Thornton Tomasetti

JANUARY 23, 2026

STATE OF PRACTICE AND POTENTIAL SOLUTIONS FOR EXPLOSIVE SAFETY DELEGATED DESIGN

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AGENDA

1. Case Study Laboratory Overview
    A. Doors and Gaskets
    A. Blast Valves
    B. Frangible Panels
    C. Wall Sleeves
2. Magazine Doors
3. Mechanical Couplers
4. Summary and Conclusions

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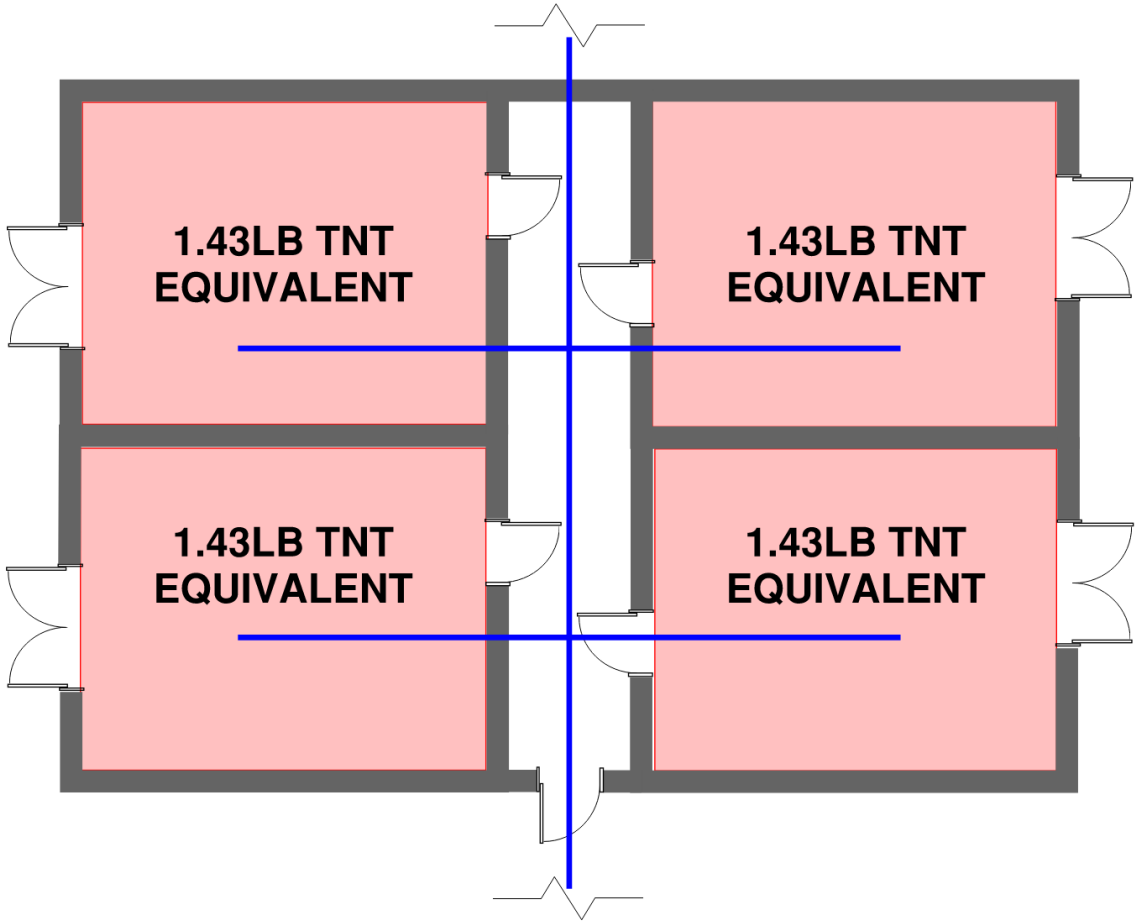
EXPLOSIVE LABORATORY CASE STUDY

- Interior explosive lab group within a larger building
- 1.43lb TNT equivalent weight
- Concurrent non-related operations
- Class I/K24 separation required
- Delegated design items:
  - Blast Doors
  - Supply Air (blast valves)
  - Frangible Panel (not shown)



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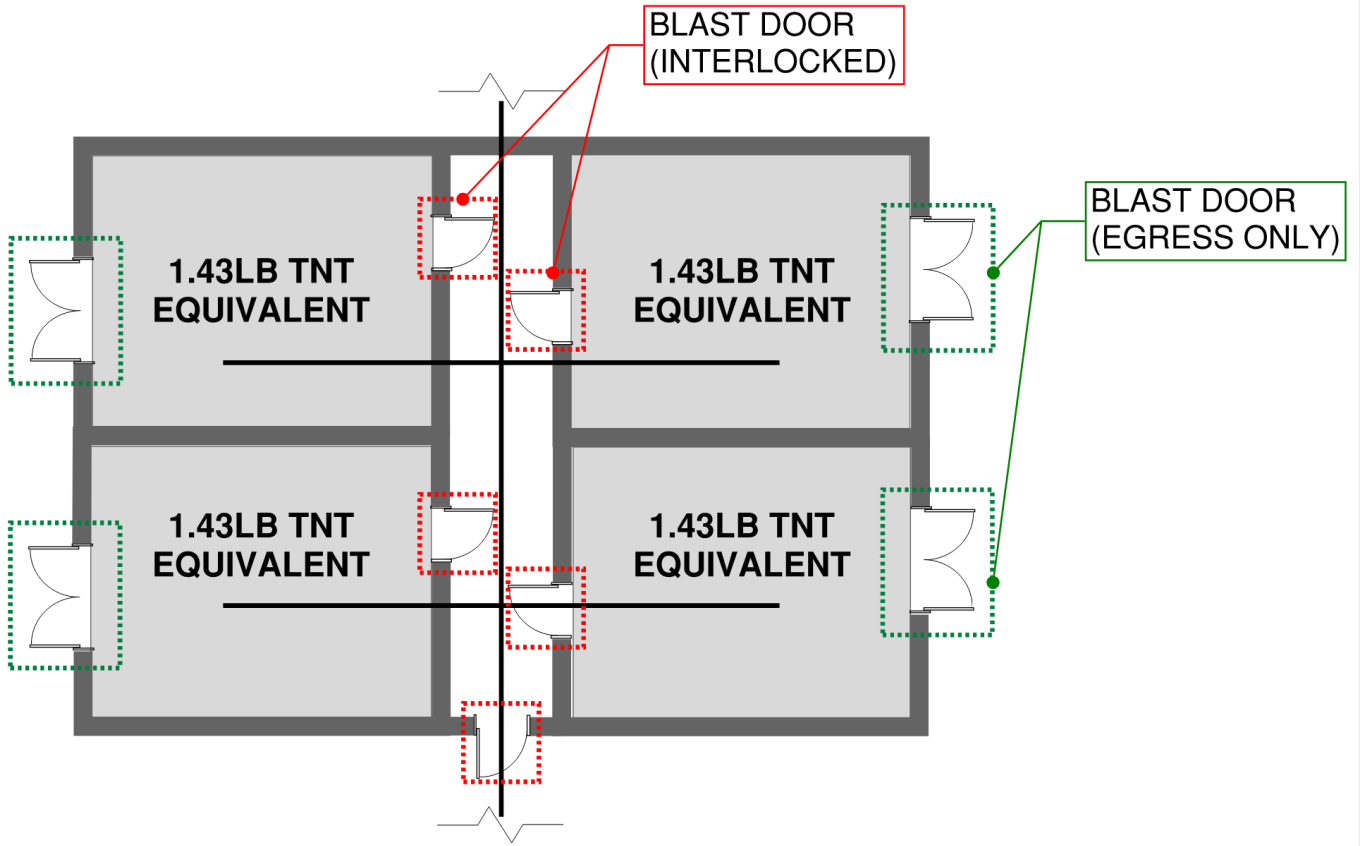
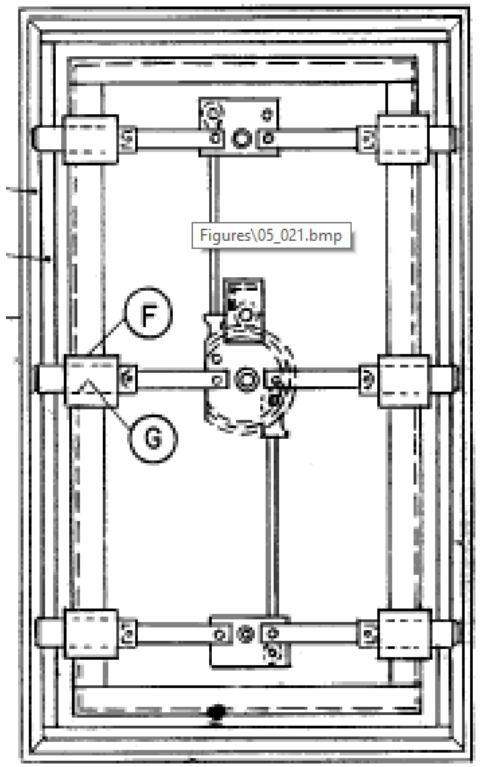
CASE STUDY - DOORS

- Delegated Design Challenges
  - Emergency egress out of the lab
  - Operation requirement to satisfy ABA/ADA
  - Interlocking doors to avoid exposure into other laboratories
  - Full containment concerns
  - Door manufacturers prefer to utilize cold formed pressed sheet steel

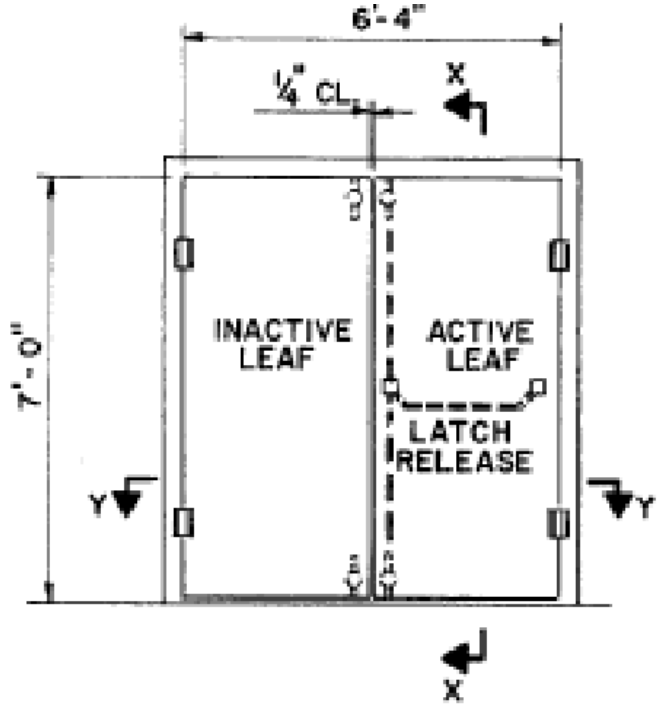


CASE STUDY - DOORS

- Solutions
  - Egress doors are operationally controlled to be used for emergencies only
  - Panic devises removed due to explosive safety requirements superseding NFPA requirements
  - Doors are electronically interlocked to avoid multiple openings within the vestibule
  - Exclusion zones around the door are provided to reduce the weight of the door and utilize cold formed pressed sheet steel
  - High pressure doors were provided by specialty manufacturers



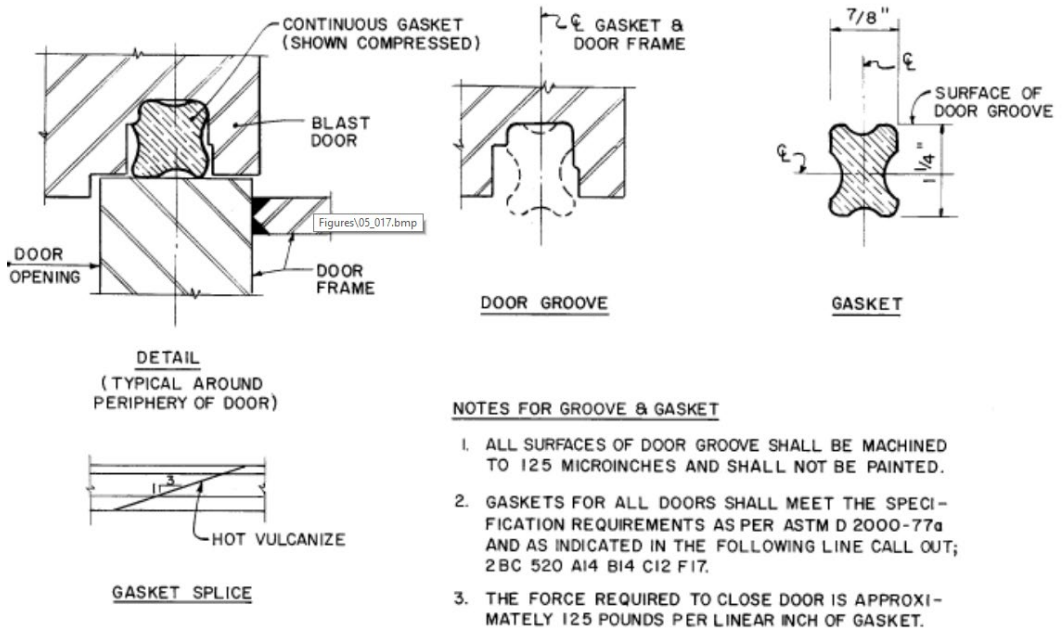
UFC 3-340-02, FIGURE 5-21



UFC 3-340-02, FIGURE 5-41

CASE STUDY - GASKETS

- End user initially wanted gasketing to eliminate the explosive hazards emanating from the room
- UFC 3-340-02 method is prescriptive
  - Requires a compressor
  - Requires a frame at the vertical jambs, head, and sill
- End user accepted risk of the of nominal leakage around the perimeter of the frame without pressure tight gasketing
- **[Action Item] Future guidance in criteria to determine prescriptive limits on threshold gaps**



UFC 3-340-02, FIGURE 5-17

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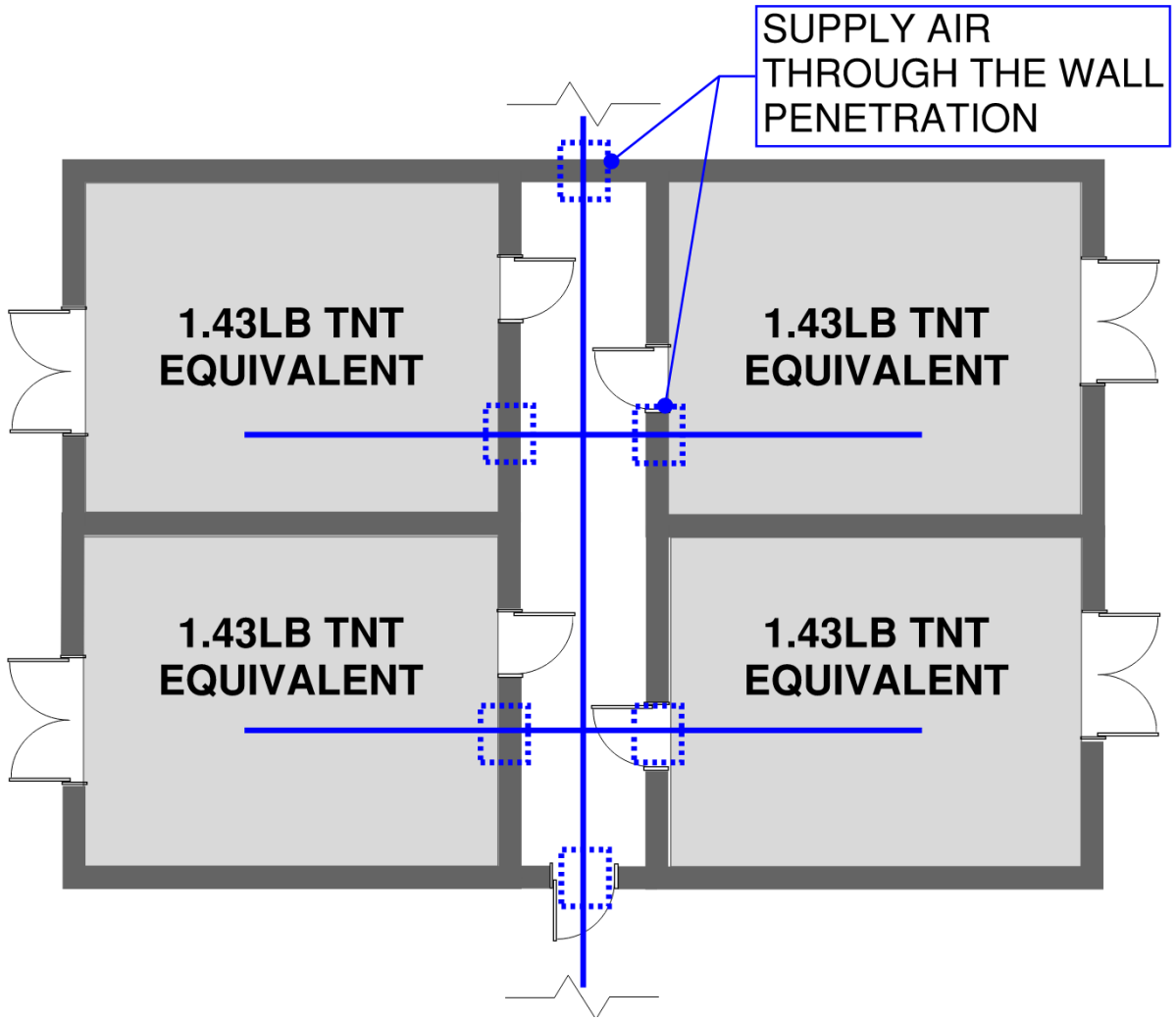
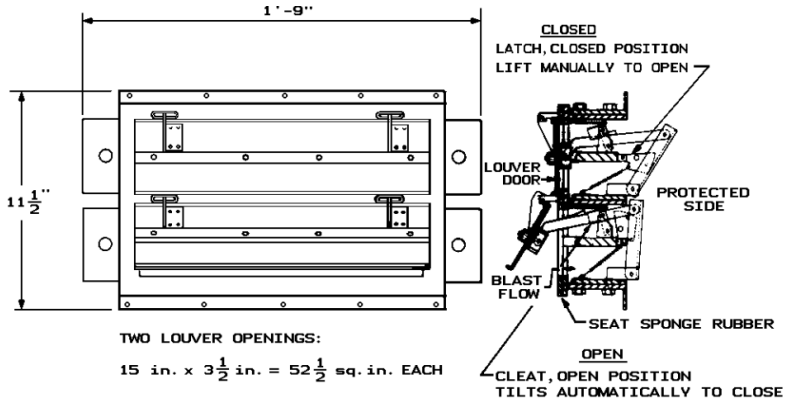
CASE STUDY – BLAST VALVES

- Delegated Design Challenges
  - Design team preferred to use a wall penetration for supply air
  - Maintaining air flow using blast valves
  - Limited suppliers of blast valves
  - Coordination of wall pier to avoid complex load paths at the support
  - Prevent ductwork falling at adjacent spaces

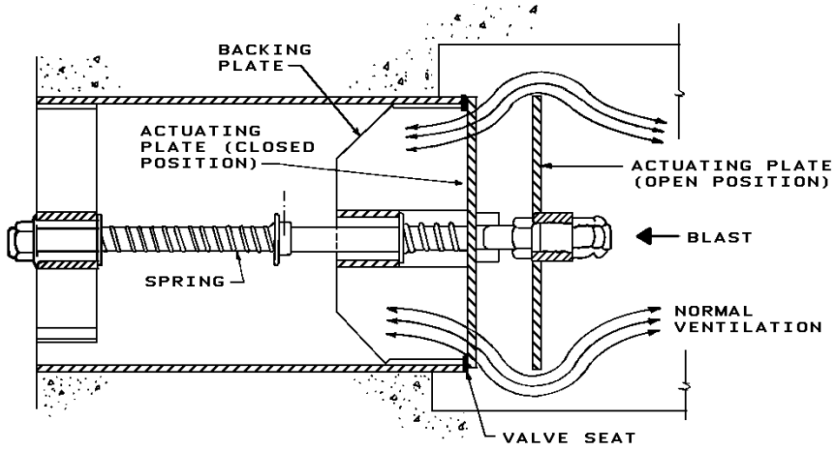


CASE STUDY – BLAST VALVES

- Hardened Solution
  - Provide “poppet” valve at laboratory space and blast louver valve at interlocked vestibule
  - Utilize welded scheduled 80 pipe to eliminate falling damage threat through hardening
- Threat removal
  - Provide supply air penetration at the roof to avoid hazards at adjacent occupied spaces
- Advanced Analysis
  - Utilize advanced analysis to determine the explosive hazards within adjacent areas to help the end-user understand the risk profile
- **[Action Item] Provide standard details for blast valves**



UFC 3-340-02, FIGURE 6-64, LOUVERED



UFC 3-340-02, FIGURE 6-65, POPPET VALVE

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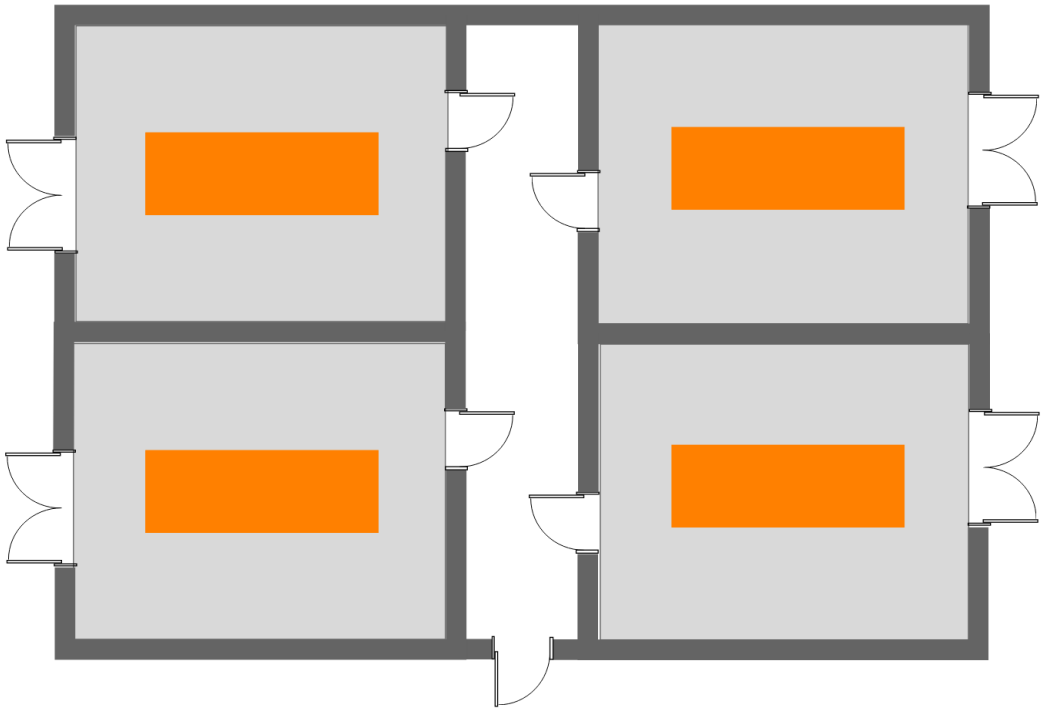
CASE STUDY – FRANGIBLE PANELS

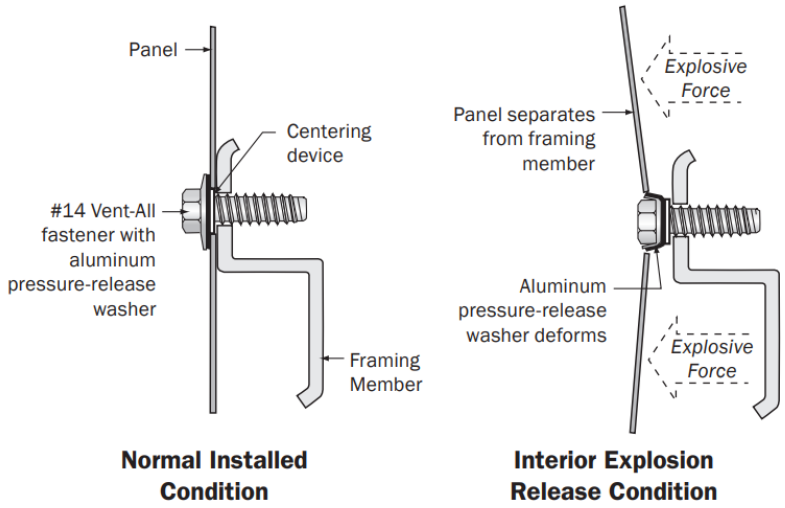
- Delegated Design Challenges
  - Required to resist environmental loads without failure (wind and snow)
  - Required to resist leakage blast loads from adjacent explosive operations
  - Required to release at minimum pressure; is it feasible?



CASE STUDY – FRANGIBLE PANELS

- Solutions
  - Consider design wind load as the frangible release
  - Consider snow load in conjunction with mass of the panel to avoid operationally clearing snow
  - Explovent product is no longer in production
  - Eclo vent-all fasteners for a custom solution

EXPLOVENT XRV-IC



ELCO VENT-ALL EXPLOSION-VENTING FASTENERS

CASE STUDY – FRANGIBLE PANELS

- Lessons learned
  - Avoid off the shelf panel solutions if environmental loads need to be considered
  - Off the shelf solutions have a very low release limit which conflicts with environmental loads
  - Use custom design solutions rather than delegating the design to maintain control over gas loading
  - 25psf break away pressure is not feasible for frangibility with most wind loads

- **[Action Item] Revisit frangibility requirement to align with environmental loads**

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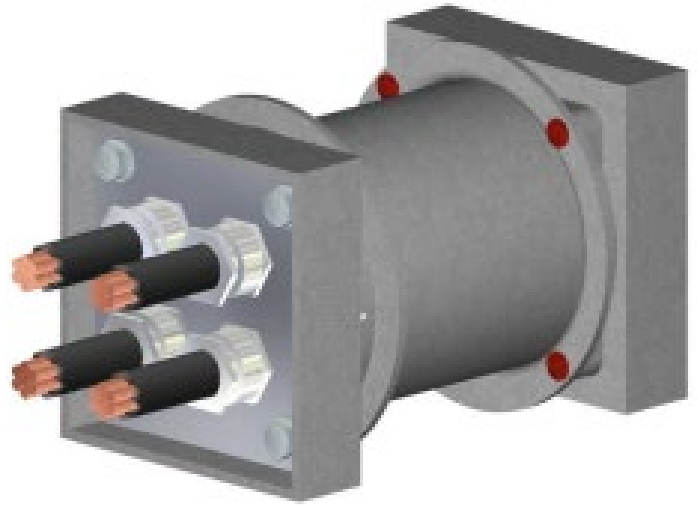
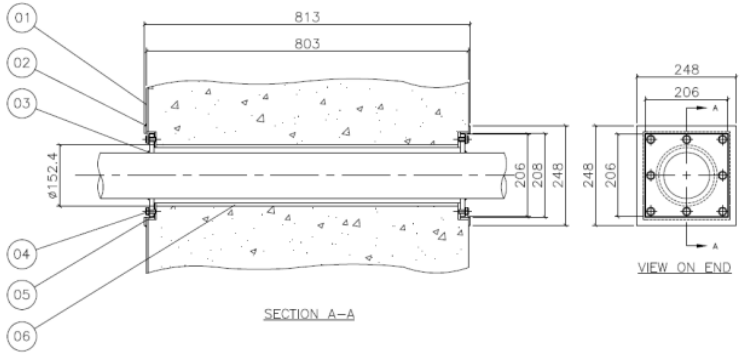
WALL SLEEVES

- Delegated Design Challenges
  - Limited suppliers
  - No domestic manufacturers
  - End users desire flexibility with cabling through the wall (number of cables, diameter of cables, etc.)
  - Additional penetrations creates complex load paths



TEMET LP-SJ-150



EEP DESIGN

WALL SLEEVES

- [Action Items]
  - Provide testing guidance that prescriptively limits opening size for different blast load magnitudes
  - Develop standard details for sleeves that are acceptable for explosive safety applications that can be incorporated into the design drawings
  - Develop a standard specification for wall sleeves

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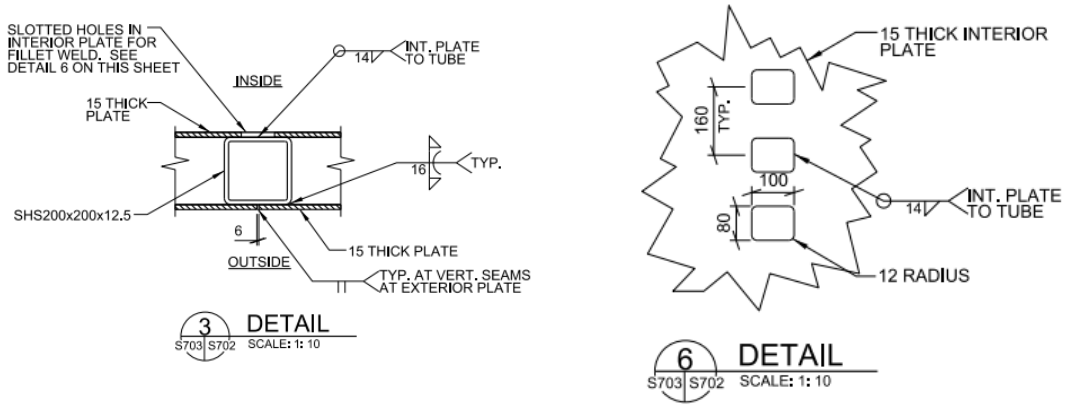
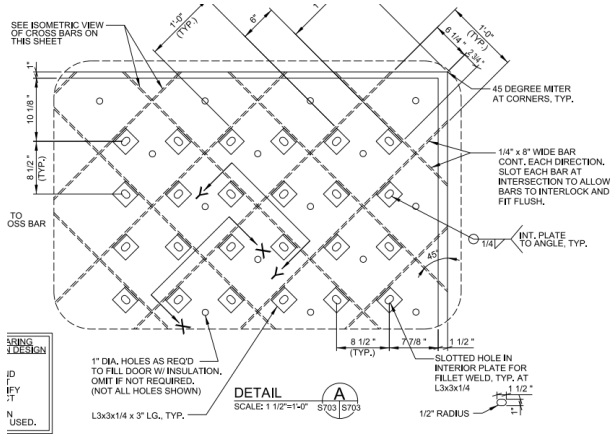
MAGAZINE DOORS

- Manufacturer Challenges
  - Approved standard magazine door weld schemes cause deformation of the skin plate
  - Typical door designs require field welding which may be difficult in remote locations
  - US Materials for approved standard magazines may not be able to be sourced internationally requiring additional analysis
- **[Action Items]**
  - **Revise weld schemes with manufacturer input**
  - **Provide bolted alternative for remote locations**



APPROVED STANDARD DWG # 421-80-13



APPROVED STANDARD DWG # 421-80-08

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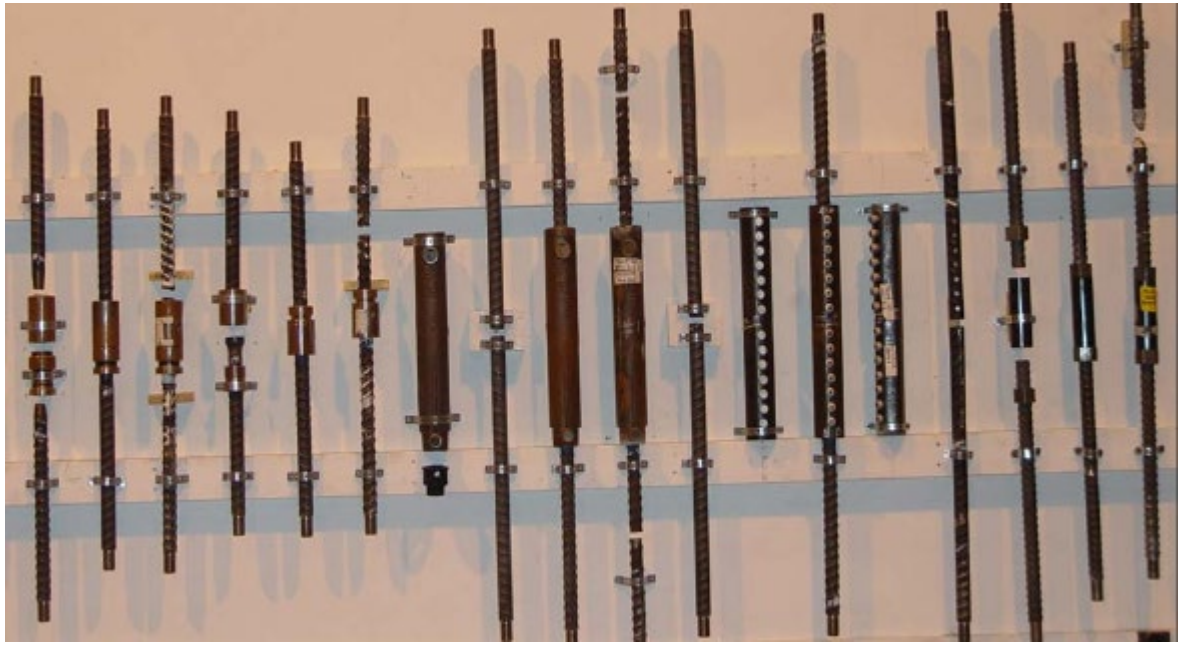
MECHANICAL COUPLERS

- Couplers are required to comply with ERDC TR-09-08
  - No coupler has fully met the ERDC testing requirements
- **[Action Items]**
  - **Develop a standardized mechanical coupler test document**
  - **Develop a list of approved vendors/standard designs**
  - **Develop strength reductions for designs with mechanical couplers**
  - **Clarify criteria to note mechanical coupler limitations**



Hight Strain-Rate Testing of Mechanical Couplers

APPROVED STANDARD DWG # 421-80-08

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SUMMARY AND CONCLUSIONS

- Additional testing to provide prescriptive limits on minor penetrations through the wall (perimeter of the door, small opening for MEP opening, etc.)
- Develop standard details/products for a wide range of acceptable applications
- Coordinate with all disciplines to confirm order of precedence for design (blast, fire, environmental, ABA/ADA)
- Develop standard specifications for wall sleeves and frangible panels
- Engage with manufacturers to develop standard details
- Engage delegated designers early in the process

THANK YOU

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