PITTSBURGH MINING RESEARCH DIVISION

BIP RA Stopping/Door System Research

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Refuge Alternative Webinar

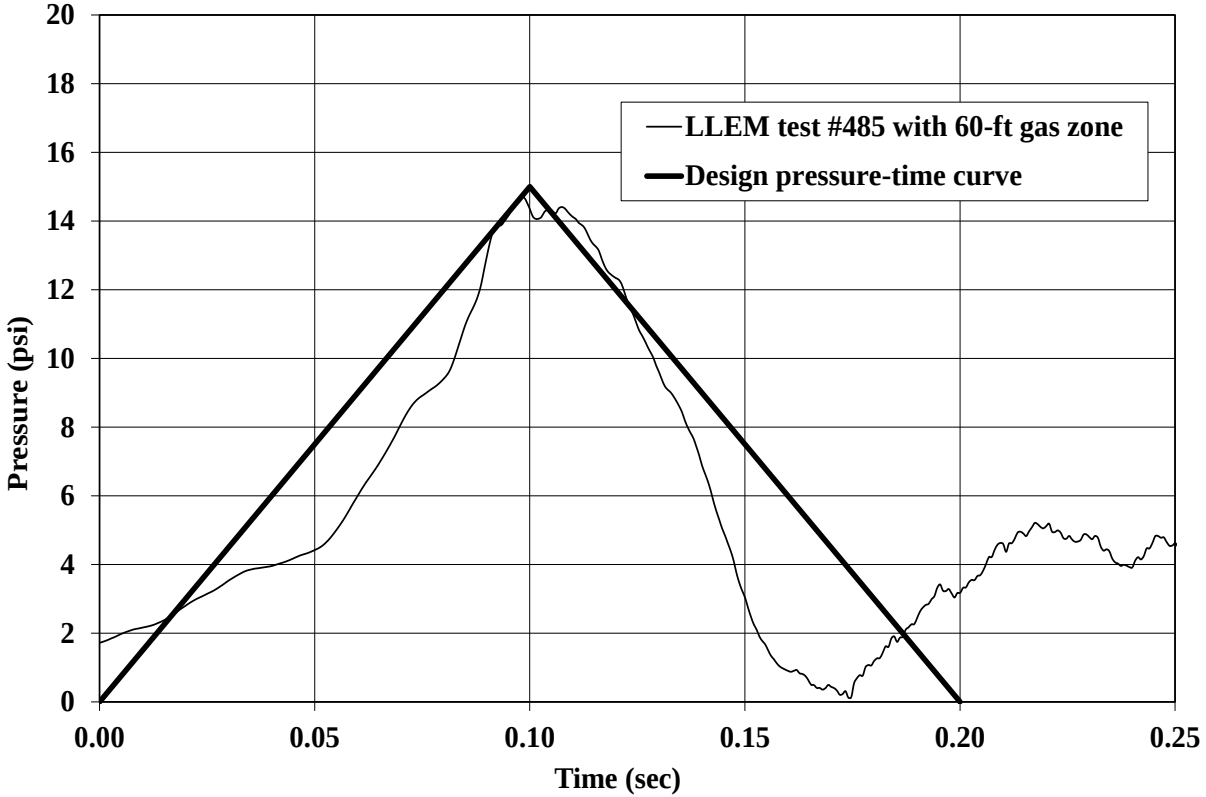
June 23, 2016

Pittsburgh, PA

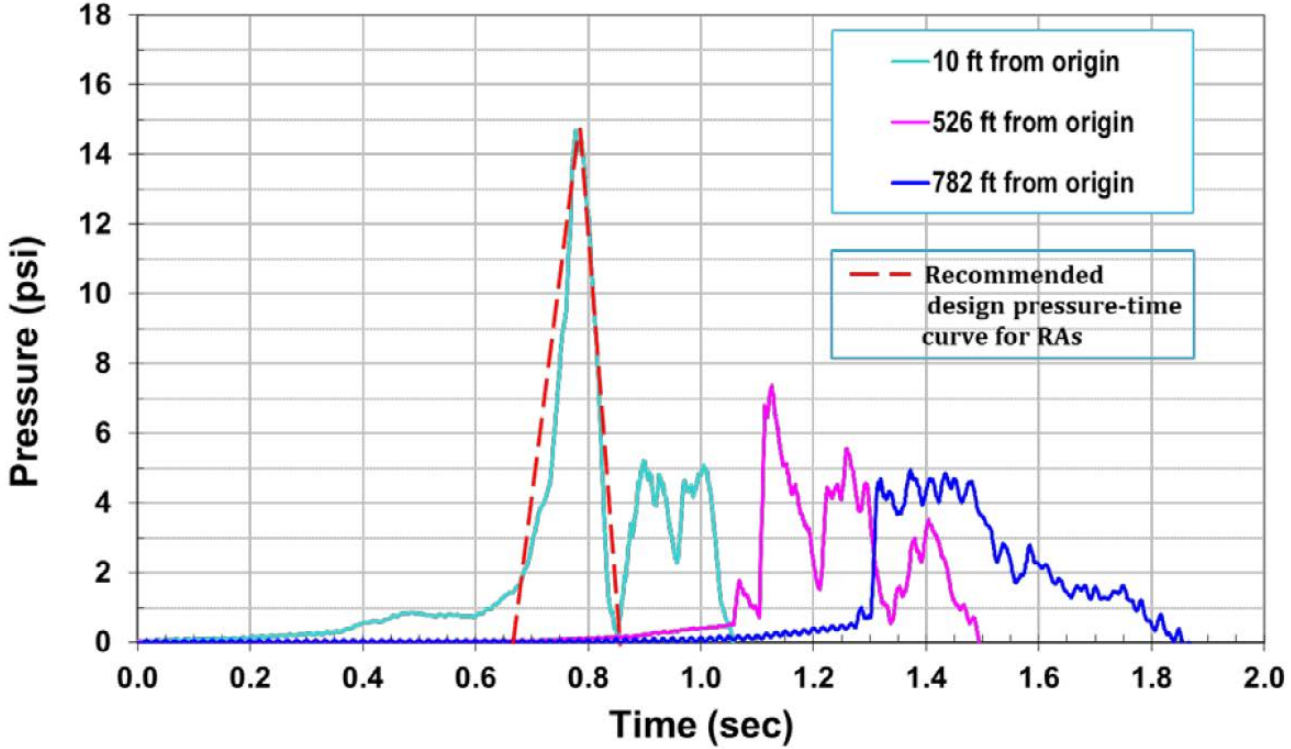
Outline

1. Introduction/background
2. Analysis/Test Methods
3. Summary

Regulations for RAs specify a design load of 15-psi with a duration of 0.2 seconds



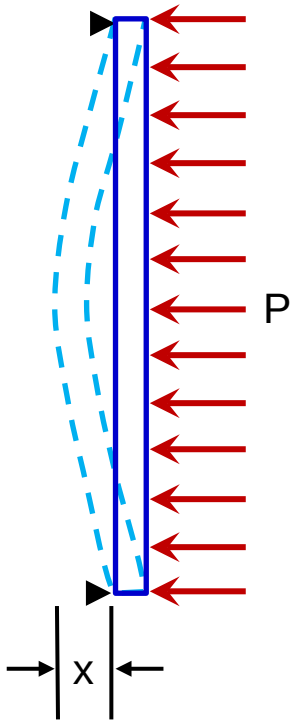
Actual blast pressure near RA may have a different peak pressure and “rise time” than design pressure

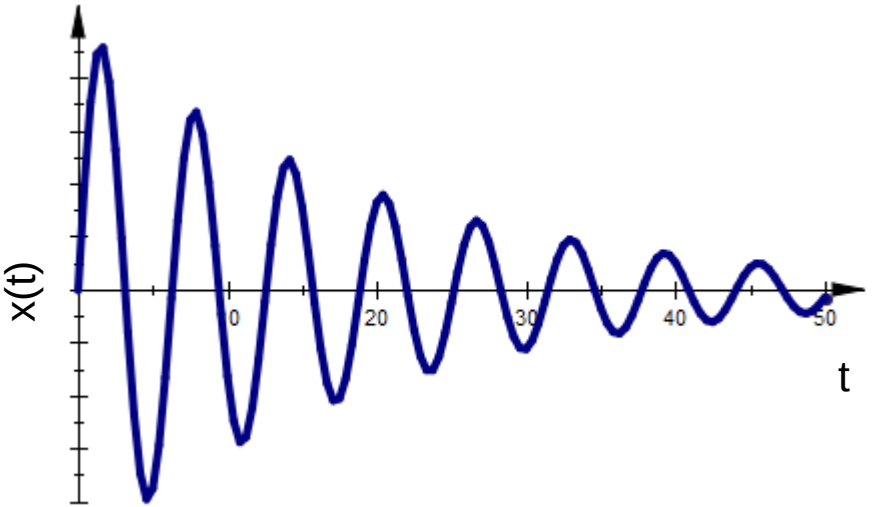


From RI 9698: Facilitating the Use of Built-in-place Refuge Alternatives in Mines

Response due to impulsive (high speed) loading is different than response due to quasi-static (slow speed) loading

- Dynamic response will include both positive and negative loading





The stopping/door must not leak after being subjected to overpressure

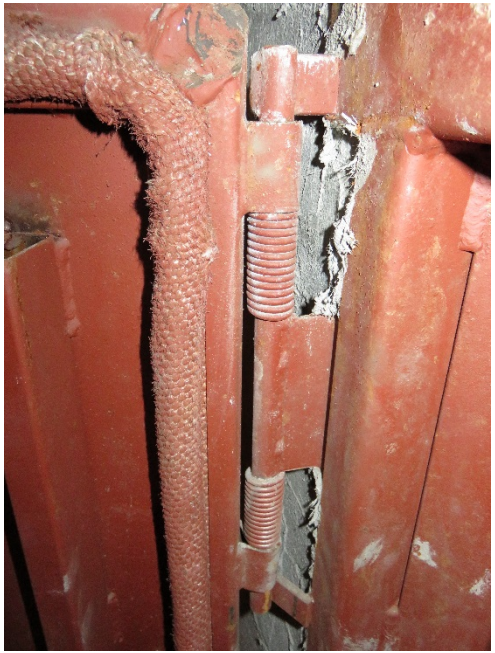
- Stopping alone may not be a concern
- All door components must withstand overpressure
  - Door “skin”
  - Latching mechanism
  - Hinges
  - Seal

Thickness of door skin and use of reinforcement ribs may prevent yielding of door skin (design dependent)

- For static loading (design pressure curve), door skin and jamb carry the load

Latching mechanism and hinges are an important part of the design that may be overlooked

- For dynamic loading
  - Door skin and jamb carry the load during “positive” response
  - Door skin, hinges, and latching components carry the load during “negative” response



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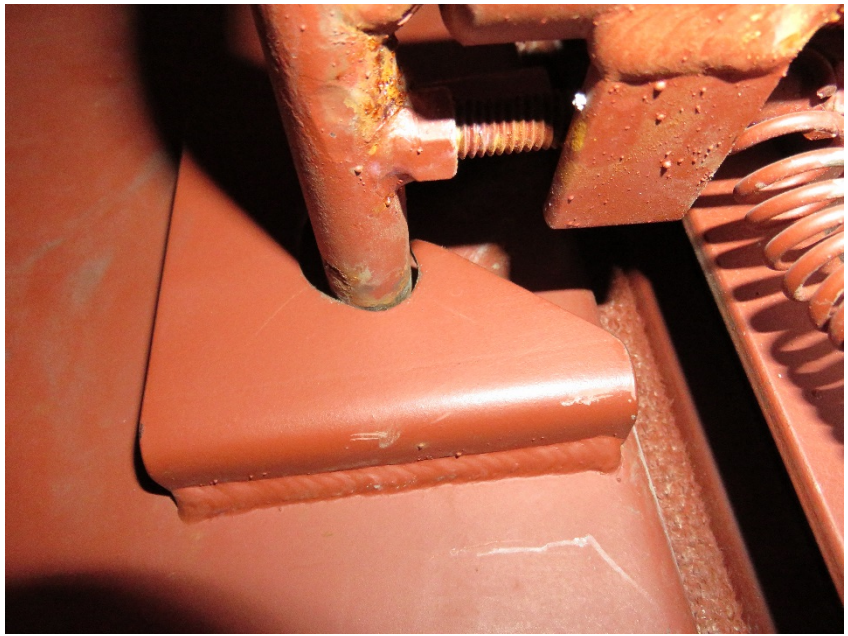
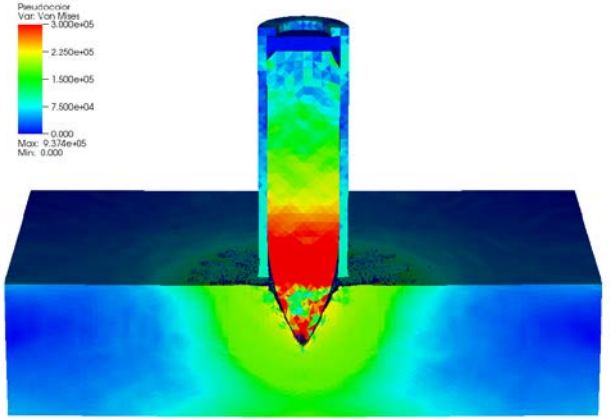
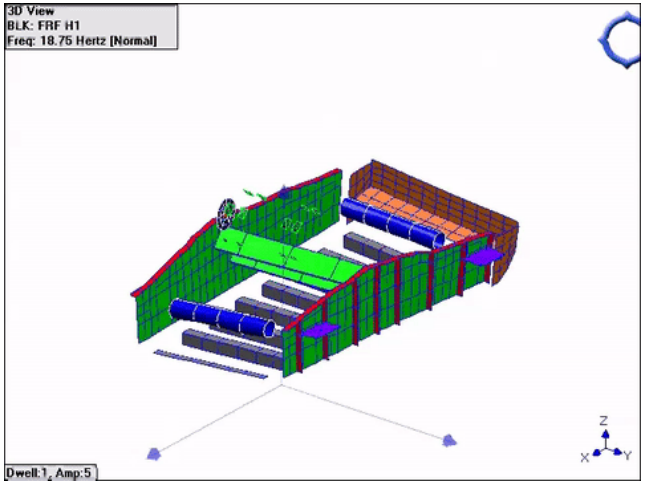


Analysis of BIP RA stopping/door systems requires a complex approach

- Finite element (FE) analysis
  - Linear and non-linear static analysis
  - Transient, linear and non-linear dynamic analysis w/ pressure and impact load
- Model validation testing
  - Non-destructive strain gauge testing with static loading
  - Modal analysis to validate dynamic behavior





Analysis of BIP RA stopping/door systems requires a complex approach

- Static (possibly destructive) testing w/ 15-psi design curve
  - Hydrostatic test facility required
  - Test for leaks before and after
- Dynamic testing
  - Blast test facility required
  - Projectile test apparatus (cinder block launcher) required
  - Test for leaks before and after testing

In summary …

- Stopping/door must withstand design pressure and dynamic blast loads
- Door skin, hinges, and latching mechanisms must be examined
- Approach will utilize combination of FE analysis, FE model validation testing, design load testing, and dynamic testing
- ANSYS FE software and work station purchased
- Two people to attend US Army Corps of Engineers Protective Design Center Blast Resistant Structural Design course in August 2016
- Plan to begin FE analysis ~August 2016

Questions?

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