RDECOM

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Cook-Off Mitigation Scaling Effects

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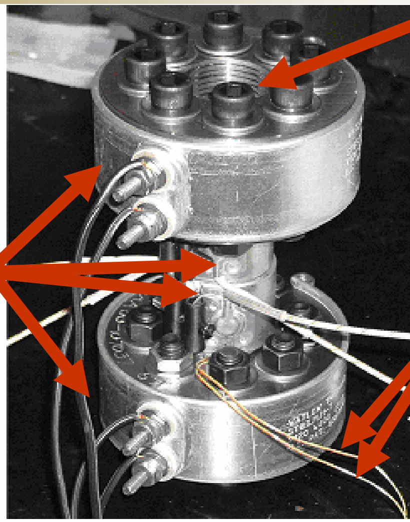
Outline

- Background
- Comp B Geometric Scaling
  - Small/Large Scale Hardware
  - Single hole
  - Multiple Vent Holes
- Full Scale Generic Hardware
  - Inert and Comp B Modeling
  - PBXN-109 Analytic Burn Modeling
  - Cast cure liner material investigation
- Conclusions

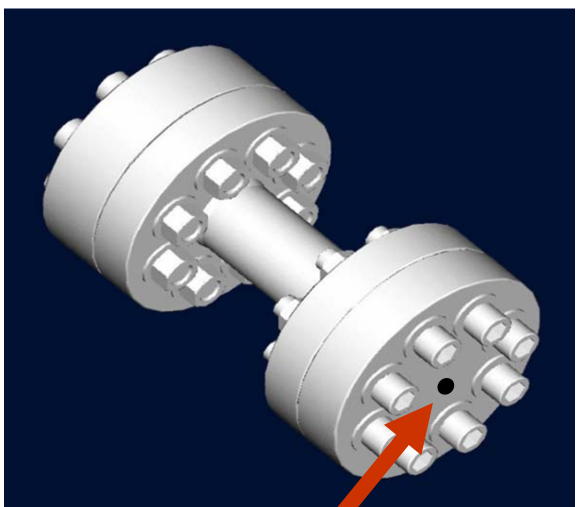
Background

- PEO Ammunition and RDECOM-ARDEC:
- Developing and Applying IM Warhead Venting Technology
- Maintaining structural requirements and warhead performance
- Lacking standard explosives venting characterization and quantification

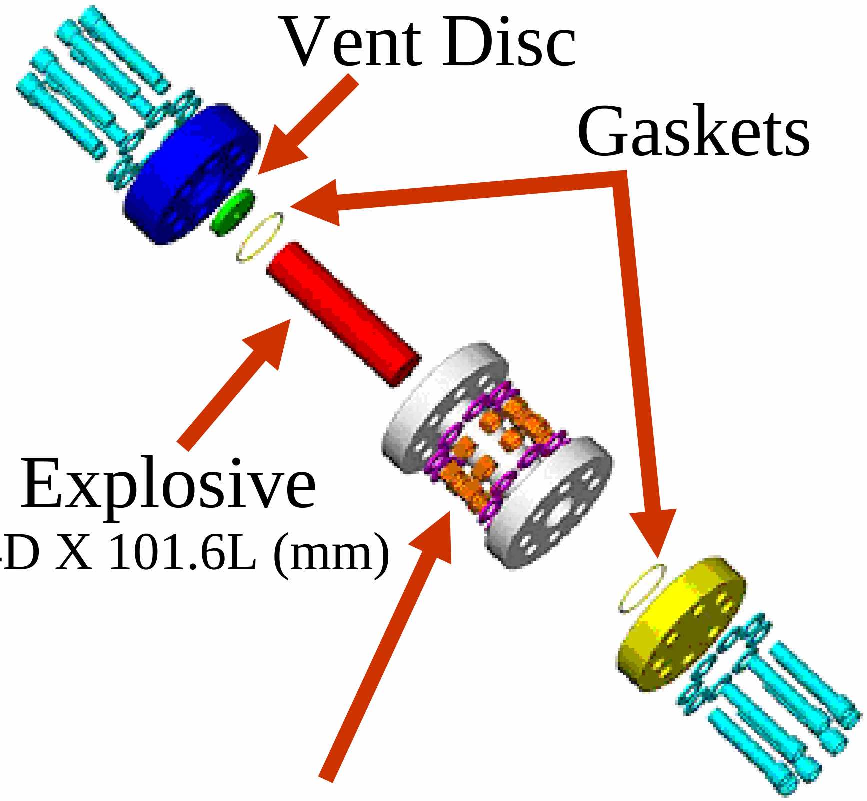
Small Scale Laboratory Fixture



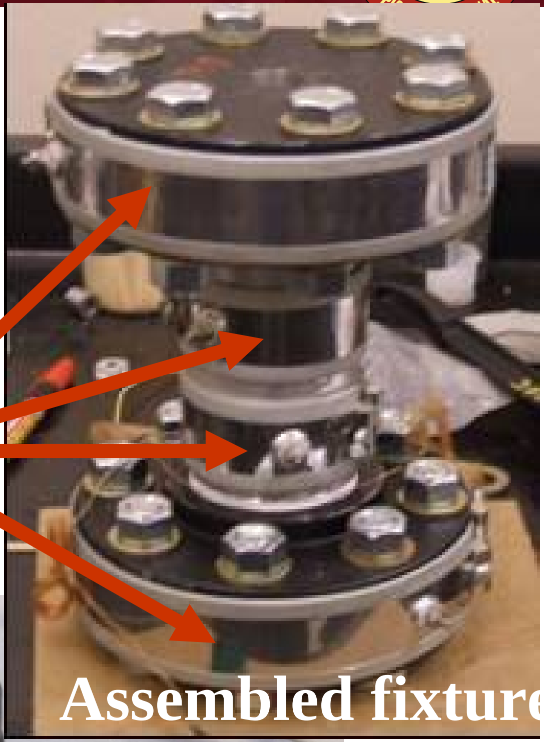
Assembled fixture



Adjusted Vent Hole



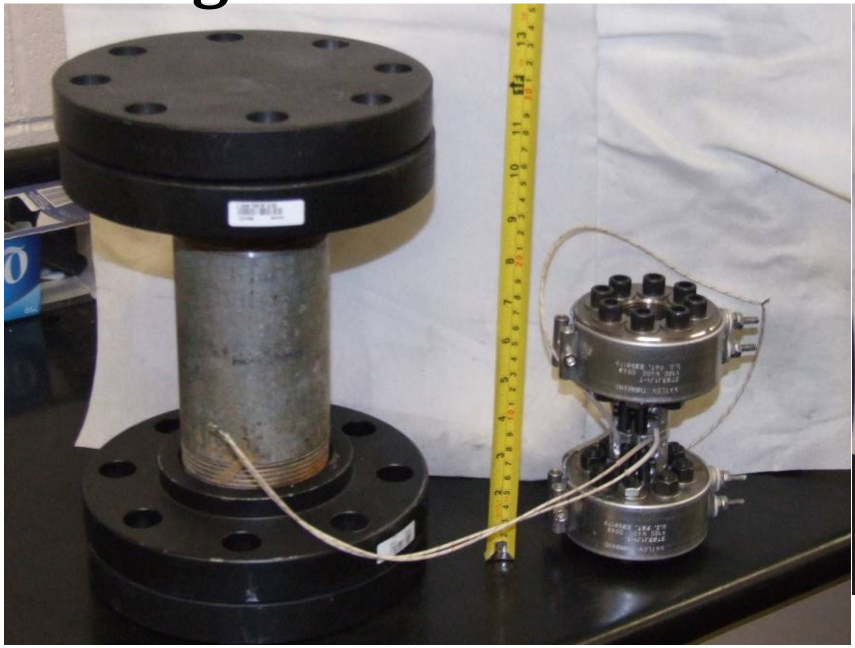
Large Scale Laboratory Fixture

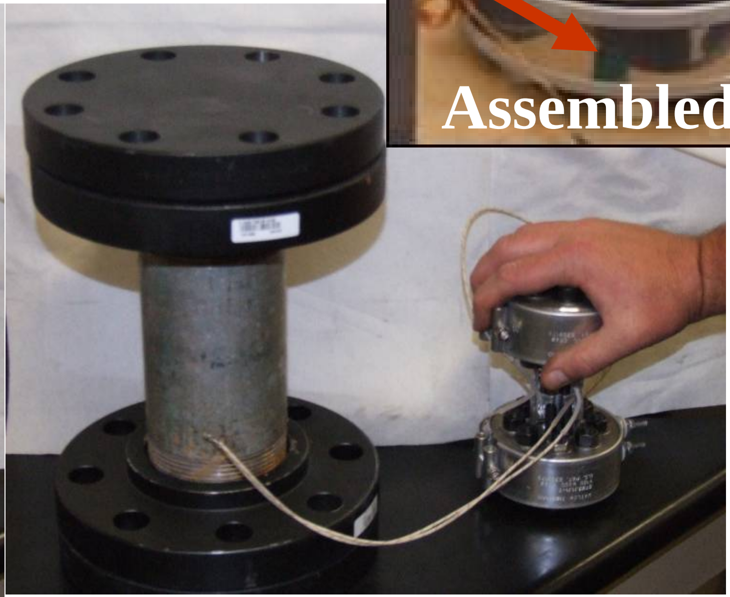


Explosive

Heating Bands

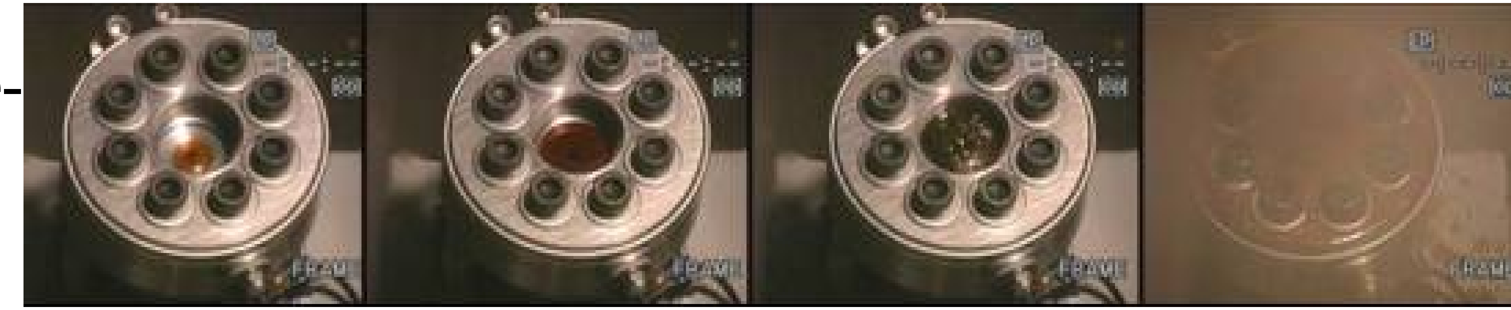
Large and Small Scale Hardware



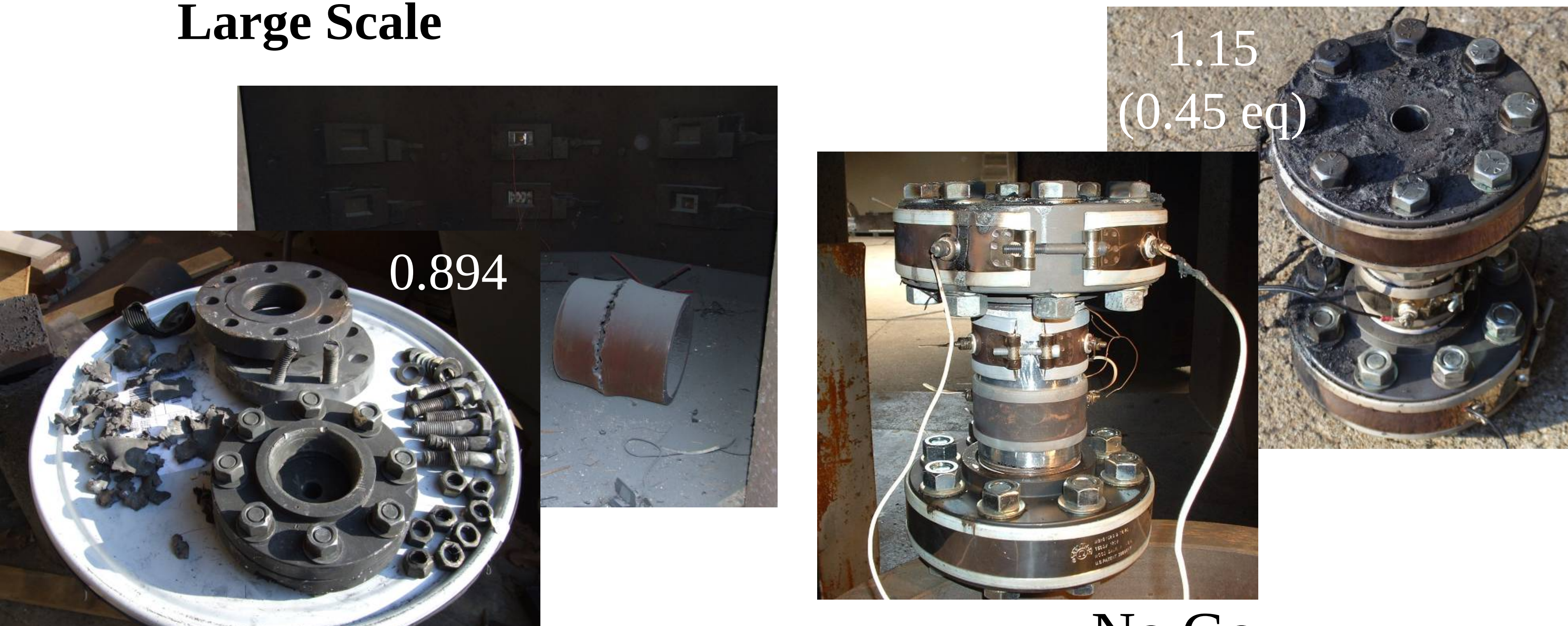


Composition B - Geometric Scaling
Single Vent Hole

Small Scale-
0.45



Large Scale



0.894

Go

1.15
(0.45 eq)

No Go

Composition B
Multiple Vent Hole

Go

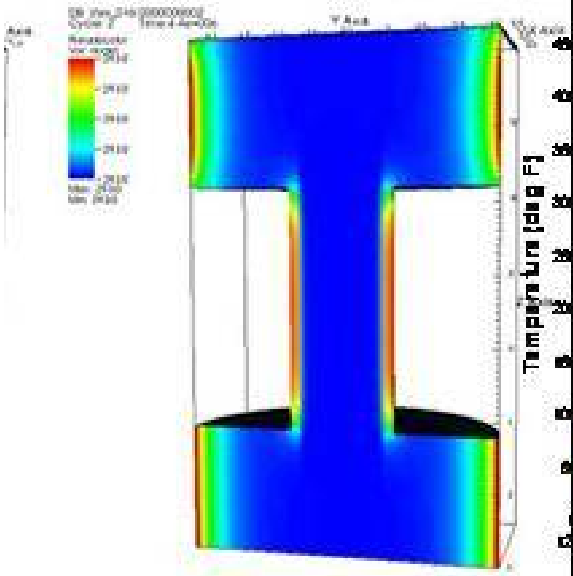
No Go

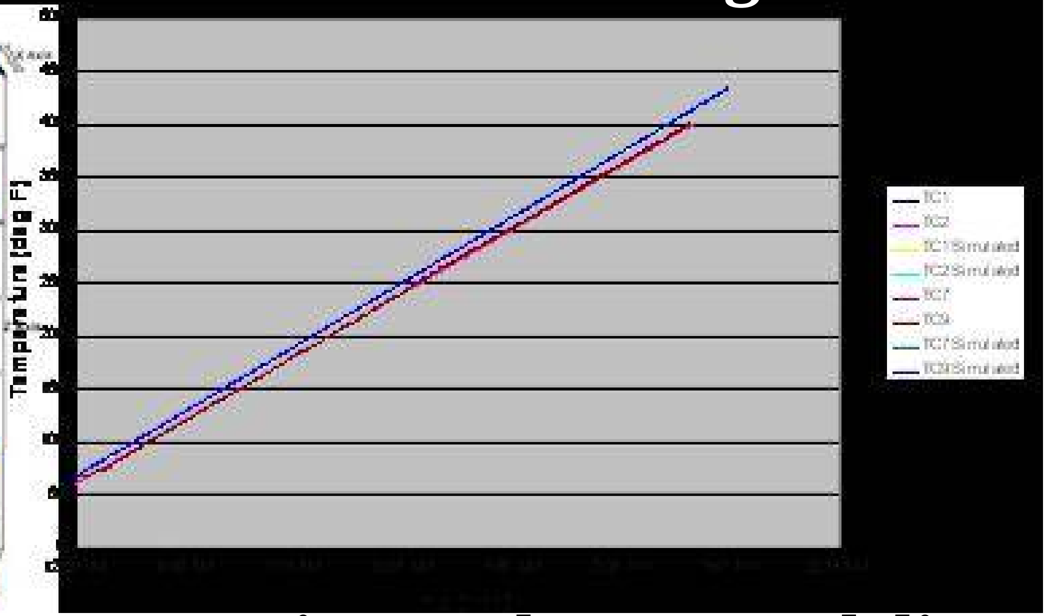
Comp B Experimental Results

Scale	Go/No Go	Vent Size(in)	Notes	T(°F)
Small Scale	Go	0.1	Throttle Plate Blown Out	370
Small Scale	Go	0.2	Explode	400
Small Scale	Go	0.2	Fixture on Side, Violent, Bolts sheared, Center Burst	379
Small Scale	Go	0.4	Explode, top end plate came off	376
Small Scale	No Go	0.4	Burn Off	390
Small Scale	No Go	0.4531	Burn off, Fixture in one solid piece	362
Small Scale	No Go	0.5	Burn Off	415
Small Scale	No Go	0.5	Burn Off	375
Small Scale	No Go	0.5	Burn Off	400
Small Scale	No Go	0.8	Fixture on Side, Burn Off, Fixture in one piece	378
Large Scale	No Go	1.15	Scaled up Vent hole as a function of total surface area	
Large Scale	No Go	1.15	0.45 eq (Comp B small scale cutoff point) Deflagration, fixture intact	350
Large Scale	Go	0.894	0.35 eq, Full Detonation	425
Large Scale	Go	1.025	0.40 eq, Transition to Detonation	430
Large Scale	Go	1.15/5	0.45 eq. Surface area divided into 5 same size holes (0.512 in)	430
Large Scale	No Go	1.15*2/10	1.15 dia vent x 2, Vent area divided by 10 same size holes (0.506 in) Burn. Initiated on heater band	
Large Scale	No Go	1.15*2/10	1.15 dia vent x 2, Vent area divided by 10 same size holes (0.506), Burn	440

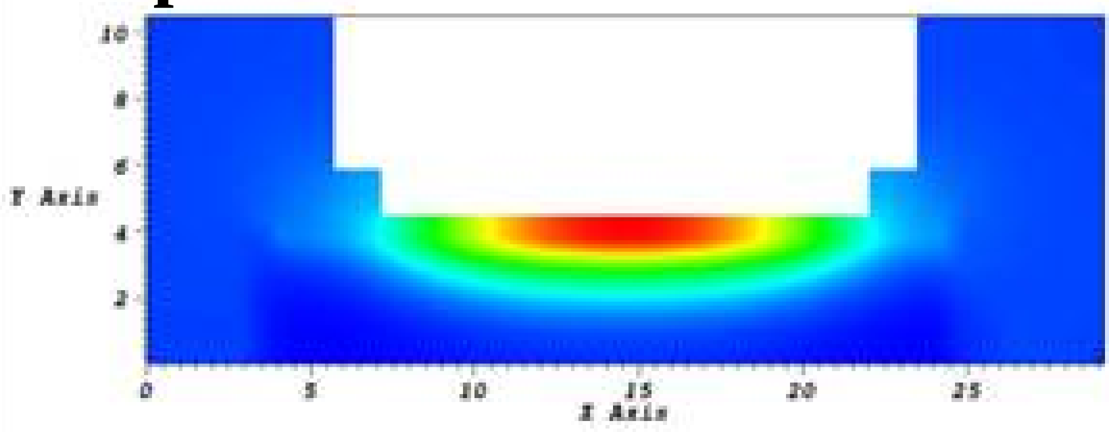
Inert and Comp B Modeling

Inert Hardware Baseline Modeling

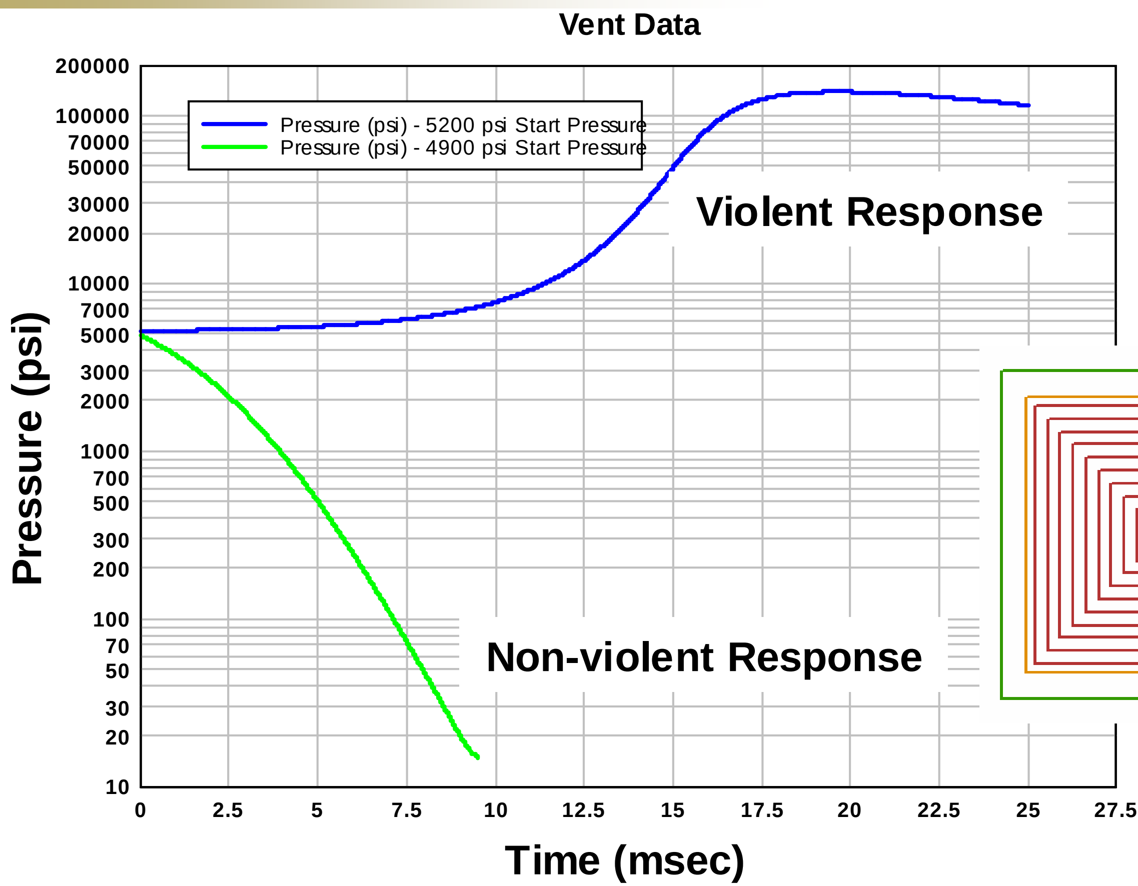




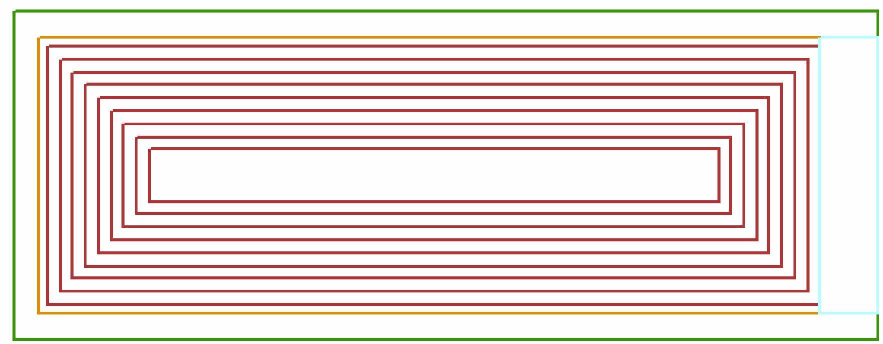
Composition B Generic Hardware Modeling



PBXN-109 Analytic Burn Modeling



Pressure Response



Billet Burn Profiles

Modeling results predict that a very small vent area is required

- -Assumes clear vent path for gas products to escape
- -Indicates liner material viscosity is important

Cast Cure
Liner Material Investigation

PBXN-109 – AHM Liner Testing

AHM=Asphaltic Hot Melt

Very low viscosity when melted!

PBXN-109
HDPE Liner Testing

HDPE=
High Density Polyethylene
(Higher viscosity than AHM)

Identical single hole vent:
AHM liner: not violent
HDPE liner: violent

Conclusions

- Melt Pour High Explosives:
  - Direct Scaling based on billet surface area for the required vent area determination
  - Required vent area increased with increased number of vent holes
  - Vent area requirement using subscale and large scale fixtures used to develop venting solutions for full sized ordanance systems
- Solid High Explosives
  - Analytic burn modeling indicates that very small vent areas can be successful, but a clear path for gas products is required
  - Melt liner viscosity is a critical factor in reducing vent area required
- Variety of melt pour, cast cure and pressed explosives testing
  - Comp B, PAX-28, PBXN-109, PBXN-9 have been vent tested with and without liners
  - Very little data exists for the burning behaviors at high temperature