National Shipbuilding Research Program
NSRP ASE
Advanced Shipbuilding Enterprise

# Electric Technologies Panel Meeting Washington DC

## Transit Sealant Evaluation Project

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July 24th, 2013

# Project Mission and Premise

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- Although robust and traditionally a strong cable penetration support system, transits using block systems are time consuming and expensive
- Looking for affordable alternatives that offer similar benefits
  - Watertightness
  - Shock, vibration and fire resistance
  - Low toxicity
- While also offering
  - Affordability
  - Minimal installation time and components
  - More flexible to change after cable routing is complete
  - Straight forward cable replacement and additions

# Project Participants

- BIW – Lead
- Bollinger Shipyards
- Huntington Ingalls Inc., Newport News
- WO Supply
- Beele Engineering
- Emerson Industrial Automation
- Sealand  Pipe
- Raytheon
- AeroNav Laboratories

# Transit Sealant Evaluation Project Goals

- Research Available Products
- Evaluate Requirements
- Generate Evaluation Guide
- Evaluate Product Information
- Develop Test Procedure
- Manufacture Demonstrator
- Conduct Testing
- Evaluate Results
- Generate Report and Recommendations

# Research Available Products

- Several products were investigated
- A down select was conducted based on data
- Three products were tested
- One product currently used on programs is considered a baseline

# Evaluate Requirements

- Several standards and Mil-Specs were reviewed, and notes made
- Compilation for future reference supporting possible requirements revision

**References for Transit Component Usage**

| Item | Reference | Section | Section Language | Remarks |
|---|---|---|---|---|
| 1 | MIL-STD-2003-3A DEPARTMENT OF DEFENSE<br>STANDARD PRACTICE<br>ELECTRIC PLANT INSTALLATION<br>STANDARD METHODS FOR<br>SURFACE SHIPS AND SUBMARINES<br>(Penetrations) | 4.1.5 | 4.1.5 Multiple (two or more) penetrations of nonstructural steel bulkheads (other than wire mesh or expanded metal), bends, web frames, transverse girders, and longitudinal girders. Unless otherwise specified, multiple cable metal), bends, web frames, transverse girders, and longitudinal girders. Unless otherwise specified, multiple cable penetrations of nonstructural steel bulkheads, bents, web frames, transverse girders, and longitudinal girders shall employ one of the following:<br>a. Metal stuffing tubes, multiple cable penetrators, nipples (for single cable penetrations) having a minimum length of two inches with a minimum annular area between the cable and the nipple of ¼ inch packed with plastic sealer<br>b. Banding collars (for multiple cable penetrations) having a minimum collar length of three inches with a minimum annular area between the cable and the collar of one inch with the entire void area within the collar (this includes the area between the collar and the cable and the area between the cables) packed with plastic sealer. Cable penetrations of vertical non-tight structures within a compartment nee | Talks about using a plastic sealer in various applications throughout this and similar sections |
| | | 4.1.6 | 4.1.6 Plastic sealer. After the cables are properly secured, plastic sealer electrical insulation (MIL-I-3064, Type HF) shall be used to seal the space around the cable as follows:<br>a. In cable clamps and bushings entering the top of an electrical enclosure and the side of an enclosure without a drip loop.<br>b. In bushings or nipples used for passing cables through light-tight and fume-tight bulkheads and to seal around cables as they enter stuffing tubes, kickpipes, and swage tubes as shown on the individual figures except that plastic sealer is not required when silicone (red or white) grommets are used. Where compartment air tests are required, it is recommended that plastic sealer be installed after the air test has been satisfactorily performed. | |
| | | FIGURE 3B51. Community cable tube – watertight decks (poured seal | | Shows the use of sealants and multicable transit applications. |
| | | FIGURE 3B22. Multiple cable penetrator installation notes (type RGS and RGA). | | This figure and next talk to using blocks, but may be applicable with sealant materials |
| | | FIGURE 3B39. Round multi-cable penetrators installation notes | | |
| 2 | MIL-STD-2003-4A DEPARTMENT OF DEFENSE<br>STANDARD PRACTICE<br>ELECTRIC PLANT INSTALLATION<br>STANDARD METHODS FOR<br>SURFACE SHIPS AND SUBMARINES<br>(CABLEWAYS) | 4.2 Spare cable space allowance | 4.2 Spare cable space allowance. In the organization of principal cableways, spare cable space of approximately 20 percent of that to be occupied by the final cable installation (as known at time of delivery of the ship) shall be reserved on cableways and in cable penetration areas for future cable installations. The additional cable space may consist of unused hangers or combination of unused hangers and space available on used hangers, assuming that for future addition of cable, double banking will be allowed. During the design phase, the contractor shall provide cableway space in excess of the spare 20 percent in order to accommodate cables added as a result of developments occurring during the construction period. Through horizontal cable runs in aircraft carriers' hanger developments occurring during the construction period. Through horizontal cable runs in aircraft carriers' hanger developments occurring during the construction period. Through horizontal cable runs in aircraft carriers' hanger spaces will not be permitted. Through vertical runs such as those from the second deck to the gallery or flight decklevels shall be g | |

# Generate Evaluation Guide

- A means to consistently compare products was needed
- Team developed a simple guide to help compare product characteristics across evaluation group, and compare to requirements

**Evaluation Criteria**

The following are criteria that will be used to evaluate the performance of the tested transit sealant products.
Some criteria are based on established standards and requirements, which are referenced for convenience.

Product: ____________________ Tested by: ____________________
Date: ____________________ Submitted by: ____________________

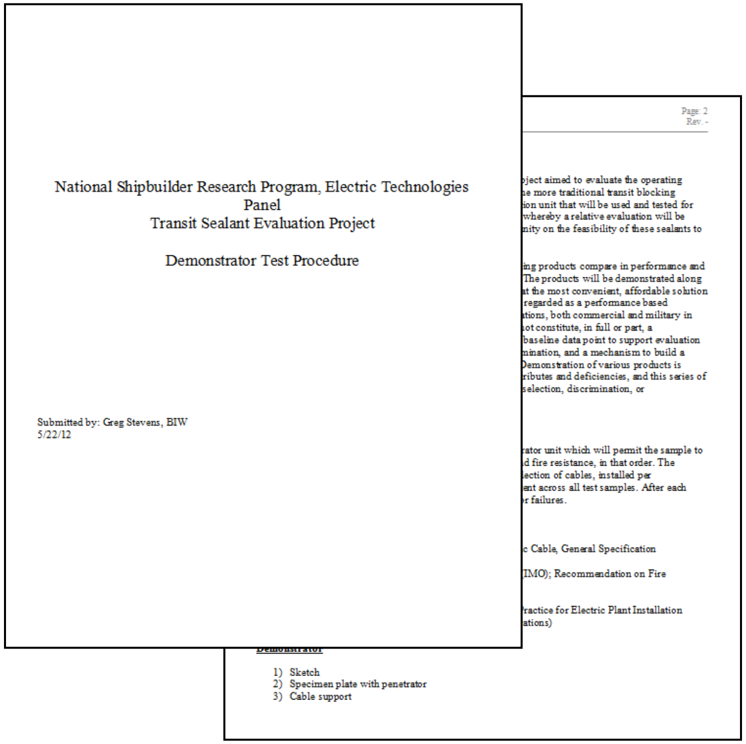
| Item | Description | Min/Max Requirement | UOM | Value | Meets Requirement? (Y/N) | Testing Date | Comments/Remarks |
|---|---|---|---|---|---|---|---|
| 1 | Cure Time | | hrs | | | | |
| 2 | Operating Temperature - nominal | | °F | | | | |
| 3 | Max. Operating Temperature | | °F | | | | |
| 4 | Flame Resistance | | °F/hr or °C/hr | | | | |
| 5 | Water/Air Pressure Withstand | | psi | | | | |
| 6 | Packaging Size | | $in^3$ | | | | |
| 7 | Packaging | | n/a | | | | how is the product packaged? |
| 8 | Delivery | | n/a | | | | how is the product applied (caulking gun, knife, etc.) |

# Evaluate Product Information

- The previous evaluation guide templates were filled in with vendor data
- This enables a consistent comparison across samples and attributes
- Allows for a down select to build unit demonstrators with sample materials

# Develop Test Procedure

- To test the samples, a test procedure was developed
- Primary tests include:
  - Vibration
  - Shock
  - Watertightness
  - Fire resistance
- Independent lab was contracted to conduct testing



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Transit Sealant Evaluation Project

Demonstrator Test Procedure

Submitted by: Greg Stevens, BIW
5/22/12

Page: 2
Rev. -

ject aimed to evaluate the operating
e more traditional transit blocking
ion unit that will be used and tested for
whereby a relative evaluation will be
nity on the feasibility of these sealants to

ing products compare in performance and
The products will be demonstrated along
t the most convenient, affordable solution
regarded as a performance based
tions, both commercial and military in
ot constitute, in full or part, a
baseline data point to support evaluation
nination, and a mechanism to build a
Demonstration of various products is
ributes and deficiencies, and this series of
selection, discrimination, or

ator unit which will permit the sample to
d fire resistance, in that order. The
ection of cables, installed per
ent across all test samples. After each
r failures.

c Cable, General Specification

IMO); Recommendation on Fire

ractice for Electric Plant Installation
ations)

1) Sketch
2) Specimen plate with penetrator
3) Cable support

# Manufacture Demonstrator

- Demonstration units were designed and built for 3 products
- General requirements for deck and bulkhead penetration were followed
- Slight modification done by lab to withstand shock testing; no functional change

NSRP ETP Transit Sealant Evaluation Project
Testing Procedure

Page: 3
Rev. -

**Demonstrator Transit Cable Configuration**

An assortment of representative cables conforming to MIL-DTL-24643 shall be used, as outlined below:

| CABLE SIZE | LSTSGU-400 | LSTSGU-200 | LSTSGU-75 | LSTSGU-23 | LSTSGU-9 | DXW-3 |
|---|---|---|---|---|---|---|
| DIAMETER | 2.203 | 1.669 | 1.134 | 0.812 | 0.575 | 0.257 |
| AREA EA | 3.81 | 2.19 | 1.01 | 0.52 | 0.26 | 0.05 |
| QTY INSTALLED | 2.00 | 2.00 | 7.00 | 7.00 | 9.00 | 10.00 |
| TOTAL AREA | 7.62 | 4.37 | 7.07 | 3.62 | 2.34 | 0.52 |

The total area of the cables listed above is 25.5 $in^2$. The area of the flat 6" x 12" oval transit is 64.3 $in^2$, resulting in a fill of 40%, consistent with standard practice. A notional cable arrangement is shown in Figure 1. Refer to the attached design document for more information on the demonstrator design attributes and components.

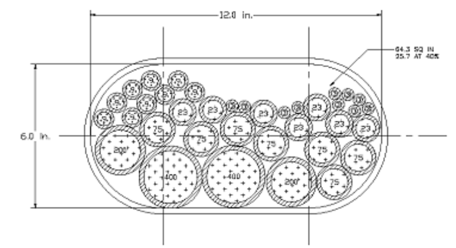
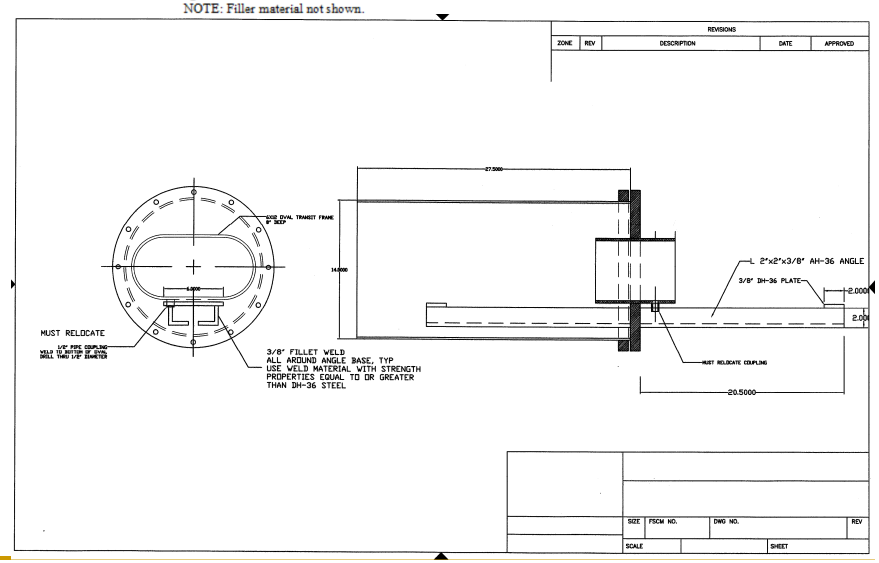
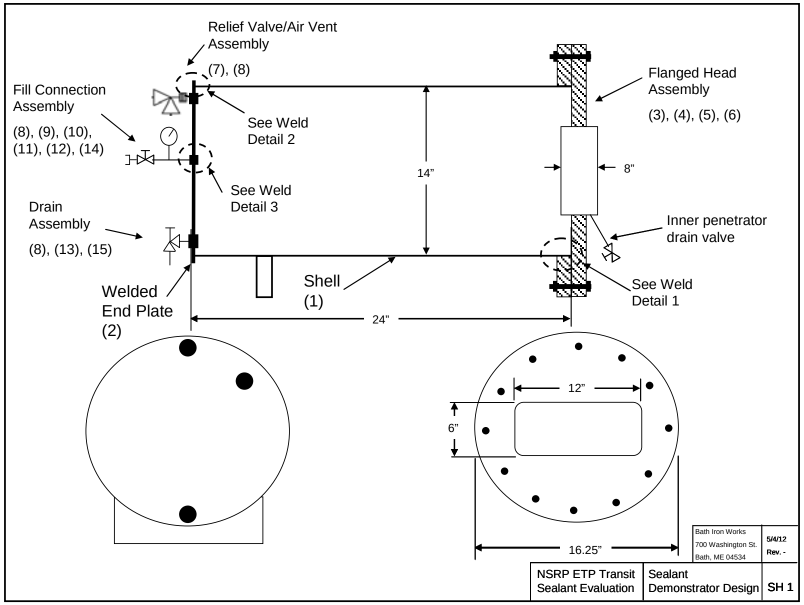
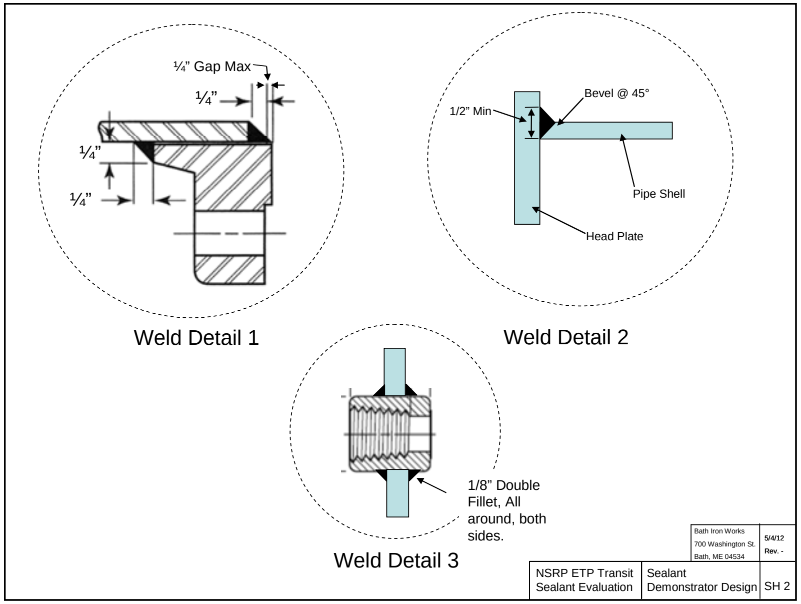



Figure 1: Notional Transit cable fill
NOTE: Filler material not shown.



# Manufacture Demonstrator (cont.)

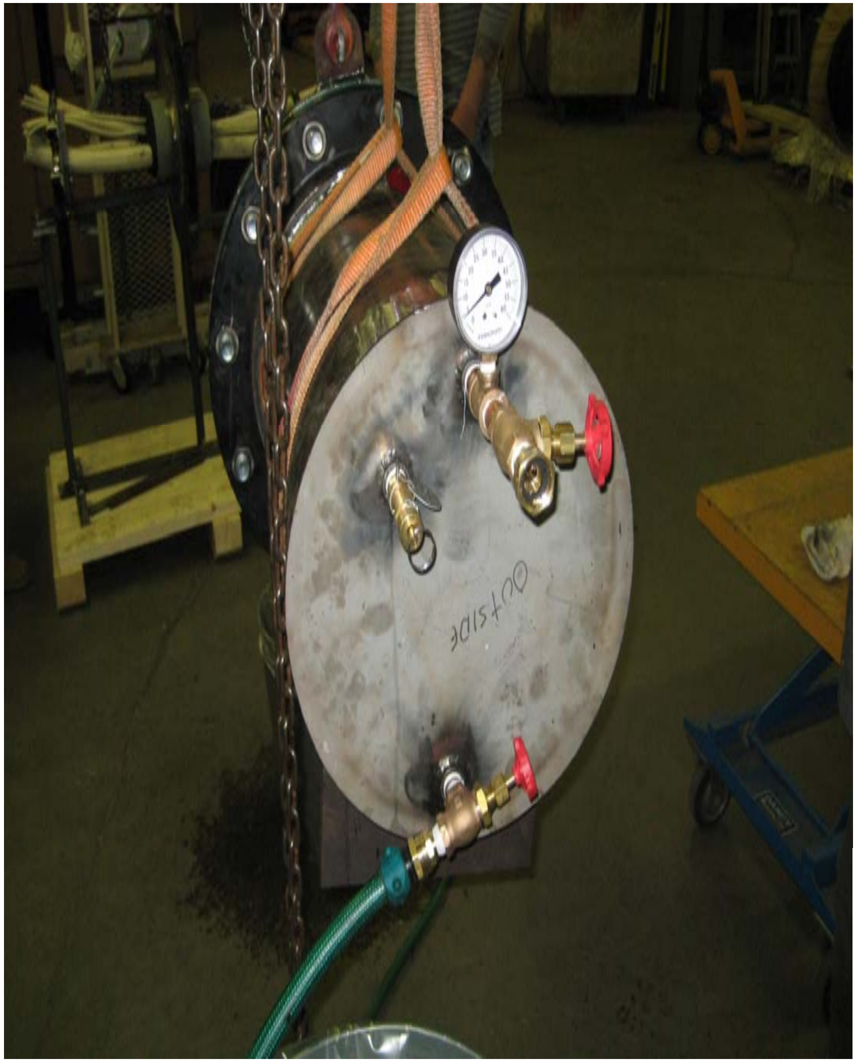


# Conduct Testing

- Hydro testing completed at BIW; repairs made
- Shock, vibration and various hydrostatic tests were conducted by the lab
- One product marginally failed the hydro testing after the shock testing
- Repairs were made and testing completed

# Nelson Firestop (BIW Testing)



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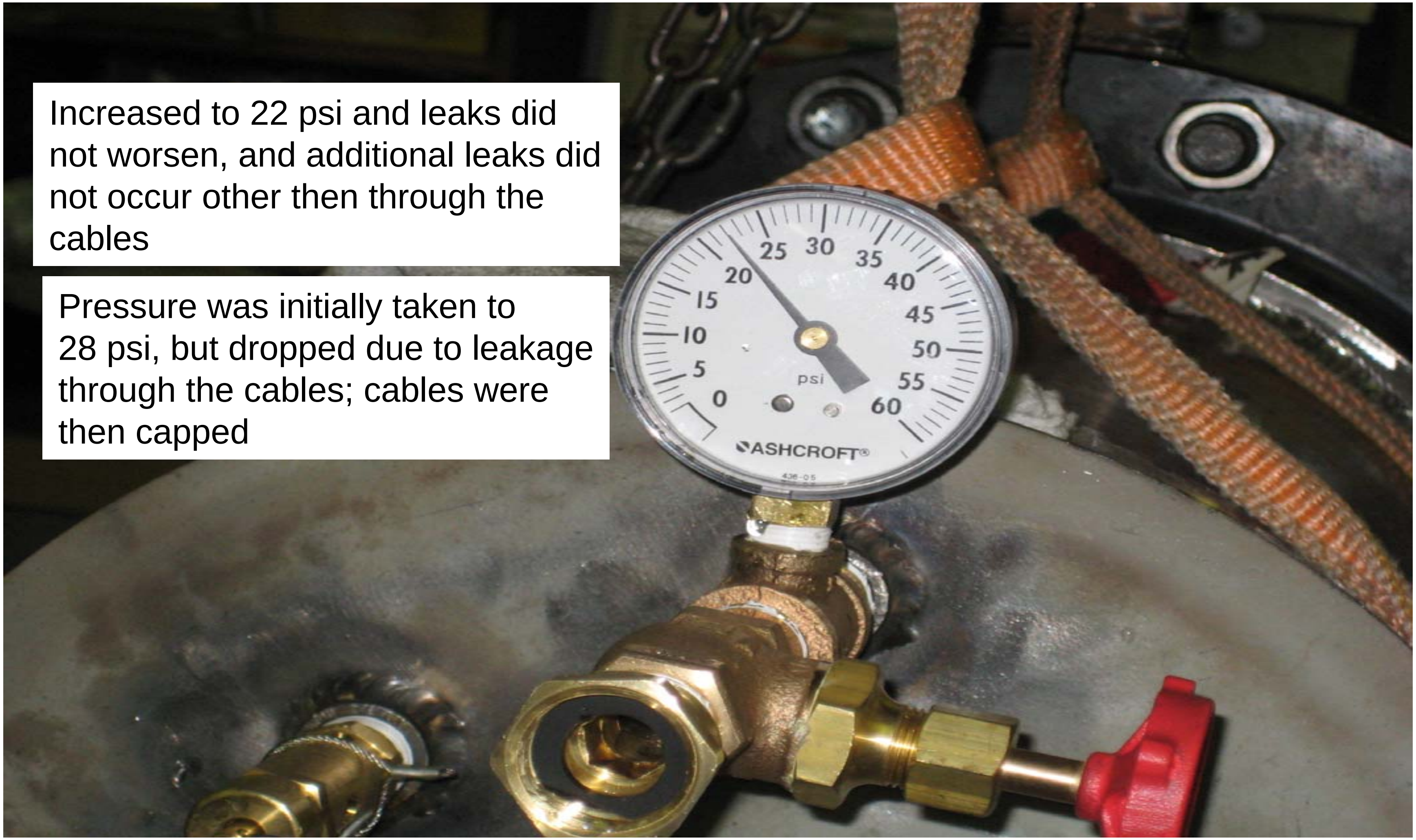
# Nelson Firestop (BIW Testing)

# FIRESTOP 3000 with D-24 BLANKET (BIW Testing)

# NOFIRNO (BIW Testing)

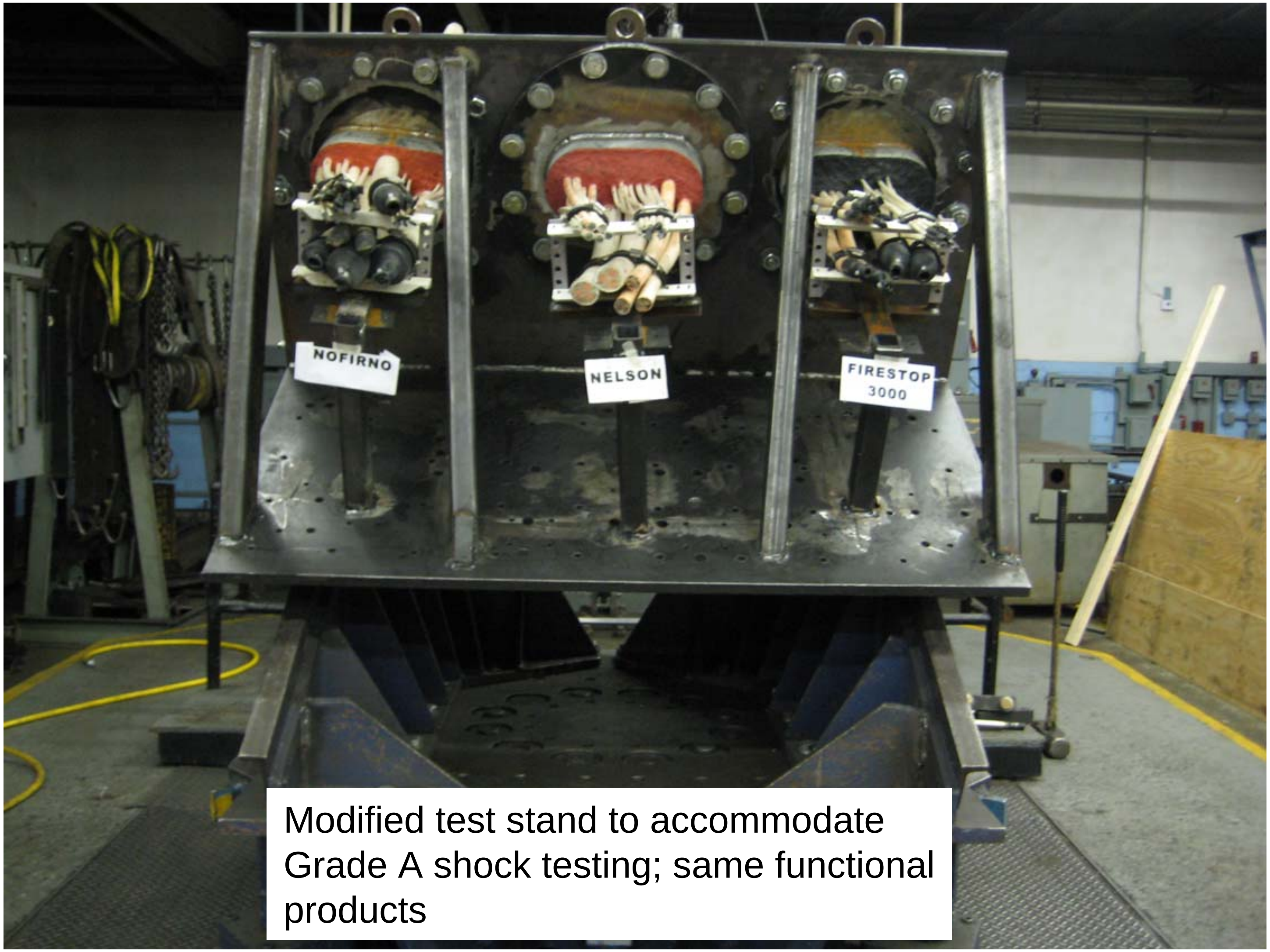
# NOFIRNO (BIW Testing)




Increased to 22 psi and leaks did not worsen, and additional leaks did not occur other then through the cables

Pressure was initially taken to 28 psi, but dropped due to leakage through the cables; cables were then capped

# Shock Testing (Lab Testing)

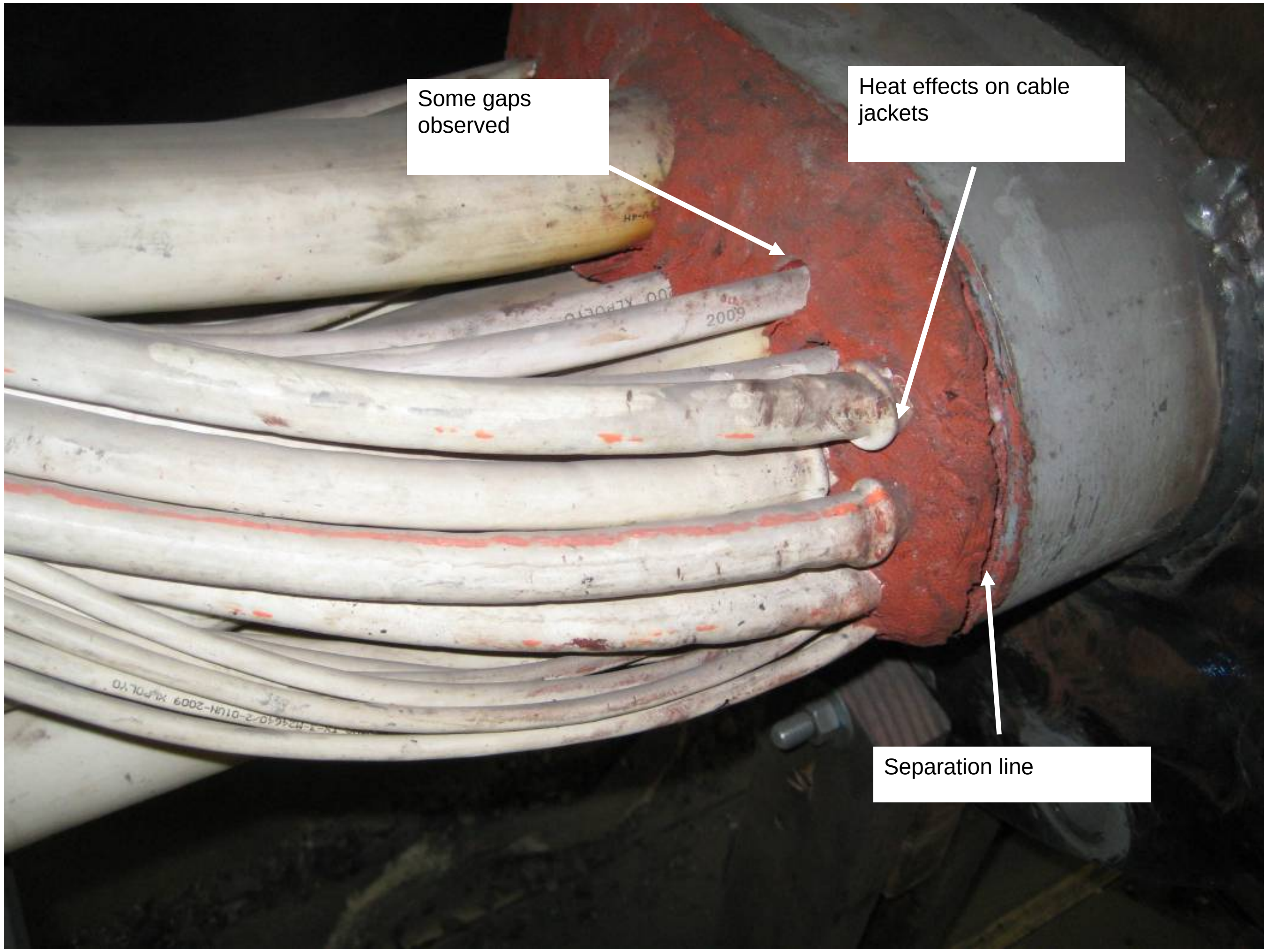



Modified test stand to accommodate Grade A shock testing; same functional products

# Results

- All units considered to have passed all tests, except for the hydrostatic test after the shock testing (NOFIRNO); repairs made and testing commenced
- Upon close inspection, after fire testing, all products appear to have good mechanical strength and withstand
- Cure time really made a difference when it was time to shock and fire test products
- Holes easily cut into material to install other cables, and easily repaired

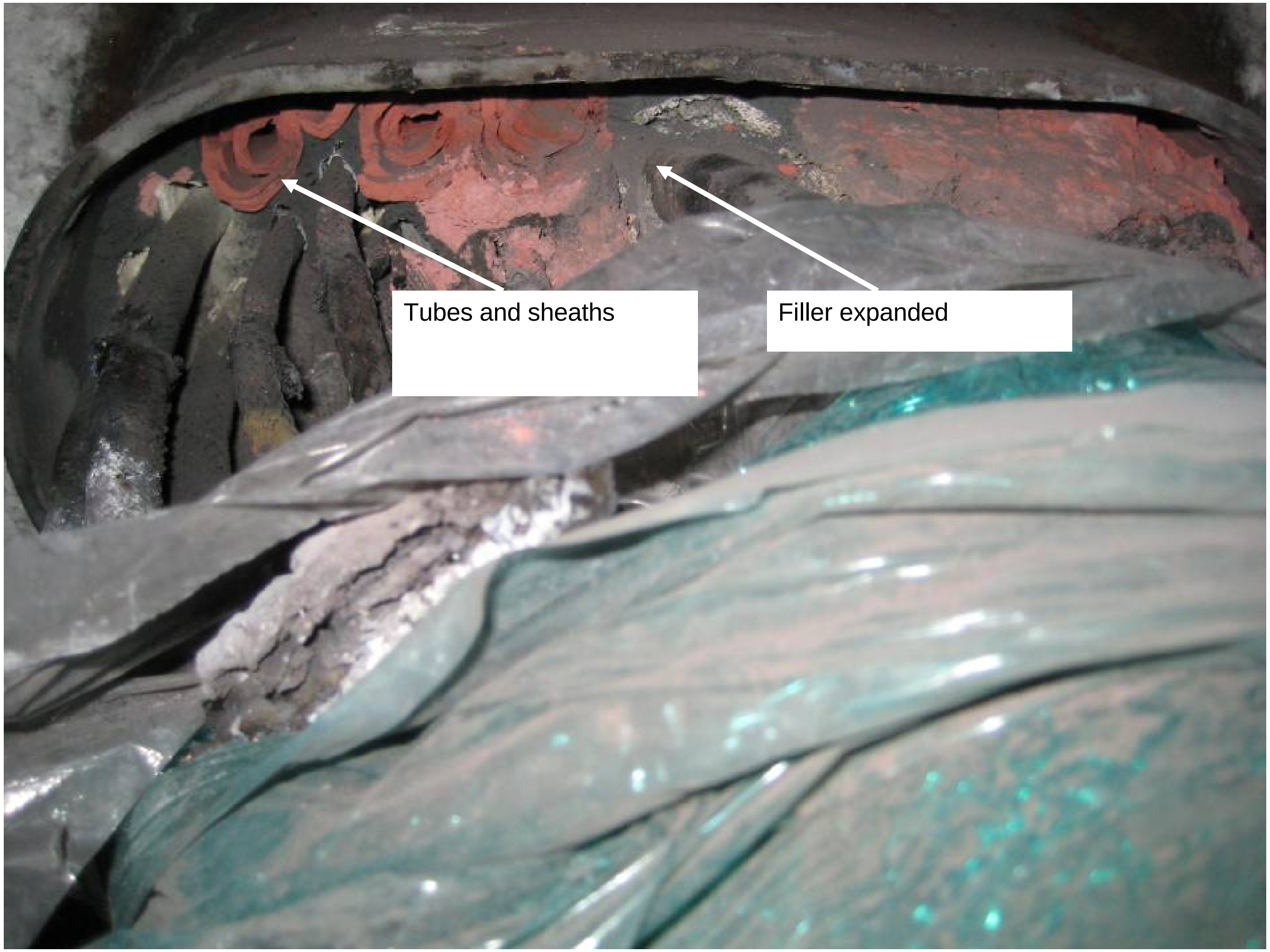
# NOFIRNO Inspection



# NOFIRNO Inspection

# NOFIRNO Post Fire Test

# NOFIRNO Inspection (fire side)

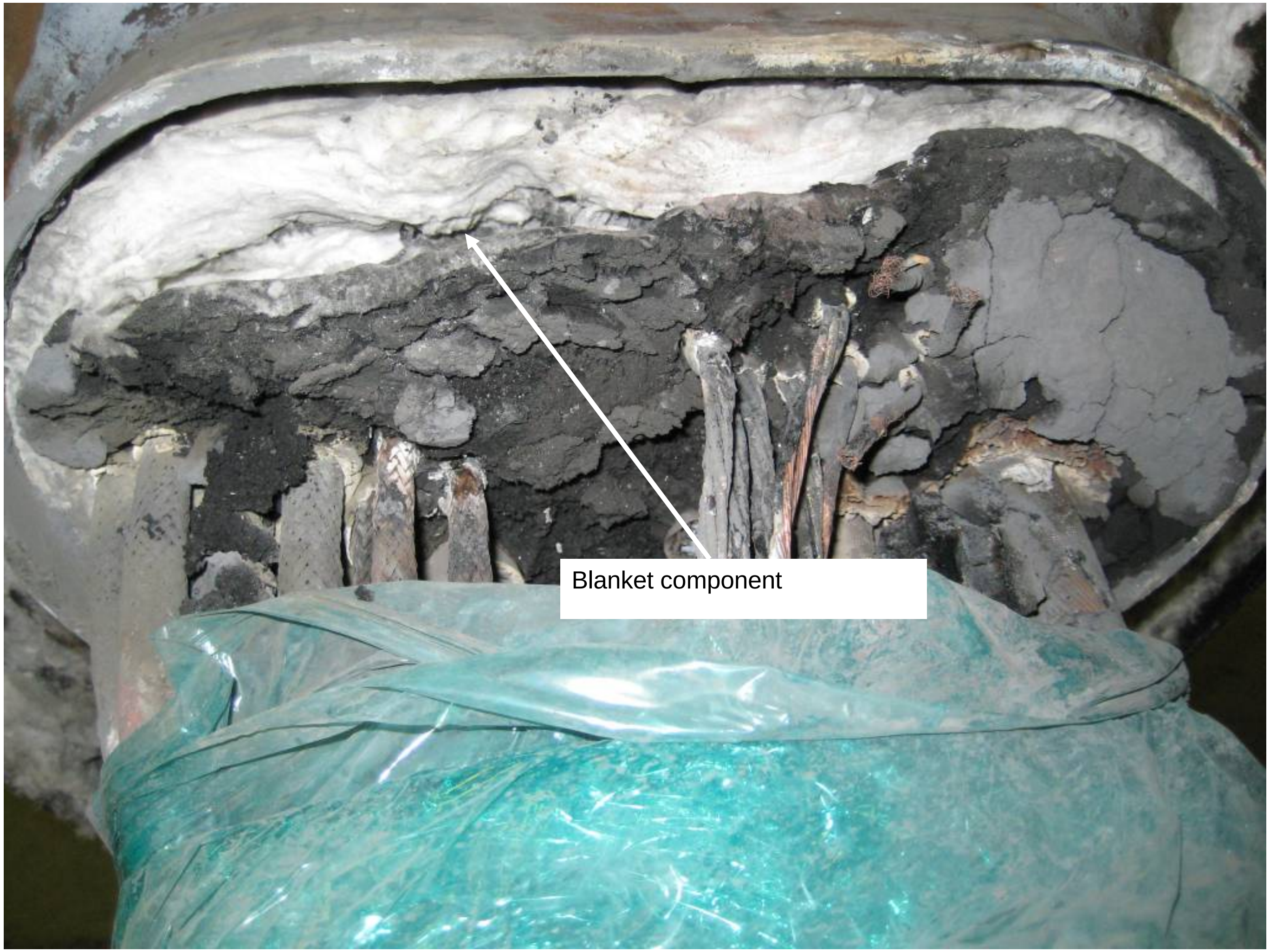


# Fire Seal Inspection

# Fire Seal Inspection

# Fire Seal Post Fire Test

# Fire Seal Inspection (fire side)



# Fire Stop Inspection

# Fire Stop Inspection

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Putty component and interface

# Fire Stop Post Fire Test

# Fire Stop Inspection (fire side)

# Quantitative Assessment: Cost Benefit Evaluation

**NSRP Transit Sealant Project: General Cost Savings Data**

| Input Data Set | Estimated Cost Difference (pu measures for Transit Systems minus Soft Sealant Systems) | | | | | Approx. Number per Ship - Scaled for Materials | Approx. Number per Ship - Scaled for Labor | Estimated Cost Difference (calculated measures for Transit Systems minus Soft Sealant Systems) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Initial Installation | | Repair | | Failure Rate | | | Initial Installation | | Repair | |
| | Materials | Labor | Materials | Labor | | | | Materials | Labor | Materials | Labor |
| | | | | | | | | | | | |
| Averages: All | $380 | 3 | ($8) | 1 | 20% | 1,413 | 2,817 | $805,482 | 6,326 | ($28,228) | 565 |
| Averages: Closest | $250 | 1 | $8 | 1 | 20% | 2,108 | 4,216 | $527,003 | 4,216 | ($42,160) | 843 |
| **Total Cost Savings Using Sealant Systems Over Transit Systems (using 2 closest averages)** | | | | | | | | **$484,842** | **5,059** | | |

Notes:
1. Failure rate is defined as not meeting a requirement, such as testing (testing is the basic vehicle referenced here to make that determination)
2. Values are approximations reflecting program experience, experimentation, etc.
3. Programs represents a per unit transit of 2" X 6"
4. Installation includes everything from the time the arrangement drawing is addressed to completion (planning cable routing, does not include testing)
5. The scale is applied to account for the difference with respect to the baseline size of 2" X 6", and the number of this scaled version as a percentage of overall on the ship
6. The above represents a very rough order of magnitude to determine just how much opportunity exists to using one technology over another.
7. Materials are in dollars, labor in hours.
8. Vendor estimates for cost differences is applied to the average scaled values
9. The closest program information is averaged to form one set of data
10. This data assumes the performance characteristics between the two methods is the same
11. It is assumed the soft sealant systems are given adequate time to cure
12. It is assumed the environmental conditions during installation and cure time are compatible with cure time requirements

# Qualification Chart: Advantages and Disadvantages Between Sealant Types and Systems

| | Block System | | Soft Sealant System | |
|---|---|---|---|---|
| | Advantage | Disadvantage | Advantage | Disadvantage |
| Cure Time | X | | | X |
| Planning Time | | X | X | |
| Repair Time | | X | X | |
| Damage Resilience | X | | | X |
| Install Time | | X | X | |
| Size | | X | X | |
| Future Revision | | X | X | |
| Sealant MSDS | X | | | X |
| Installation Messiness | X | | | X |
| Difficulty of Installation Due to Limited Access | | X | | X |

# Conclusions

- Sealant materials are a bit messy to use
- All inner components worked pretty well once totally cured, including fire matting material
- Long cure times may affect space preparation planning
- Pretty easy to cut and install another cable once cured
- Very impressive fire test results for all sealants
- These sealants are quite resilient and strong; could be used below the waterline/v-line

# Recommendations for Future Work

- Cost Data Estimates
  - Confirm sealant system qualification testing costs
  - Confirm ROI for sealants for a particular ship program
  - Numbers presented are considered ROMs
- Qualification Program
  - Sealant manufacturers should generate qualification programs and approach the NTWHs
- Universal Requirements
  - Requirements should be expanded, universal and allow for larger number of configurations
  - This will be driven in part on results of qualification testing

# Recommendations for Future Work (cont.)

- Product Effectiveness
  - Through testing cycles and life cycle assessment, determine the effectiveness of products over the application life cycle
  - Should be data in the commercial sector to do this
- Vendors should expand product capability
  - Quick cure components
  - Low smoke, low toxicity improvements
  - Maintain strength and flexibility

# Questions??

Thank you for your support and participation