HR2 Development - Status and Plan

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Introduction

- HR2 Goal: Define a robust method to determine peak and total heat release that improves repeatability and reproducibility when compared with OSU

Status

- NASA Technical Readiness Level (TRL) model adopted
- TRL 4 - Robustness completed - DOE defined key parameters and variation
  - Identification of key parameter influence levels
  - Reduced variation in Calibration Factors
  - Improved uniformity of Stability Runs
- HR2 is in TRL phase 5 - Repeatability

Note: Specific improvement target not been agreed to in prior breakout sessions
## HR2 Development TRLs & Gates

<table>
<thead>
<tr>
<th>TRL 5 - <em>Repeatability</em></th>
<th>variation in measurements taken on the same item under the same conditions. Homogenous coupon tested multiple times using one unit.</th>
<th>Gate 5 / Enter TRL 6: Coefficient of Variation (CoV) improvement vs. OSU</th>
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</thead>
<tbody>
<tr>
<td>TRL 6 - <em>Reproducibility</em></td>
<td>variation in measurements taken on the same items under the same conditions using different machines.</td>
<td>Gate 6 / Enter TRL 7: Individual coupon type CoV and ANOVA evaluation</td>
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<td>TRL 7 - <em>Range</em></td>
<td>Finalized prototype equipment demonstration on range of production configurations. HR2 pass/fail criteria (peak/total) established.</td>
<td>Gate 7 / Enter TRL 8: Consistent results over a range of sample types</td>
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<td>TRL 8 - <em>Guidance</em></td>
<td>drawings release, equipment built to standards, ‘qualified’ through test and demonstration.</td>
<td>Gate 8 / Enter TRL9: Qualification criteria and test guidance established</td>
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<td>TRL 9 - <em>Round Robin</em></td>
<td>Multiple production units verified by successful round robin testing.</td>
<td>Gate 9 / Production Readiness: Significant R&amp;R improvements vs. OSU</td>
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</tbody>
</table>
TRL 5 Test Plan

30 randomized samples of 3 homogenous coupon types

1. 0.060” Al panel with 3M 950 transfer tape - provided by Boeing
2. Standard laminate panel - provided by Schneller
3. Honeycomb panel with decorative (dec) - provided by Boeing

Two test locations - two instruments

- Marlin Engineering OSU baseline - tested August 15 - 18th at Boeing, Everett, WA
- Marlin Engineering HR2 - tested September 11 - 14th at FAA TC, Egg Harbor Twp, NJ

Repeatability evaluated using the coefficient of variation (CoV = \( \frac{\sigma}{\mu} \))

- Anticipated CoV improvement versus OSU baseline - no exact target defined
No significant repeatability improvement versus OSU CoV baseline

Statistical analysis indicates that HR2 variation is equivalent to that of OSU
HR2 Changes Prior to TRL 5 Retest

Equipment and Process Changes to Improve Repeatability

- Active supply voltage control and monitoring
- Active globar voltage and current monitoring
- Verified mass flow controller calibration
- Daily calibration prior to testing
- Standard coupon preparation process
- Standard operating process and intervals
- Investigating calibration factor adjustment for thermal response time
TRL 5 Retest Plan

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Repeatability evaluated using the coefficient of variation (CoV = $\sigma/\mu$)

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## Next Steps

<table>
<thead>
<tr>
<th>Anticipated Schedule</th>
<th>Date</th>
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<tbody>
<tr>
<td>Mass flow controller calibration</td>
<td>Complete</td>
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<tr>
<td>Define standard coupon preparation process</td>
<td>March 2019</td>
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<tr>
<td>Define standard operating process and intervals</td>
<td>March 2019</td>
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<tr>
<td>Implement voltage control and monitoring</td>
<td>April 2019</td>
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<tr>
<td>Implement globar voltage and current monitoring</td>
<td>April 2019</td>
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<tr>
<td>Coupon preparation and fabrication</td>
<td>April 2019</td>
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<tr>
<td>Conduct TRL 5 retesting</td>
<td>May 2019</td>
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<td>Data analysis</td>
<td>June 2019</td>
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<td>Presentation of findings</td>
<td>June 2019</td>
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