

Beyond Limits: Material Performance in Polar Regions



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Talk Outline



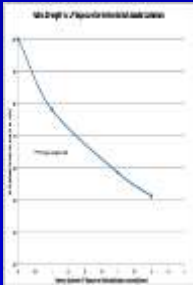
1. Big Picture

- Why?
- Guidance
- ROI



2. Methods

- Actions
- Challenges
- Results



3. Conclusions

- Test Processes
- Material Advances



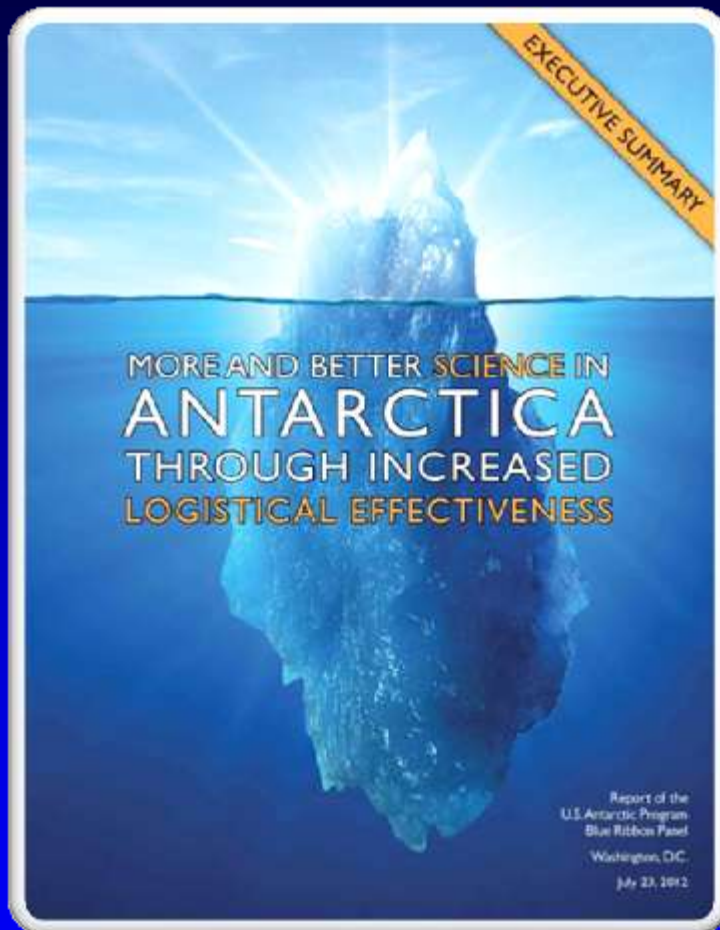
4. What's Next...

- Planned Test Development
- Field Applications

Big Picture: Why?



Big Picture: Guidance



RECOMMENDATIONS

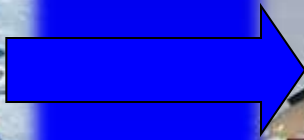
Below is a summary of the Panel's top ten overarching recommendations, in priority order, with brief illustrative examples of supporting actions. Please see the full report for supporting information.

1. **ANTARCTIC BASES.** Continue the use of McMurdo, South Pole, and Palmer Station as the primary U.S. scientific and logistical hubs on the continent. (There is no reasonable alternative, particularly concerning McMurdo.)
2. **POLAR OCEAN FLEET.** Restore the U.S. polar ocean fleet (destroyers, polar research vessels, icebreakers and smaller vessels) to support science, logistics, and national security in both polar regions over the long term. (Follow through on pending action in the President's FY 2013 Budget Request for the USCG to initiate the design of a new submarine.)
3. **LOGISTICS AND TRANSPORTATION.** Implement state-of-the-art logistics and transportation support as identified in this report to reduce costs and expand air- and sea-operational capability continent-wide and at the Southern Ocean. (Replace some DC-10 flights with additional narrow-body jets by automating the transfer and by constructing a shared capable runway at South Pole Station for C-17 use; reduce the LC-130 fleet.)
4. **MCMURDO AND PALMER FACILITIES.** Upgrade or replace, as warranted by an updated master plan, aging facilities at McMurdo and Palmer Stations, thereby reducing operating costs and increasing the efficiency of support provided to science projects. (Modify or replace the pier and reconstruct the boat ramp at Palmer Station; install fire suppression –with backup power– in un-protected berthing and key operational facilities; upgrade medical clinics; and improve dietary use to prevent the transmission of disease.)
5. **USAP CAPITAL BUDGET.** Establish a long-term facilities capital plan and budget for the USAP. (Provide phased plan for modernization of USAP facilities.)
6. **SCIENCE SUPPORT COSTS.** Further strengthen the process by which the fully burdened cost and technological readiness of research instrumentation and observing systems, as well as overall projects, are considered in the review and selection of science projects. (Increase overall awareness of the true cost of resources provided in Antarctica.)
7. **COMMUNICATIONS.** Modernize communication capabilities in Antarctica and the Southern Ocean to enable increased science output and reduced operational footprint. (Provide increased bandwidth on as well as to and from the continent.)
8. **ENERGY EFFICIENCY.** Increase energy efficiency and implement renewable energy technologies to reduce operational costs. (Provide additional wind turbine generators at McMurdo; better insulate selected buildings; and invest in technology for converting trash-to-energy and burning waste oil so that it does not have to be returned to the United States.)
9. **INTERNATIONAL COOPERATION.** Pursue additional opportunities for international cooperation in shared logistics support as well as scientific endeavors. (The existence of numerous national stations in the Peninsula region offers a particularly promising opportunity for an international supply system.)
10. **ANTARCTIC POLICY.** Review and revise as appropriate the existing documents governing Antarctic Policy. (Examine the Antarctic Treaty of 1959 and Presidential Decision Directive 25 of 1984 and implementing mechanisms for Antarctica, taking into account current realities and findings identified by the National Research Council report and the present report. Discuss on policy and national issues as opposed to operational matters.)

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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

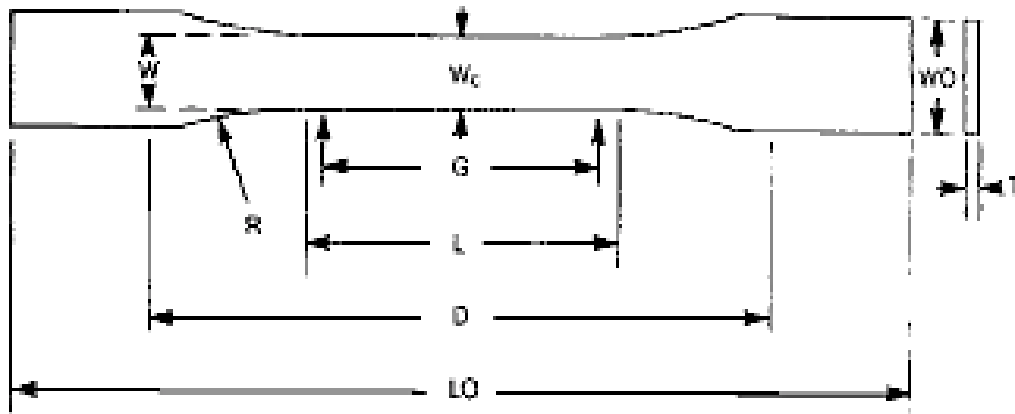
Tests Implemented to Date:

- 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

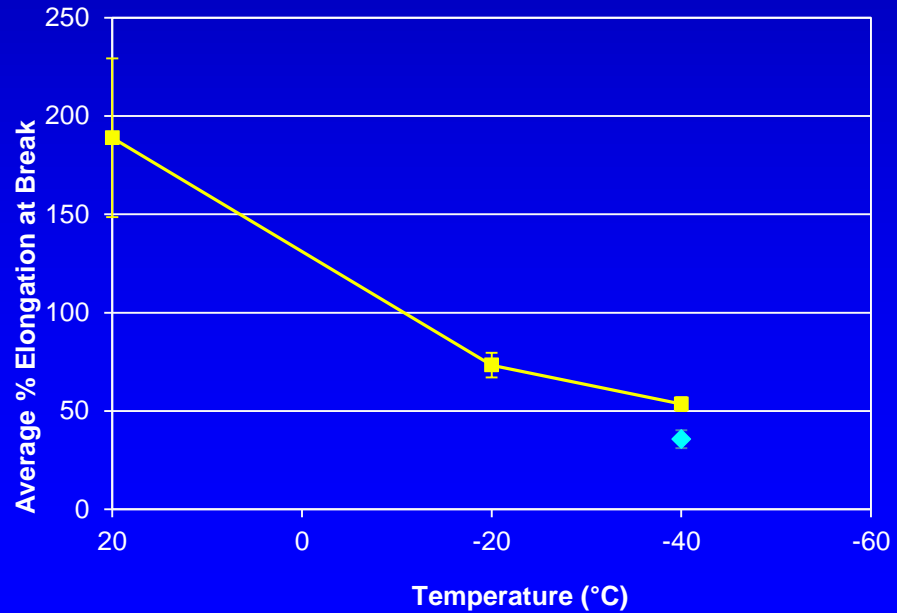
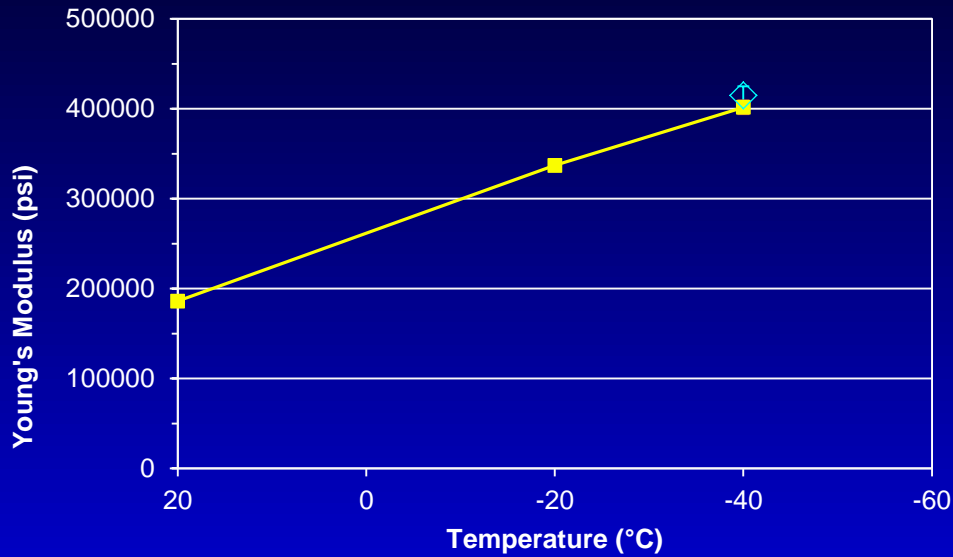


Type III Specimen Dimensions for a Sample between 0.28 and 0.55 Thick

W-Width of narrow section	0.75
L-Length of narrow section	2.25
W _O -Width overall, (nominal minimum)	1.13
L _O -Length overall, (nominal minimum)	9.7
G-Gage length	2.00
D-Distance between grips	4.5
R-Radius of fillet	3.00

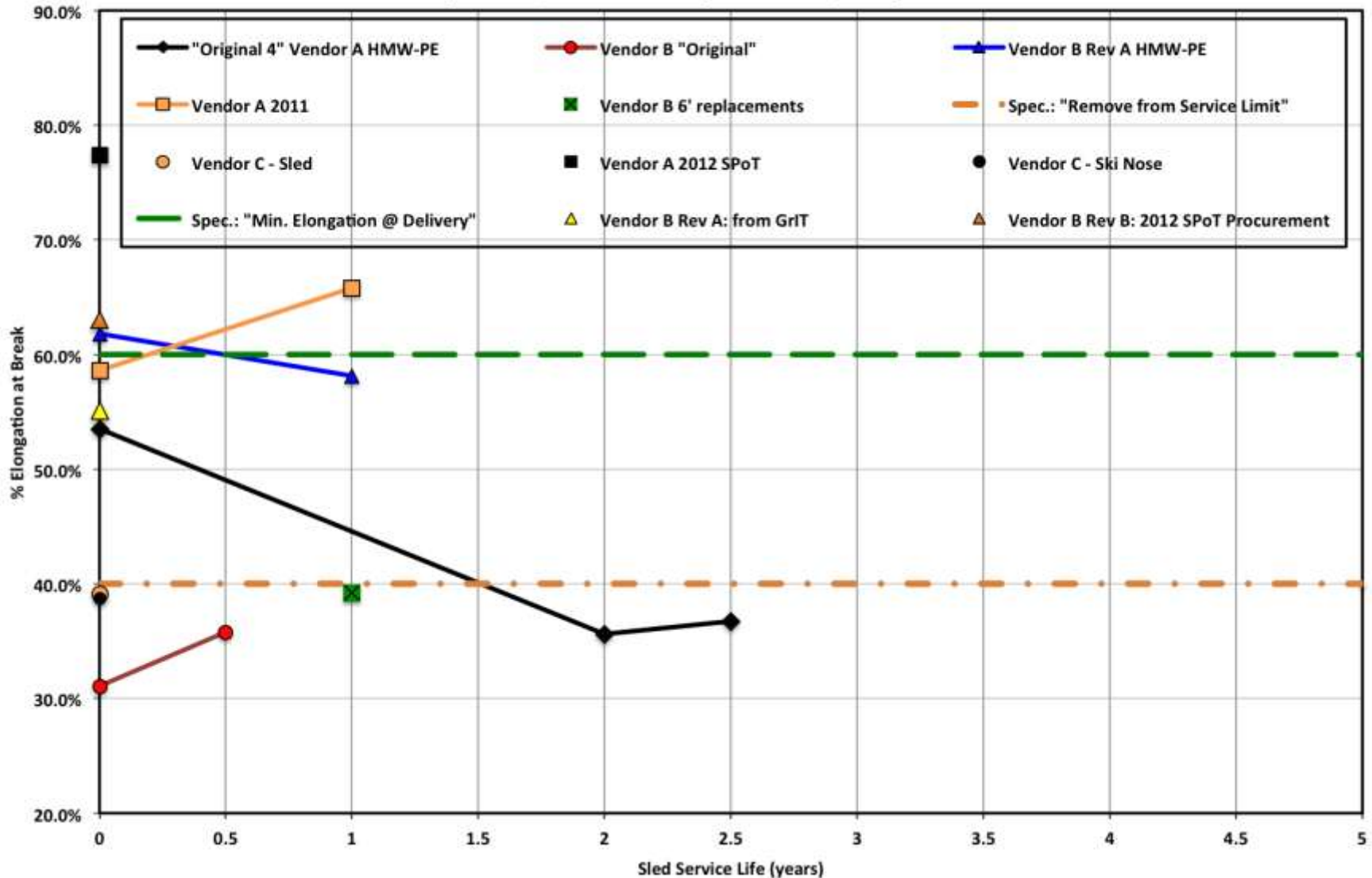


Results: Tensile Tests For HMW-PE



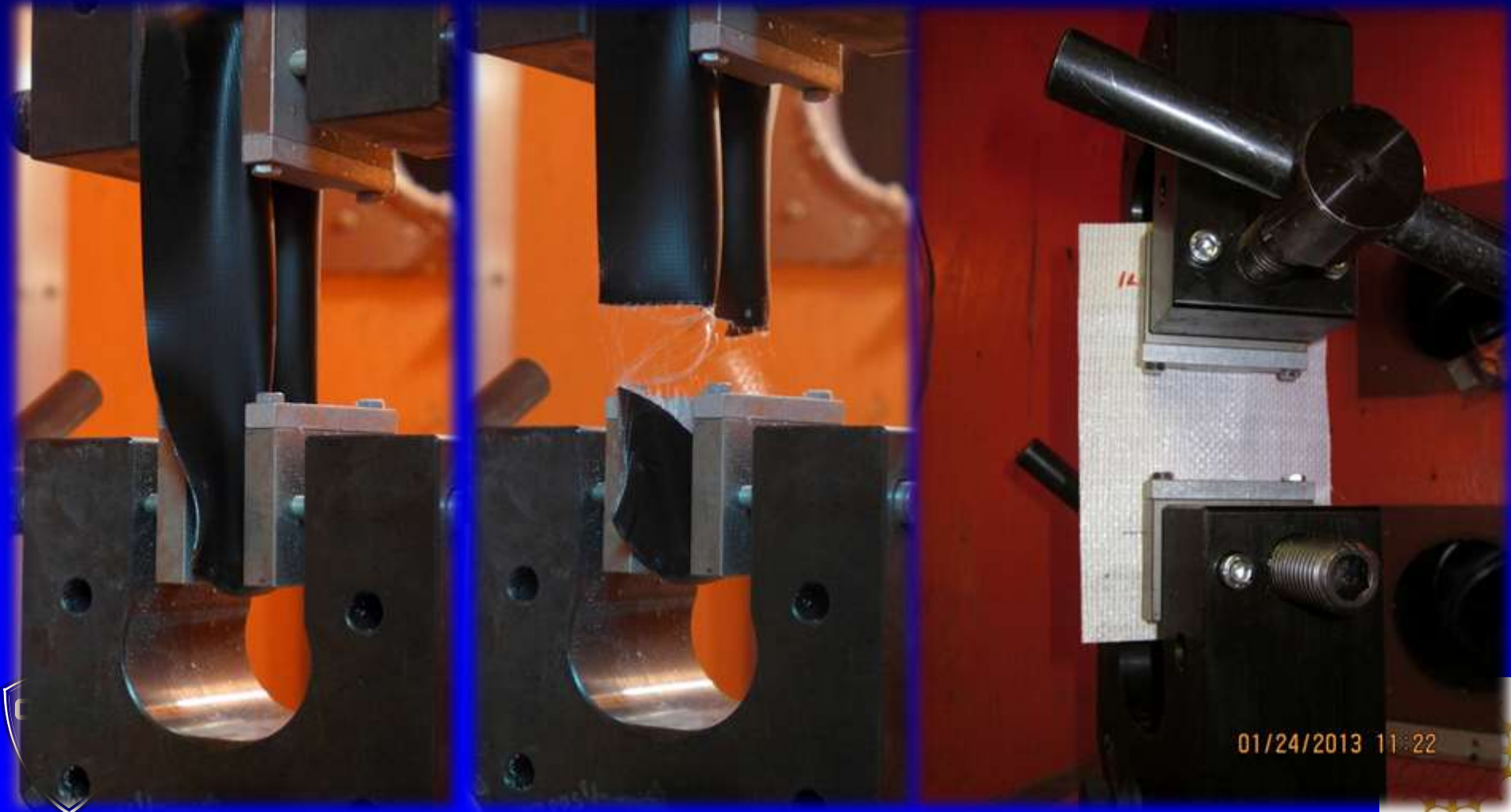
Results: Tensile Tests For Plastic

% Elongation at Break vs. Sled Service Life (years)
(T=-40C, Crosshead Speed 20in/min)



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

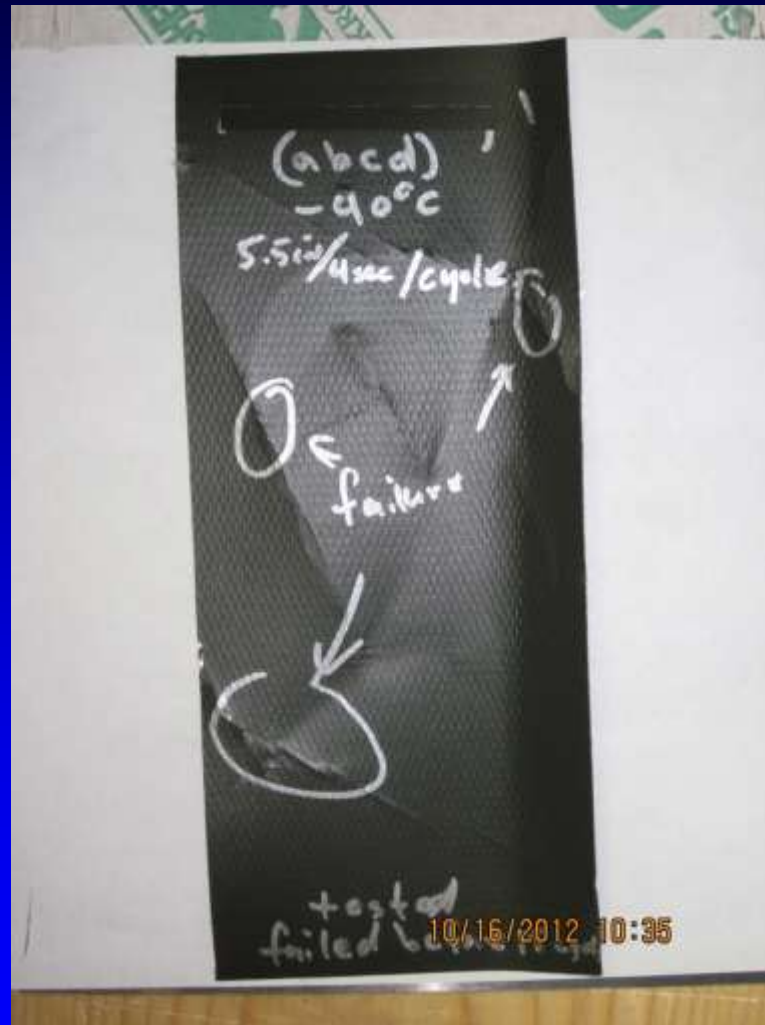


Method: Gelbo Flex Testing, Adapted

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)



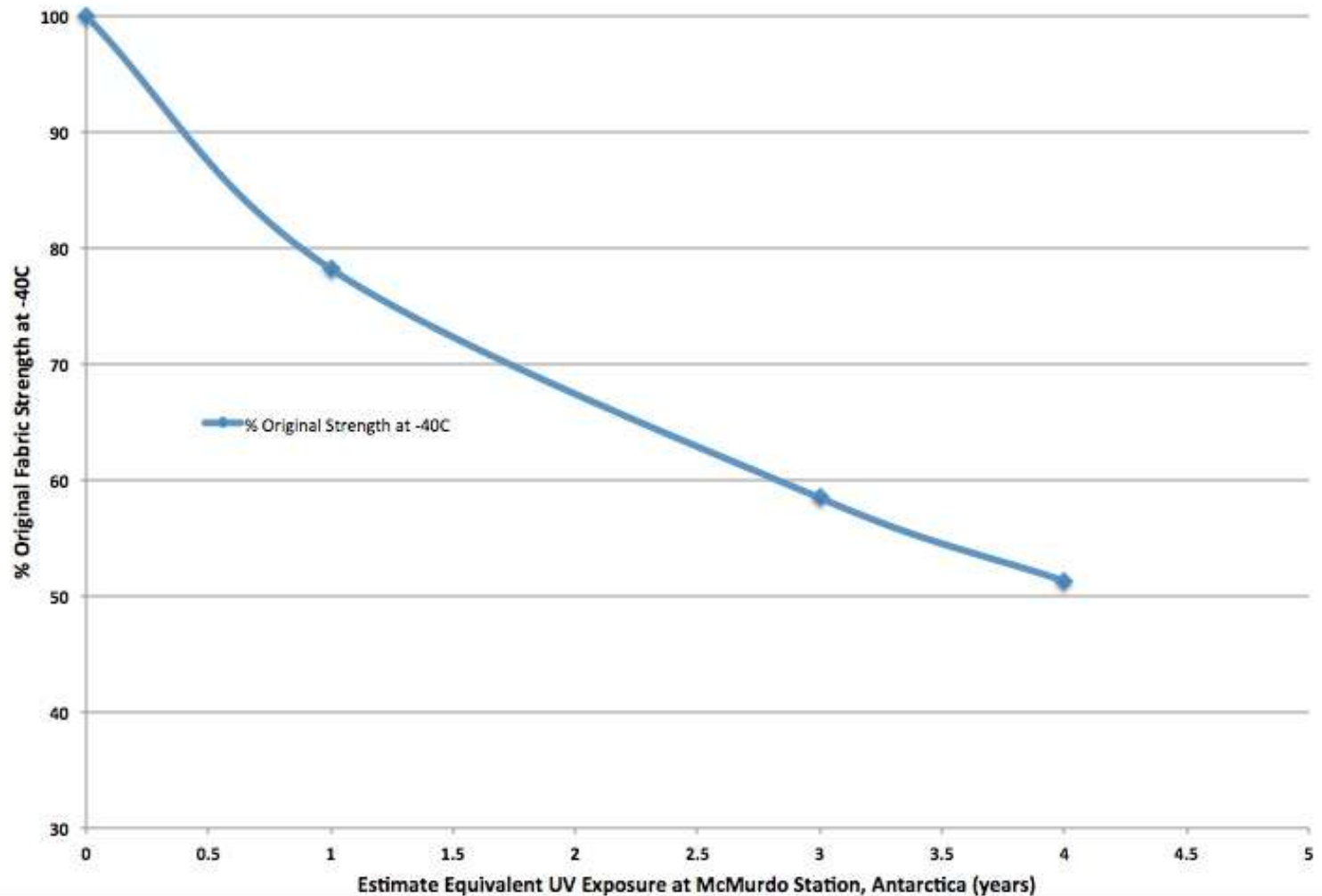
Method: Tensile Tests After Accelerated UV Exposure Tests

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

Fabric Strength vs. UV Exposure for McMurdo Bulk Waste Containers



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



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.

