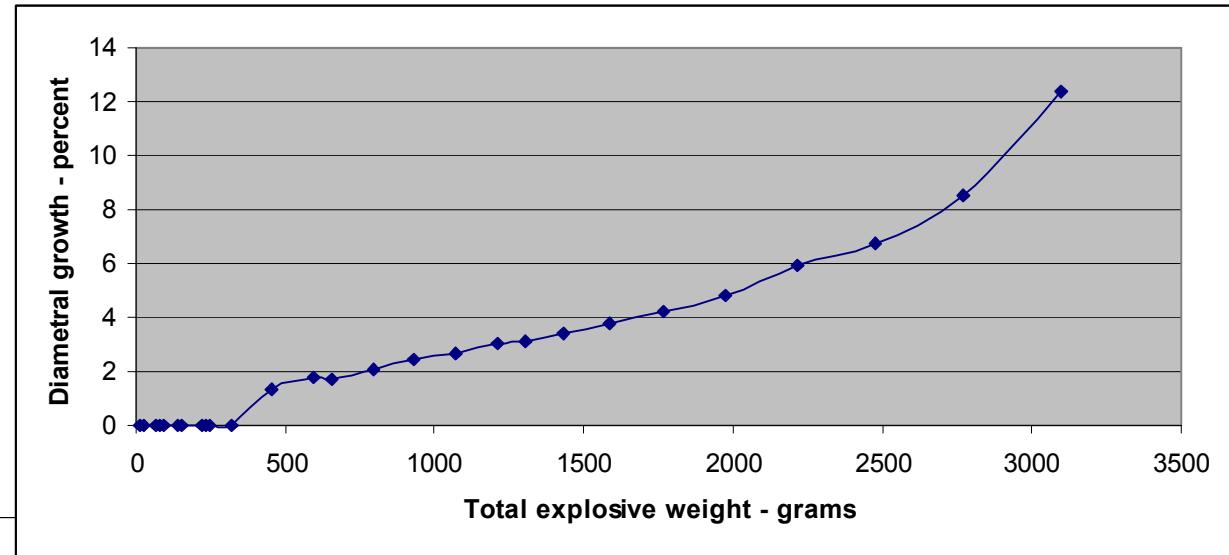


6.25" I.D. x 7.5" O.D. x 15.6" long



Cumulative Vessel Growth

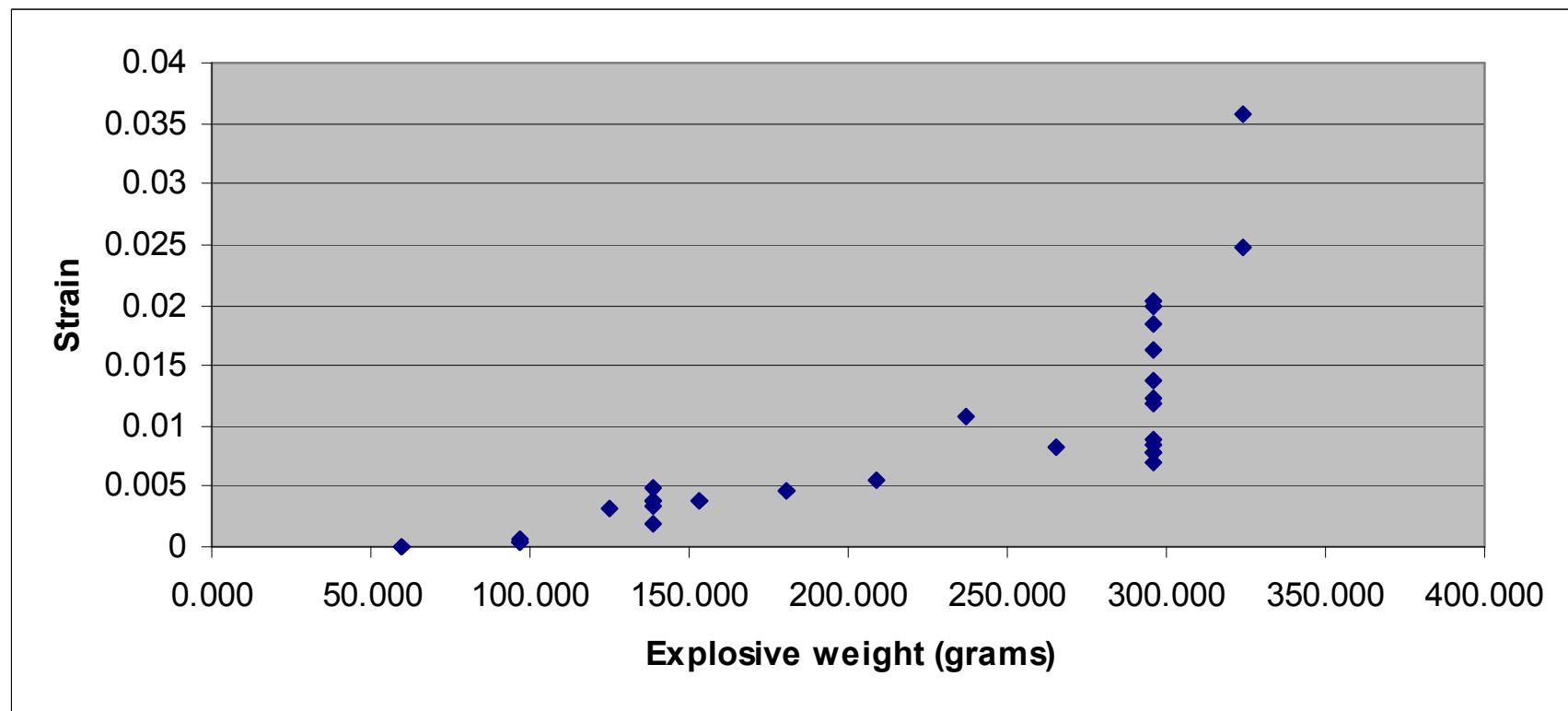
Vessel 2
Growth at the middle
of the vessel



Vessel 3

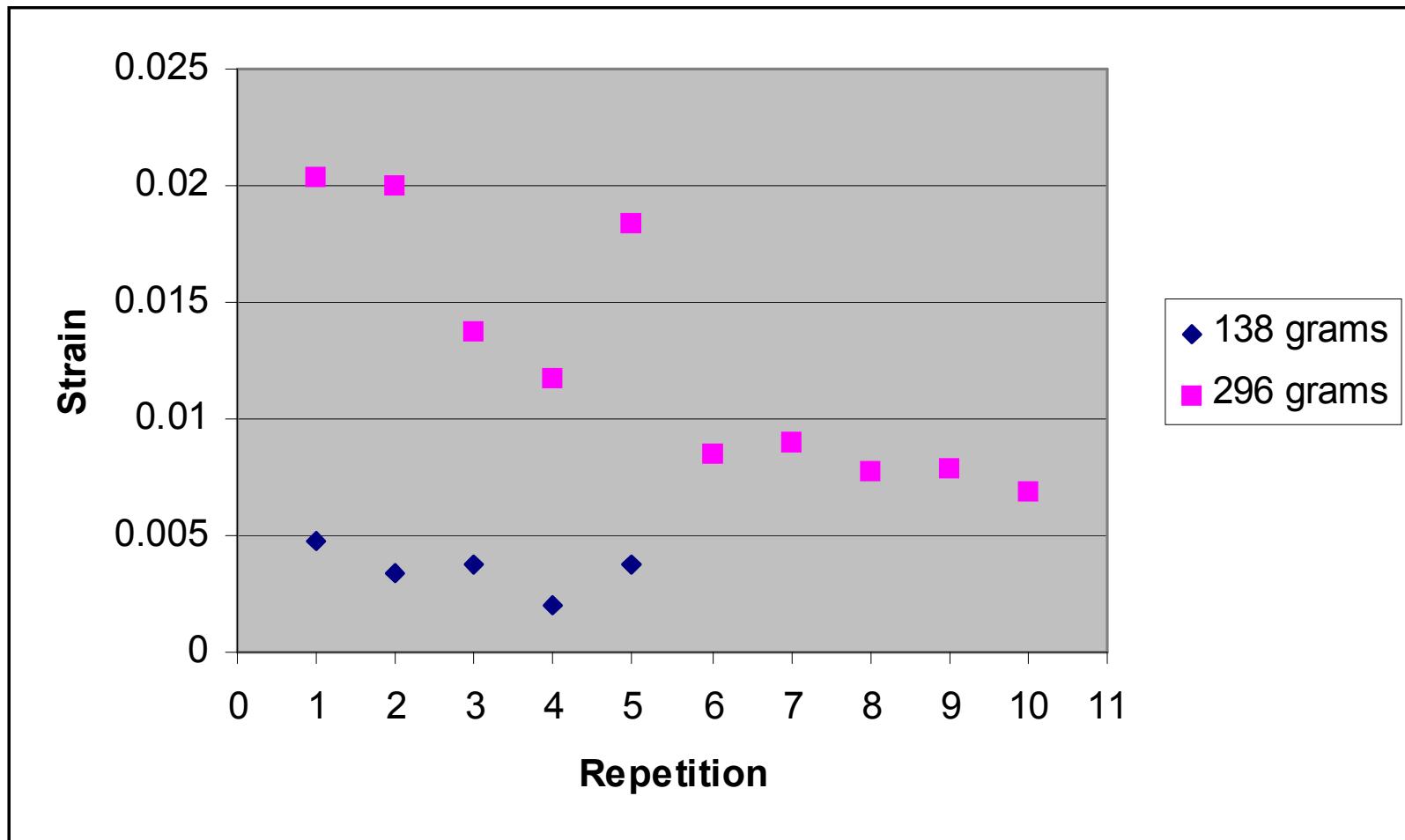


Strain vs. Explosive Weight



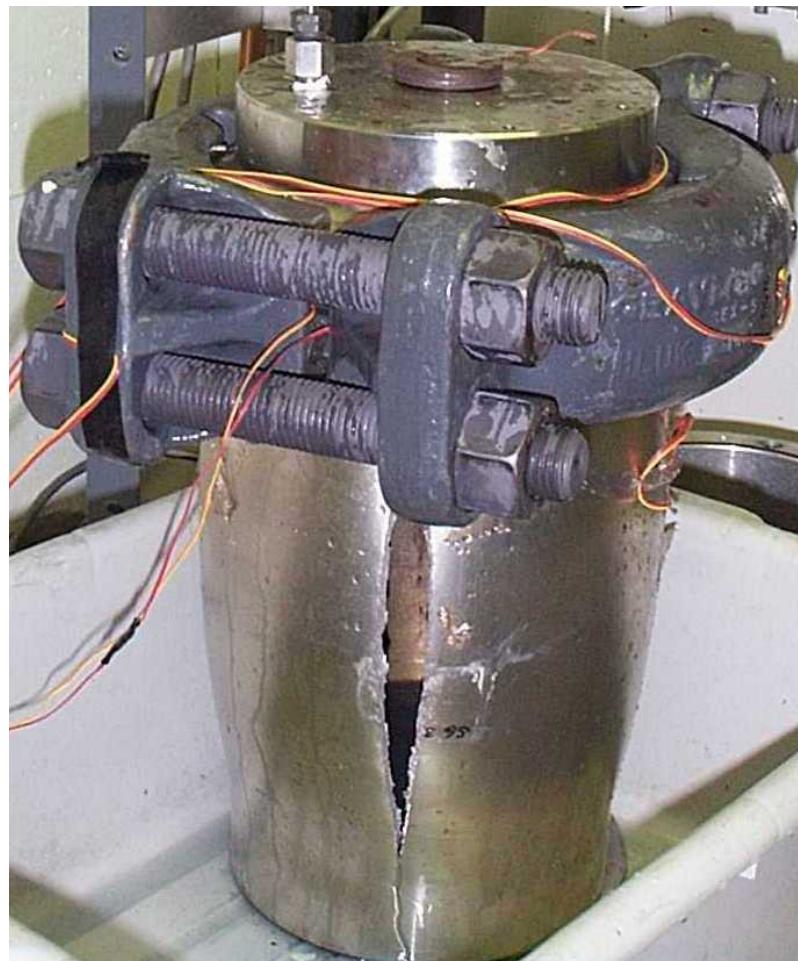


Effect of Strain Hardening



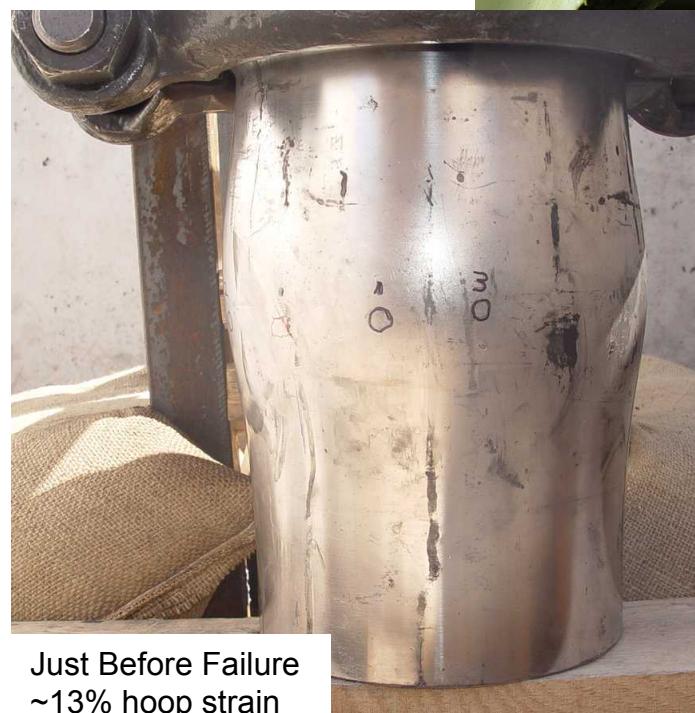
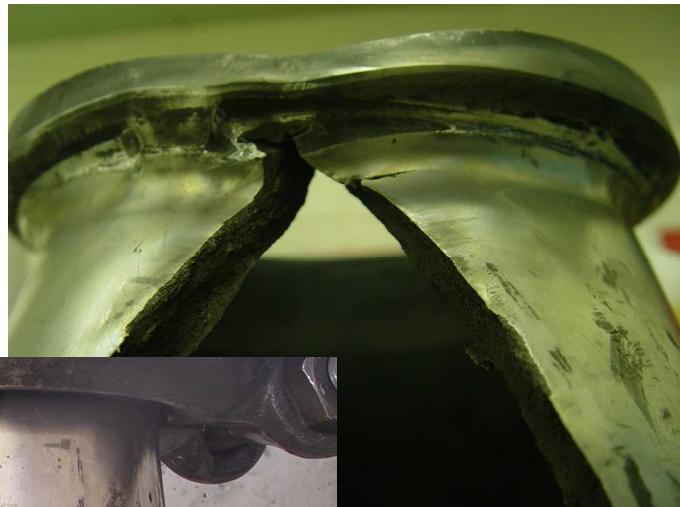


Vessel 1 – Static Burst Test





Vessel 2



Just Before Failure
~13% hoop strain



Vessel 3



8 detonations
10-11% strain



13 detonations
17.1% strain

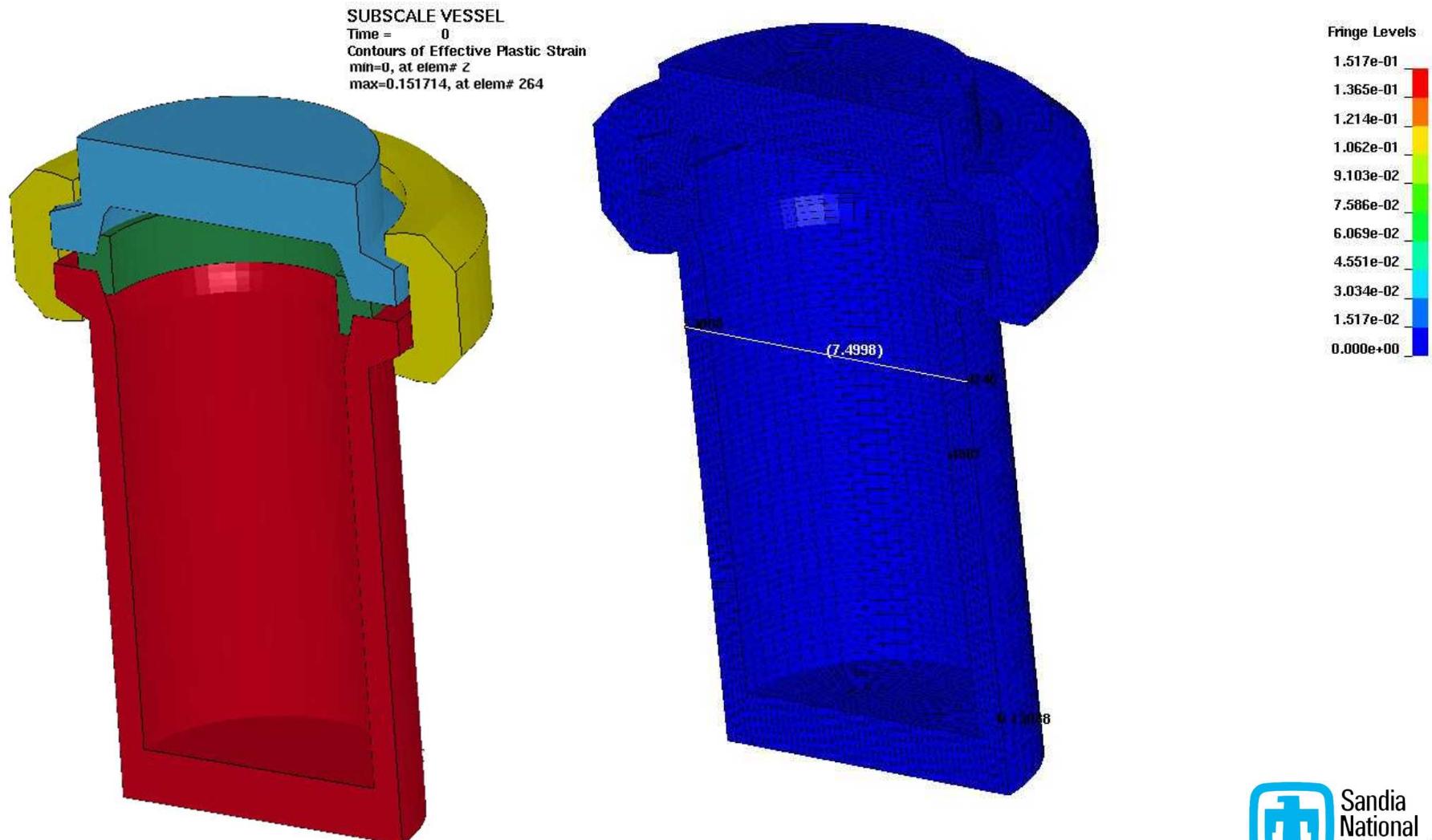


The Seal Ring Failed Before the Vessel



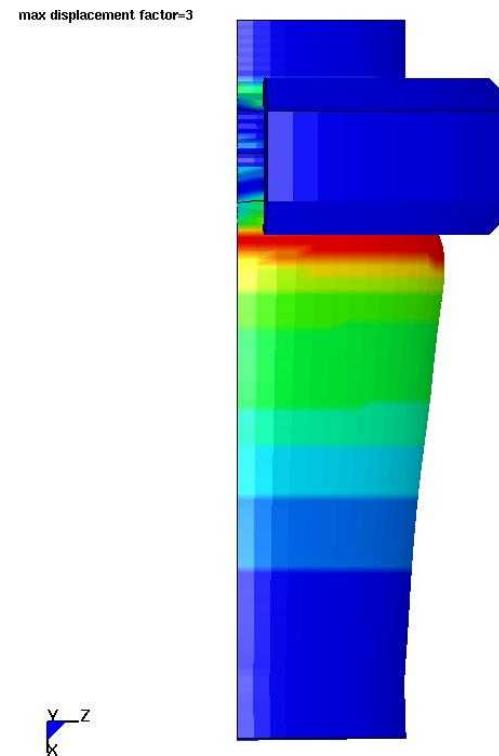
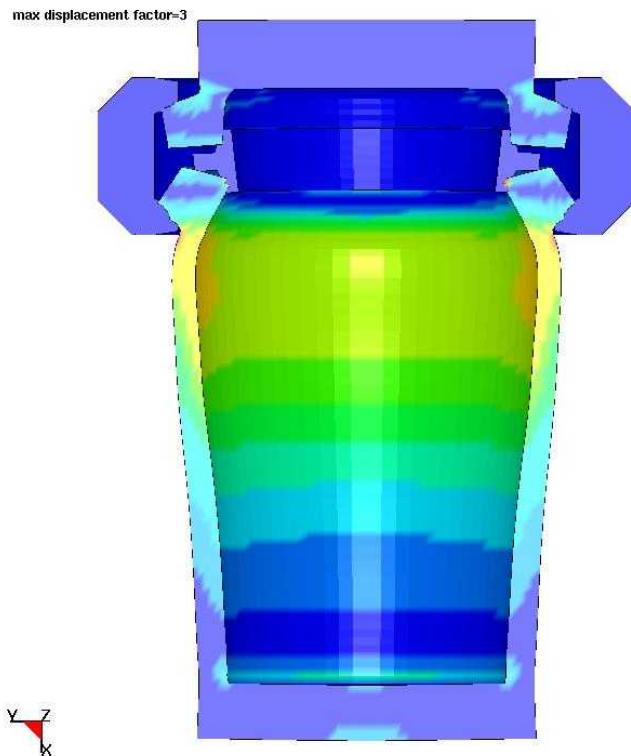


Computer Simulation, 300 grams





Displacement



3x scaled displacement



Conclusions

- Failure results from accumulated strain
- Incremental strain decreases with repeated detonations due to strain hardening
- Strain is greatest near the top initially
- Greater strain occurs near the waist on subsequent detonations
- Seal ring appears to fail by buckling