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

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HR2 Development TRLs & Gates

TRL 5 - *Repeatability* - variation in measurements taken on the same item under the same conditions. Homogenous coupon tested multiple times using one unit.

➡ Gate 5 / Enter **TRL 6**: Coefficient of Variation (CoV) improvement vs. OSU

TRL 6 - *Reproducibility* - variation in measurements taken on the same items under the same conditions using different machines.

➡ Gate 6 / Enter **TRL 7**: Individual coupon type CoV and ANOVA evaluation

TRL 7 - *Range* - Finalized prototype equipment demonstration on range of production configurations. HR2 pass/fail criteria (peak/total) established.

➡ Gate 7 / Enter **TRL 8**: Consistent results over a range of sample types

TRL 8 - *Guidance* - drawings release, equipment built to standards, 'qualified' through test and demonstration.

➡ Gate 8 / Enter **TRL9**: Qualification criteria and test guidance established

TRL 9 - *Round Robin* - Multiple production units verified by successful round robin testing.

➡ Gate 9 / **Production Readiness**: Significant R&R improvements vs. OSU

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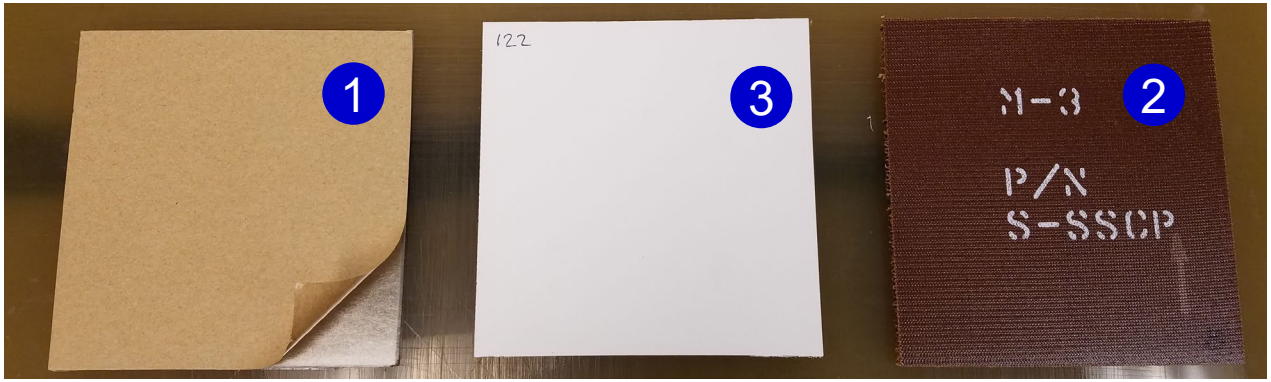
TRL 5 Test Plan

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 = σ/μ)

- Anticipated CoV improvement versus OSU baseline - no exact target defined

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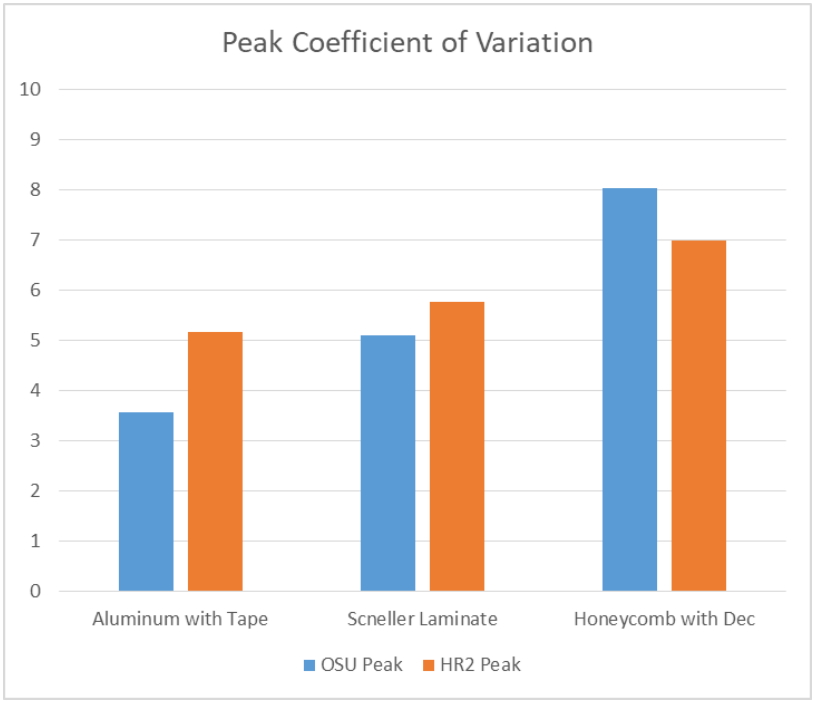
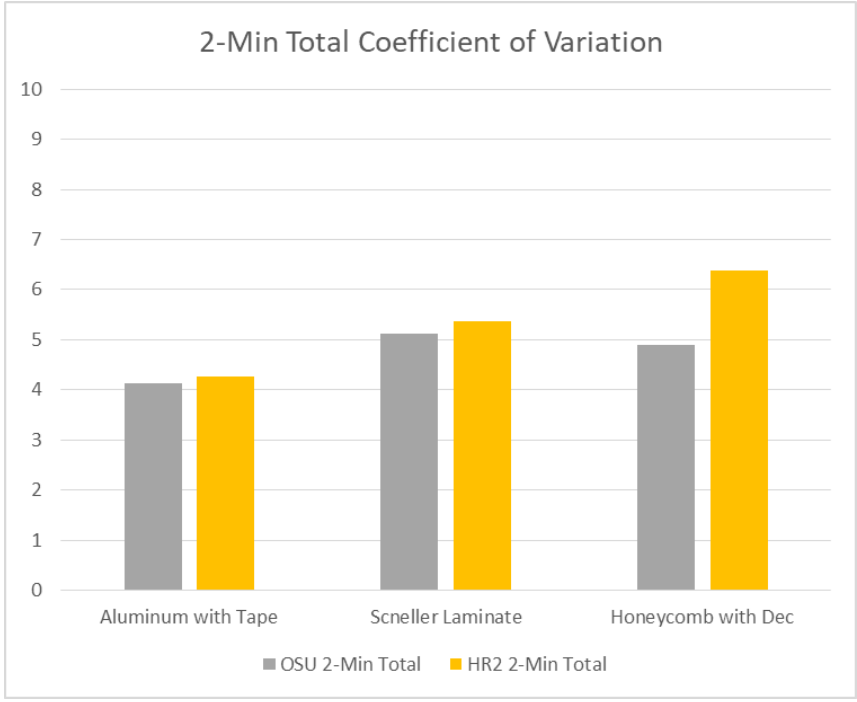
TRL 5 Test Data - Summary

	Coefficient of Variation (CoV) (%)			
	Peak		*2-Min Total*	
Coupon Type	OSU	HR2	OSU	HR2
Aluminum with Tape	3.58	5.18	4.14	4.27
Scneller Laminate	5.10	5.77	5.12	5.36
Honeycomb with Dec	8.05	6.99	4.89	6.38
Empty Sample Holder	12.2	9.86	38.4	26.2





- No significant repeatability improvement versus OSU CoV baseline
- Statistical analysis indicates that HR2 variation is equivalent to that of OSU

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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

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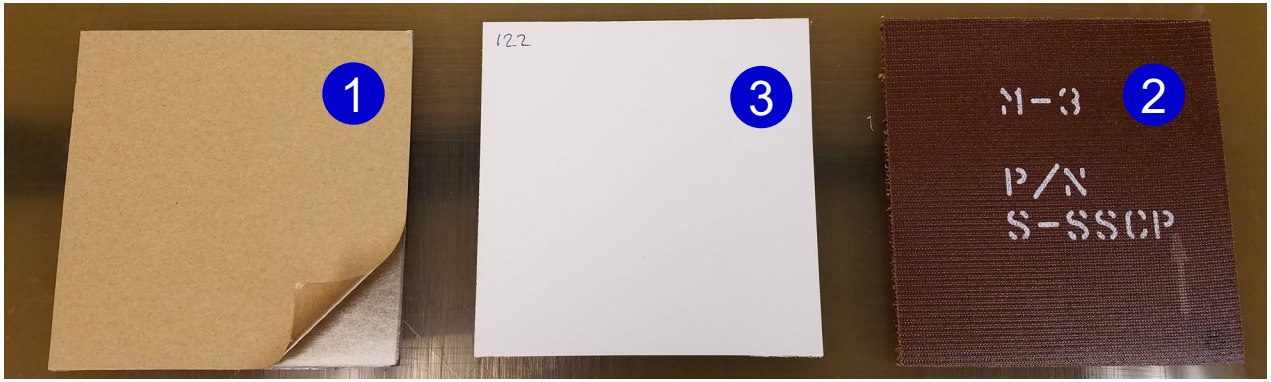

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Next Steps

Anticipated Schedule

Mass flow controller calibration	Complete
Define standard coupon preparation process	March 2019
Define standard operating process and intervals	March 2019
Implement voltage control and monitoring	April 2019
Implement globar voltage and current monitoring	April 2019
Coupon preparation and fabrication	April 2019
Conduct TRL 5 retesting	May 2019
Data analysis	June 2019
Presentation of findings	June 2019

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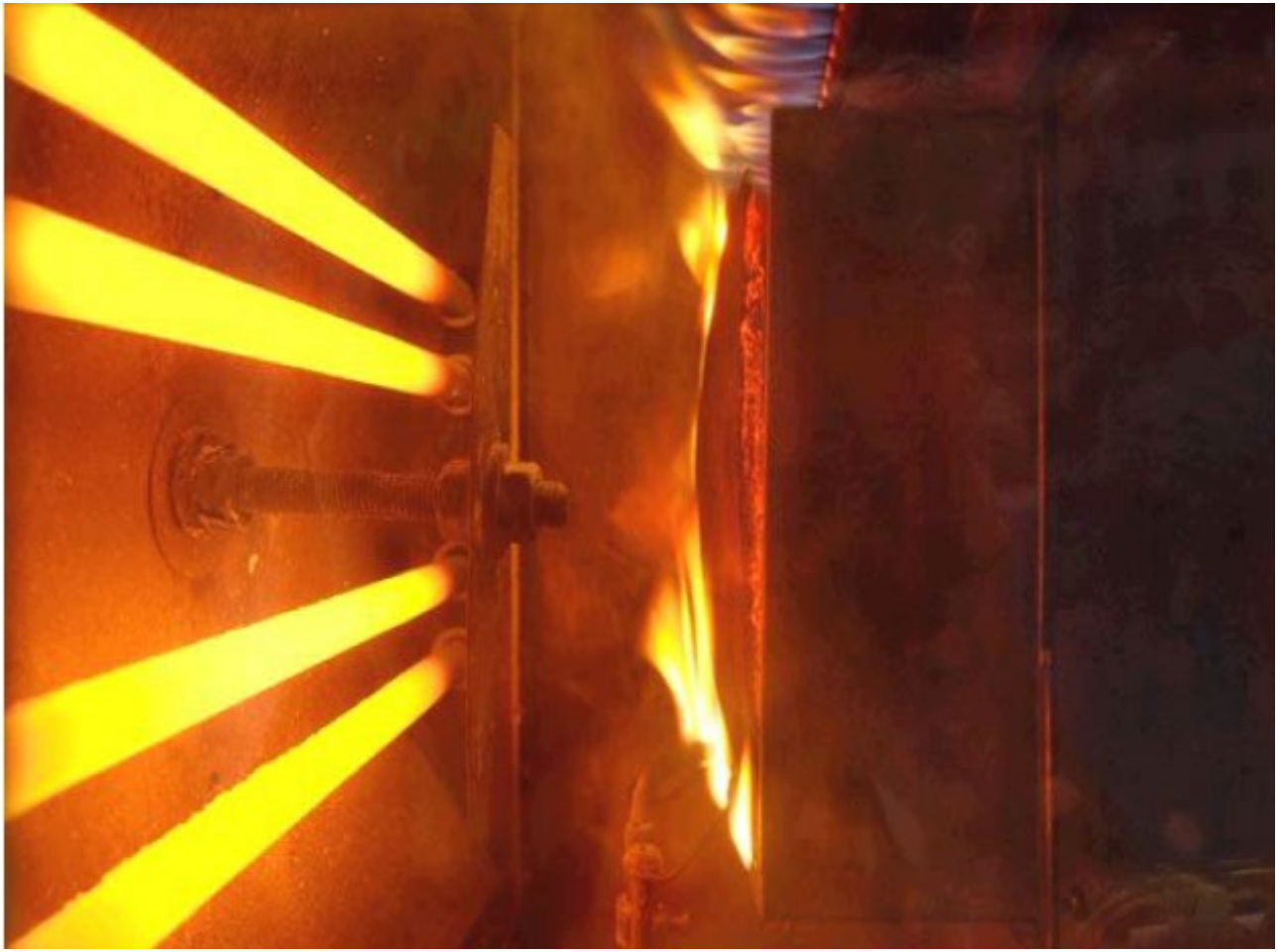
Questions?



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