Exit Presentation

Kate Melone

12/8/16
Overview

• About Me
  – Education
  – Hobbies and Interests
  – Past Experiences
• Projects
  – Radiated Materials Tensile Testing
  – Outgassing Testing for SHERLOC on Mars 2020 Rover
  – Z2 Support
  – LCVG Flush and Purge Console
• Lessons Learned
• Future Plans
• Acknowledgements
About Me

• Born and raised in Delaware
• I have a cat named Comet
• Dream car: Lamborghini
• Favorite TV Show: Leave It To Beaver
• Space Geek
  – Manned Space Exploration
  – Crew Systems, Orbital Mechanics, Aerodynamics, Propulsion
Education

• University of Maryland, College Park
  – Go Terps!

• Pursuing my B.S. in Aerospace Engineering
  – Concentration in Astronautics
Hobbies and Interests

• Sports
  – Basketball, football, hockey, baseball, soccer

• Music
  – Listening to music and going to concerts

• Family and Friends
  – Spending time with family and friends
Past Experiences: UMD Research and Conferences

• Undergraduate research
  – Analog space suit joint torque elbow testing
  – Development of analog spacesuits
  – Pneumatically powered EVA Glove

• Conferences and Papers
  – AIAA Region 1 Student Paper Conference (Spring 2014, planning to go Spring 2017)
  – AIAA Young Professionals, Students, and Education Conference (Fall 2014 and Fall 2015)
Past Experiences: JSC SK3
Summer 2014 Internship

EVA Glove Sensor Feasibility II Project

• **Goals:** Develop a method and list of sensors for measuring the glove environment acting on the fingers and hands inside the glove box

• **Importance:** Obtain data that can be correlated with astronaut injury reports

• **Accomplishments:** Analyzed extensive amounts of data and assisted in writing the EVA Glove Sensor Feasibility II Report
Past Experiences: JSC EC5
Summer 2015 Internship

RoboGlove Cycle Tester

- **Goals:** Test repeatability and endurance of Force Sensitive Resistors (FSRs)
- **Importance:** Determine whether or not FSRs will suffice for long term use
- **Accomplishments:** Successfully designed and built a cycle tester by the completion of my internship
Tensile Testing of Radiated Materials

- Objective: Tensile test radiated space suit materials
- Purpose: Compare pre/post radiation mass, max tensile load, and max tensile extension
Radiated Materials Tensile Testing

Orthofabric | Teflon | Vectran | Dacron

Spectra | Bladder Material | nGimat Coated Orthofabric | nGimat Coated Teflon | Polycarbonate
Radiated Materials Tensile Testing

• Conducted tensile testing of various radiated materials
  – Prepared samples for testing
  – Set up tests
  – Collected data
Radiated Materials Tensile Testing

- Assembled Test Reports
- Analyzed data and put together a test results summary of total mass loss (TML), fabric appearance, maximum/minimum max load, maximum/minimum max tensile extension
Radiated Materials Tensile Testing

Tensile Test Results Takeaways

- Control test mean tensile extension: 0.017 in, curve 3: maximum tensile extension.
- Range of max tensile extensions vary greatly, O-ring difference: 0.038 in.
- Extension: 0.017, 0.014, 0.012 in.
- Control: 0.017 in.
- Mass Tensile Extension: 0.017 in.

General Considerations:
- Radiation does have a significant effect on O-rings.
- Mass test significantly affected.
- Mass tensile extension was significantly affected, but slightly affected.

1. Teflon

- Mass Tensile Extension: 0.017 in.
- Key Values:
  - Mass Tensile Extension: 0.017 in.
  - Mass Tensile Extension: 0.017 in.
  - Mass Tensile Extension: 0.017 in.

2. Mass Change (Absolute Value)

<table>
<thead>
<tr>
<th>Mass Change (g)</th>
<th>Mass Change (g)</th>
<th>Mass Change (g)</th>
<th>Mass Change (g)</th>
<th>Mass Change (g)</th>
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<td>0.0027</td>
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<td>0.0066</td>
<td>0.0058</td>
<td>0.0005</td>
<td>0.0002</td>
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<tr>
<td>0.0035</td>
<td>0.0090</td>
<td>0.0035</td>
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<td>0.0015</td>
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</table>
## Radiated Materials Tensile Testing: Summary of Results

<table>
<thead>
<tr>
<th>Material</th>
<th>Mass Difference (g)</th>
<th>Average Max Load Baseline (lbf)</th>
<th>Average Max Load Radiated (lbf)</th>
<th>Average Max Tensile Extension Baseline (in)</th>
<th>Average Max Tensile Extension Radiated (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthofabric</td>
<td>.0053</td>
<td>335.9</td>
<td>343.4</td>
<td>.410</td>
<td>.238</td>
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<td>Teflon</td>
<td>.0053</td>
<td>30.6</td>
<td>24.1</td>
<td>3.76</td>
<td>2.01</td>
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<td>Vectran</td>
<td>.0055</td>
<td>464</td>
<td>241</td>
<td>.640</td>
<td>.444</td>
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<tr>
<td>Dacron</td>
<td>.0010</td>
<td>245</td>
<td>105</td>
<td>1.10</td>
<td>.476</td>
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<tr>
<td>Spectra</td>
<td>.0191</td>
<td>1363</td>
<td>1190</td>
<td>14.0</td>
<td>12.0</td>
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<tr>
<td>Bladder Material</td>
<td>.0032</td>
<td>117</td>
<td>100</td>
<td>.85</td>
<td>.50</td>
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<tr>
<td>nGimat Coated Orthofabric</td>
<td>.0061</td>
<td>304</td>
<td>379</td>
<td>1.18</td>
<td>.93</td>
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<td>nGimat Coated Teflon</td>
<td>.0006</td>
<td>67.1</td>
<td>51.8</td>
<td>3.32</td>
<td>2.25</td>
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<tr>
<td>Polycarbonate</td>
<td>.0034</td>
<td>1071</td>
<td>1079</td>
<td>.360</td>
<td>.325</td>
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Tensile Testing of Radiated Space Suit Materials

Outgassing Testing for SHERLOC on Mars 2020 Rover

Z2 Support

LCVG Flush and Purge Console
Outgassing Testing for SHERLOC on Mars 2020 Rover

• SHERLOC
  – Scanning Habitable Environments with Ramen and Luminescence for Organics and Chemicals
  – Will search for organic materials altered by water environments
• Space suit materials will be placed on the SHERLOC calibration target
Outgassing Testing for SHERLOC on Mars 2020 Rover

- Became familiar with and understood contents of the Goddard outgassing database
- Put together database summary of relevant materials
- Compared to NASA’s MAPTIS materials database
- Helped to determine additional testing would be required for some samples
Outgassing Testing for SHERLOC on Mars 2020 Rover

- Requirements: Must pass ASTM E595 standards
  - <1.0% Total Mass Loss (TML)
  - <.1% Collected Volatile Condensable Materials (CVCM)

<table>
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<tr>
<th>Pass</th>
<th>Fail</th>
<th>Unsure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthofabric</td>
<td>Bladder Material (&gt;1.0% TML)</td>
<td>Spectra</td>
</tr>
<tr>
<td>Polycarbonate</td>
<td>nGimat Coated Orthofabric</td>
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<tr>
<td>Teflon</td>
<td>nGimat Coated Teflon</td>
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<td>Vectran</td>
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<tr>
<td>Dacron</td>
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Outgassing Testing for SHERLOC on Mars 2020 Rover

• Requirements: Must pass ASTM E595 standards
  – <1.0% Total Mass Loss (TML)
  – <.1% Collected Volatile Condensable Materials (CVCM)

<table>
<thead>
<tr>
<th>Pass</th>
<th>Fail</th>
<th>Unsure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthofabric</td>
<td>Bladder Material (&gt;1.0% TML)</td>
<td></td>
</tr>
<tr>
<td>Polycarbonate</td>
<td>Spectra (.4% CVCM)</td>
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<tr>
<td>Teflon</td>
<td>nGimat Coated Orthofabric (1.2% TML)</td>
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<td>Vectran</td>
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<td></td>
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<tr>
<td>Dacron</td>
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<td></td>
</tr>
<tr>
<td>nGimat Coated Teflon</td>
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</tbody>
</table>
Tensile Testing of Radiated Space Suit Materials
Outgassing Testing for SHERLOC on Mars 2020 Rover
Z2 Support
LCVG Flush and Purge Console
Z2 Support: Pre Manned NBL Testing

- Assisted with preparing Corn Man
- Made a communication box mockup for the Corn Man test
Z2 Support: Pre-NBL Testing

• Assisted with preparing Z2 Processing Procedures
  – DIDB
  – MAG
• Assisted with preparing data scales
• Suit Fit Checks
Z2 Support: NBL Testing

• Weigh outs
  – Assisting as needed with keeping track of weight pack adjustments

• Contact Points
  – Recording contact points during testing
  – Developing standardized system/guidelines
  – Interpreting contact points results

• NBL Data
  – Organizing and combining data into one spreadsheet
Z2 NBL Support: Contact Points Analysis
Tensile Testing of Radiated Space Suit Materials

Outgassing Testing for SHERLOC on Mars 2020 Rover

Z2 Support

LCVG Flush and Purge Console
LCVG Modified Flush and Purge Console

• Objective:
  – Design an LCVG Flush and Purge Console

• Requirements:
  – Must be able to flush and purge the LCVG
  – Must be able to structurally test the LCVG
  – Must have access to both air and water
  – Must be as small as possible
  – ~$2000 budget

• Importance:
  – Ability to test at higher pressures
  – B34 location
LCVG Modified Flush and Purge Console

• Preparation
  – Became familiar with pressure system components
  – Pressure Systems Design Course
  – Reference previous LCVG Flush and Purge Console Design
LCVG Modified Flush and Purge Console

Breathing Air @ MAWP 30 psig

Breathing Air @ MAWP 200 psig

Water @ MAWP 60 psig

Breathing Air Source @ Maximum MAWP 200 psig
LCVG Modified Flush and Purge Console: Structure Test

Breathing Air @ MAWP 30 psig

Breathing Air @ MAWP 200 psig

Breathing Air Source @ Maximum MAWP 200 psig

Air

Water

Water @ MAWP 60 psig

Notes:
1. System fluid is compressed air or water at room temperature (10 degrees Fahrenheit).
2. System pressure is 30 psi for the air side, and 60 psi for the water side.
3. System is equipped with high-capacity filter for air and water.
4. System is equipped with filter for air and water.
5. System is equipped with filter for air and water.
6. System is equipped with filter for air and water.
7. System is equipped with filter for air and water.

LIQUID SYSTEM OF THE MODIFIED FLUSH AND PURGE CONSOLE

VALIDATED BY:

[Signature]

[Date]

LIQUID SYSTEM OF THE MODIFIED FLUSH AND PURGE CONSOLE

[Signature]

[Date]
LCVG Modified Flush and Purge Console: Purging LCVG

Water @ MAWP 60 psig

Breathing Air @ MAWP 30 psig

Breathing Air Source @ Maximum MAWP 200 psig

Air

Water
<table>
<thead>
<tr>
<th>Ref // Model</th>
<th>Manufacturer</th>
<th>Item Description</th>
<th>Manufacturer Part #</th>
<th>Internal Part #</th>
<th>Notes</th>
<th>Qualifications</th>
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<tr>
<td>30-FP-31</td>
<td>Andrew Brush Company</td>
<td>Shut Off Valve</td>
<td>36652X24</td>
<td>200 psi @ 90°F</td>
<td>TA x 1 1/4 Pipes 10,000</td>
<td>Brass, Polytrole, Stainless Steel, 316, Male</td>
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<tr>
<td>FG-FF-09</td>
<td>Andrew Brush Company</td>
<td>Pressure Gauge (0-300 psi)</td>
<td>60063X82</td>
<td>NA</td>
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<td>FOR Pipe, Brass, Stainless Steel, 316, Male,</td>
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<tr>
<td>PSLP-25</td>
<td>Swagelok</td>
<td>Pressure Regulator (Air)</td>
<td>KLPBFM4X11X05G000</td>
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<td>TA x 1 1/4 Pipes 10,000, Brass</td>
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<td>RVFLP-04</td>
<td>Quick Seal</td>
<td>Relief Valve (Air)</td>
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<td>CVFLP-05</td>
<td>Coats &amp; Clark</td>
<td>Check Valve</td>
<td>4768624</td>
<td>240 psi</td>
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<td>Relief Valve (Air)</td>
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<td>120°</td>
<td>TA x 1 1/4 Pipes 10,000</td>
<td>Brass, Polytrole, Stainless Steel, 316, Male,</td>
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<tr>
<td>GFLP-05</td>
<td>Quick Seal</td>
<td>Relief Valve (Air)</td>
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<td>120°</td>
<td>TA x 1 1/4 Pipes 10,000</td>
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<td>PSLP-10</td>
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<td>60 psi</td>
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<td>NWF-11</td>
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<td>Needle Valve</td>
<td>44683X10</td>
<td>2000 psi @ 40°F</td>
<td>TA x 1 1/4 Pipes 10,000, Brass, Polytrole</td>
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<td>TSNL-12</td>
<td>Dan Moring</td>
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<td>PFP-14</td>
<td>Andrew Brush Company</td>
<td>Pressure Gauge</td>
<td>8911-PUL-004-10A</td>
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<td>60°</td>
<td>Polyethylene plastic, 38°F, temperature limit 20°C</td>
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<tr>
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<td>Needle Valve</td>
<td>TL46035G</td>
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<td>FLP-16</td>
<td>General Electric</td>
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<td>60063X82</td>
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<td>GDLA-F-03</td>
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<td>Relief Valve (Air)</td>
<td>NS42D0006</td>
<td>120°</td>
<td>TA x 1 1/4 Pipes 10,000</td>
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<td>TFLA-24</td>
<td>Quick Seal</td>
<td>Needle Valve</td>
<td>TL46035G</td>
<td>1600 psi</td>
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</tbody>
</table>
LCVG Modified Flush and Purge Console: RV Calculation

Pressure Regulator

- \( Q = C_v \times \frac{816 \times P_1}{\sqrt{S.G. \times T}} \)
- \( Q = 0.02 \times \frac{816 \times 214.7}{\sqrt{1 \times 530}} \)
- \( Q = 153 \; SCFH = 2.5 \; SCFM \)
LCVG Modified Flush and Purge Console: Approval Process

Hazard Analysis for the Liquid Cooling Ventilation Garment (LCVG) Modified Flush and Purge Console

Crew and Thermal Systems Division Systems Test Branch

November 21, 2016
Revision: Basic

Verifying this is the correct version before use.

1876 Form
366S Form
366C Form
Hazard Analysis
LCVG Modified Flush and Purge Console: Status

- ✔ Preliminary Research/Preparation
- ✔ Design Sketches
- ✔ Technical Drawing
- ✔ Bill of Materials/ Determining Components (Calculations)
- ✔ Required Forms (1876, 366S, 366C)
- ✔ Hazard Analysis
- ✔ Pressure Systems Approval
- ☐ Order Components and Assemble
- ☐ Test/Inspect/Final Approval
Lessons Learned

• Data can be confusing at times
  – Example: Material appeared to be stronger after radiation
• A lot goes into the formal design process
  – Design review, forms, Hazard Analysis, inspection, etc.
• Understanding specifications
  – AN vs NPT
  – Tube vs Pipe
• Learning about pressure system components
  – In addition to pressure ratings, need to consider size and flow rates
Skills Acquired

• Tensile Testing
  – Prepare materials and setting up the tensile tests
  – Collect and interpret (messy) data

• Outgassing Testing
  – Understand TML and CVCM
  – Collaboration with other NASA centers

• Z2 Support
  – Hands on building mockups of components
  – Analyze data
  – Work with others; understanding what both parties need in order to make a run successful

• LCVG Flush and Purge Console
  – Both formal design and design review process
  – How to determine which components to use; flow calculations, pressure ratings, size, etc.
  – Hazard Analysis
  – How to make design tradeoffs
Future Plans

2017
- Spring: UMD
- Summer: CM4 Co-op
- Fall: UMD

2018
- Spring-Summer: Co-op
- August: Class and Graduate with B.S. in Aerospace Engineering
- Fall: UMD for M.S. in Aerospace Engineering

2019
- Spring: UMD for M.S. in Aerospace Engineering
- Summer: UMD and finish M.S. in Aerospace Engineering
- Fall: Grad co-op/Starting Ph.D.
Acknowledgements

- Kris Larson
- Amy Ross
- Richard Rhodes
- Raul Blanco
- Teresa Shurtz
- Ian Meginnis
- Ben Peters
- Steve Anderson
- John Harris
- Pete Meeh

- Kevin Groneman
- Nate Smith
- John Hollis
- Joe Settles
- April Smith
- Jonathan Abary
- Amber Tucker
- Everyone in EC5
- All the co-ops and interns in EC5 (Chad, Kelly, Sarosh)
Questions?