Beyond Limits: Material Performance in Polar Regions

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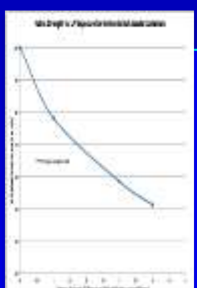
Talk Outline

1. Big Picture

- Why?
- Guidance
- ROI

2. Methods

- Actions
- Challenges
- Results



3. Conclusions

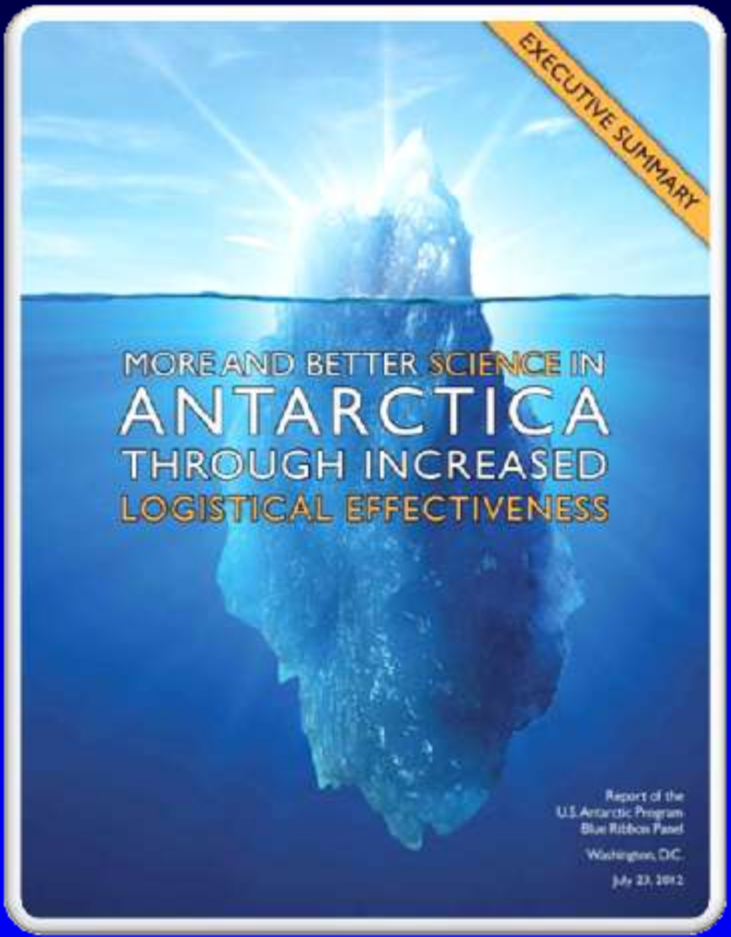
- Test Processes
- Material Advances

4. What's Next…

- Planned Test Development
- Field Applications

Big Picture: Why?

Big Picture: Guidance



RECOMMENDATIONS

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1. ANTARCTIC BASES.

2. POLAR OCEAN FLEET.

3. LOGISTICS AND TRANSPORTATION.

4. MCMURDO AND PALMER FACILITIES.

5. USAP CAPITAL BUDGET.

6. SCIENCE SUPPORT COSTS.

7. COMMUNICATIONS.

8. ENERGY EFFICIENCY.

9. INTERNATIONAL COOPERATION.

10. ANTARCTIC POLICY.

Big Picture Example: Efficiency = Payback (Return On Investment)

Methods: Understanding Material Limits & Defining Performance Parameters

Issue: High-performance materials have demonstrated superior efficiency in polar region applications, BUT their mechanical properties and behaviors are not well defined

Challenge: Identify, apply and adapt test standards to evaluate materials for polar service conditions

Goal: Understand performance parameters for these materials & present results in common language

Goal: Monitor material conditions & predict replacement cycles

Methods: Identify Meaningful Tests

Where Possible we Prefer Standard Test Guidelines

ASTM Tests Offer Flexibility to Refine Procedures and Parameters based on Environmental and Operational Needs

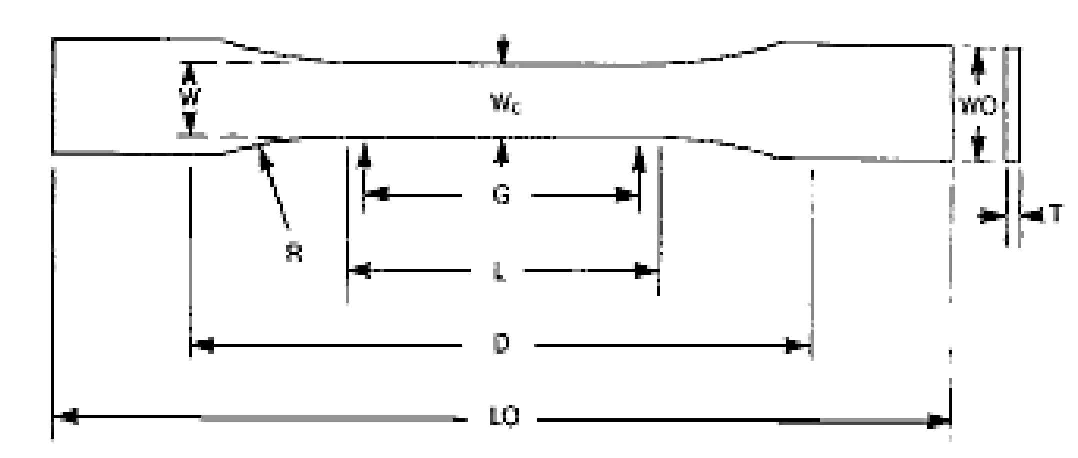
Library of Test Results for Future Decision Tools

Tests Implemented to Date:

- Tensile performance of plastics, woven & coated fabrics
- Dynamic flex tests of fabrics
- UV exposure of all materials

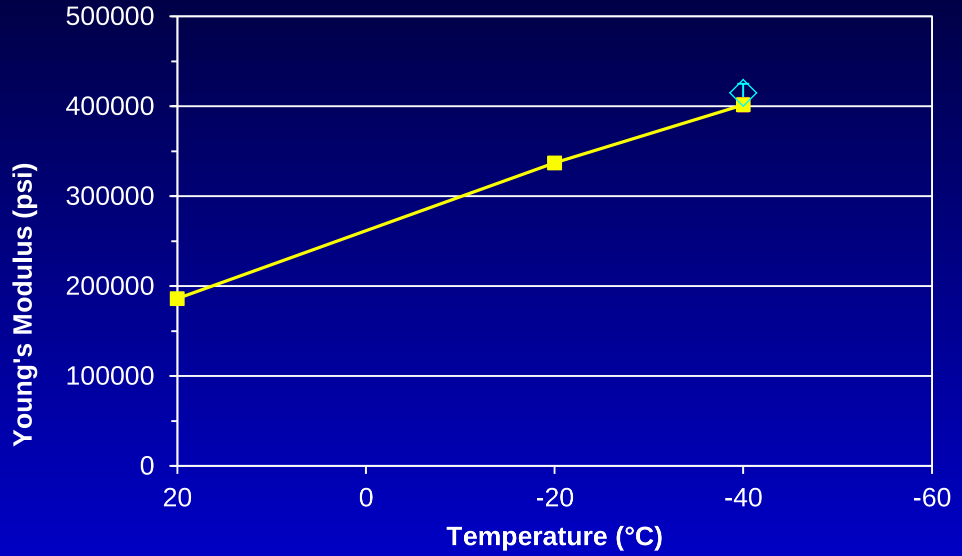
Method: Tensile Tests For Plastic

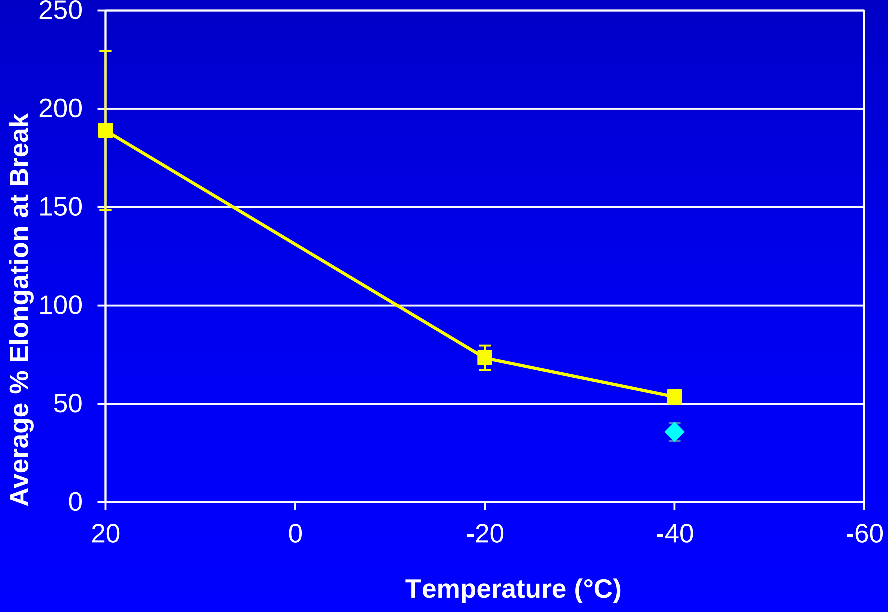
ASTM D638-10 Standard Test Method for Tensile Properties of Plastics



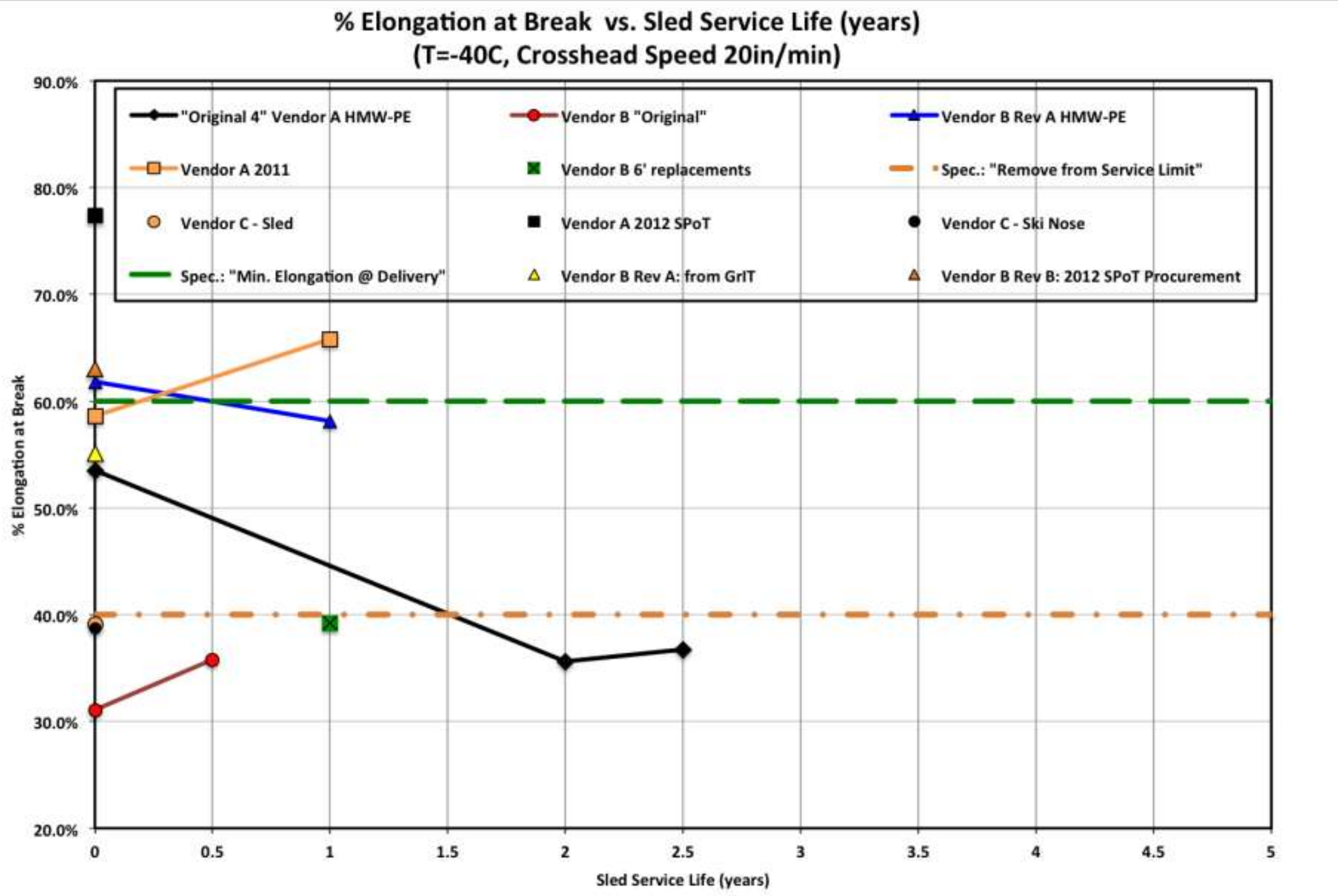
Type III Specimen Dimensions for a Sample between 0.28 and 0.55 Thick	
W–Width of narrow section	0.75
L–Length of narrow section	2.25
WO–Width overall, (nominal minimum)	1.13
LO–Length overall, (nominal minimum)	9.7
G–Gage length	2.00
D–Distance between grips	4.5
R–Radius of fillet	3.00

Results: Tensile Tests For HMW-PE



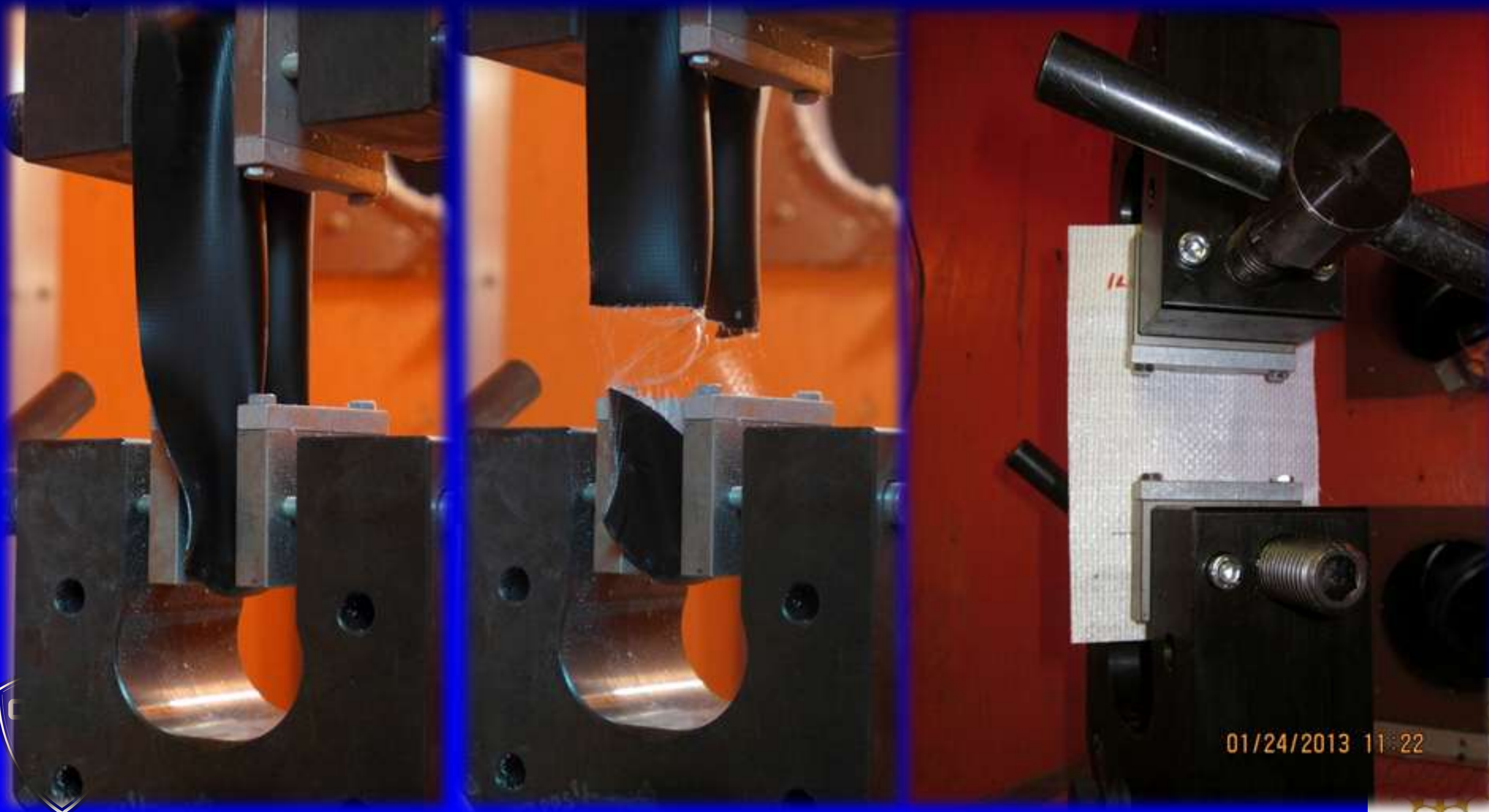


Results: Tensile Tests For Plastic



Method: Tensile Tests For Coated Fabrics

ASTM D751-06(2011) Standard Test Methods for Coated Fabrics



Method: Gelbo Flex Testing

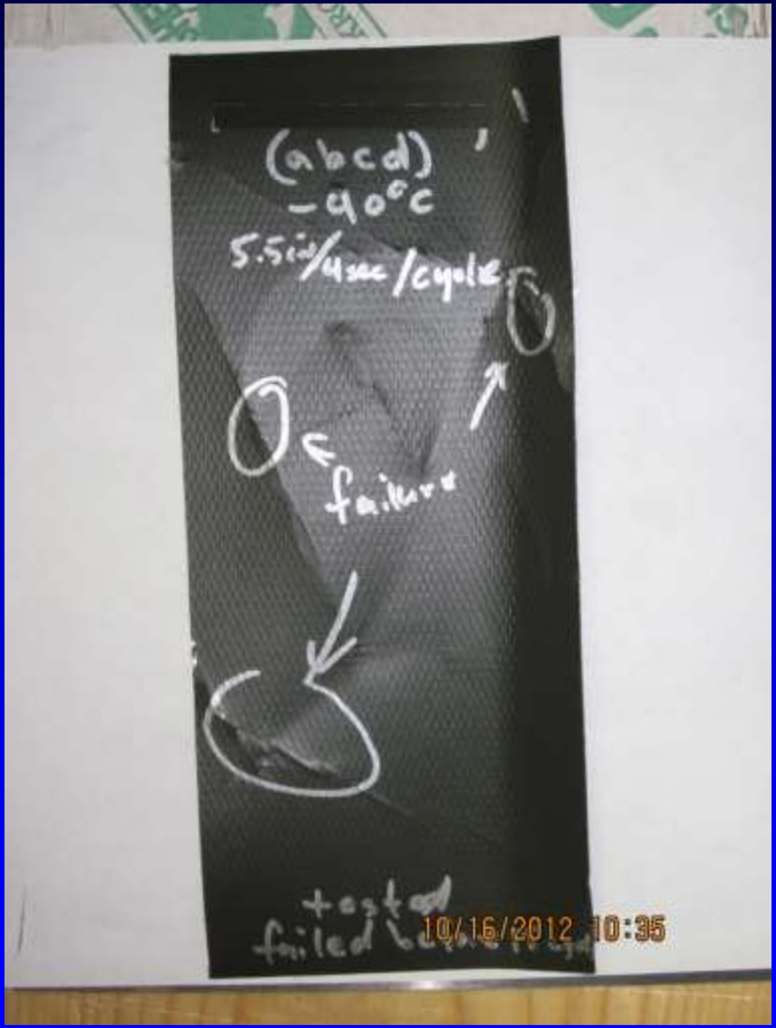
ASTM F392 Standard Test Method for Flex Durability of Flexible Barrier Materials

Method: Gelbo Flex Test, Challenges

Method: Gelbo Flex Testing, Adapted

ASTM F392 Standard Test Method for Flex Durability of Flexible Barrier Materials

Results: Gelbo Flex Tests



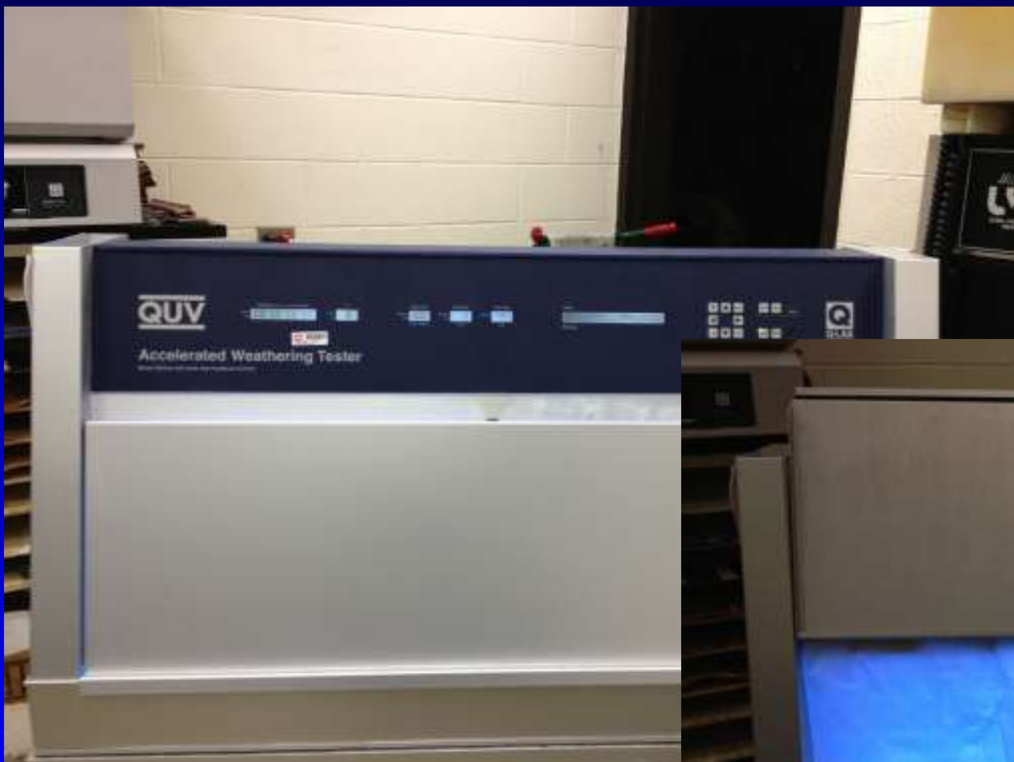
Method: Gelbo Might Seem Extreme…

… but this is what a fuel bladder sled can experience during a sudden stop

Method: Accelerated UV Exposure Tests

ASTM D4329 (05) Standard Practice for Fluorescent UV Exposure of Plastics

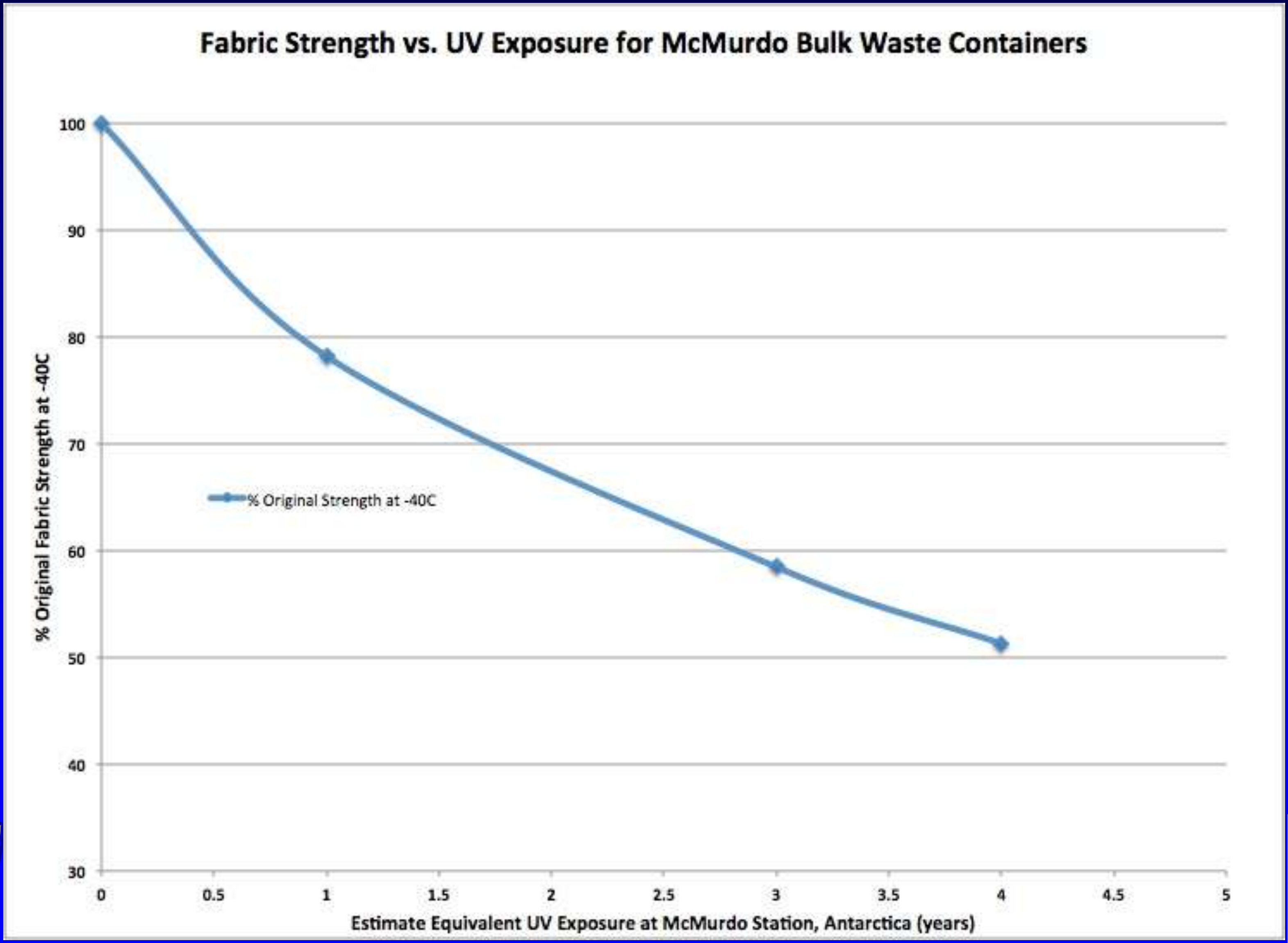
Estimate 1mo. In UV cabinet ~1yr. McMurdo exposure (~340-345nm)



Method: Tensile Tests After Accelerated UV Exposure Tests

1. ASTM D4851 (05) Standard Practice for Fluorescent UV Exposure of Plastics
2. ASTM F392 Standard Test Method for Flex Durability of Flexible Barrier Materials

Results: UV & Tensile Tests for Coated Fabrics



Conclusions

1. Tensile test method is best tool yet for defining HMW-PE properties

2. Combination of tensile, Gelbo and UV tests work best for composite fabrics

3. Site specific UV performance is critical – understand exposure conditions

4. Material performance specifications are critical (i.e. HMW-PE):
   a) -40C service temp & 20 in/min crosshead speed
   b) Critical limit of elongation at failure : 40%= lifecycle replacement
   c) Set target spec. at min. 60% elongation at failure for new materials

1. Work with vendors
   a) 2 competing HMW-PE vendors – both with new mix designs
   b) Many coated fabrics to choose from, many vendors

2. "Next Generation" sliding surfaces, pontoons, fuel bladders, etc. – most likely layered and/or composite/coated fabric systems
   a) These will need to be identified and winnowed through testing
   b) Develop quantifiable abrasion test methods
      a) Implement ASTM D3884 Standard Test Method for Abrasion Resistance of Textile Fabrics
      b) Follow those with our pressure test device

What's Next: Cargo Sled Technology

Advantages

- Existing fabric technology
- Pouch is structural & keeps out snow
- Easy to swap tubes
- 1/5 tare weight,1/4 cost
- 3 x payload efficiency

Pine Island Glacier (PIG) traverse

- ~ 1,700 mi x 4 sleds
- Great ride over sastrugi
- No abrasion problems
- No leaks

GrIT12-13

- Five 16' x 20' decks
- Outsized & heavy cargo
- No leaks

CRREL

What's Next: REALLY Big Picture

- A state-of-the-art sub-mm/THz telescope near peak of the Greenland ice sheet.
- Conduct mm-wave VLBI observations of the super-massive black hole at the center of M87 Galaxy.
- Also excellent for sub-mm and THz observing.
- First light and commissioning observations are planned for winter 2016/2017, with full science operations in 2017.