



# HR2 Development Model and Plan

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# Introduction

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

## Status

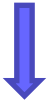


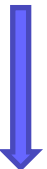
- Technical Readiness Level (TRL) model adopted
- HR2 has achieved TRL 4 and is now in TRL 5

## Need

- Clarify definition and gate criteria for future TRL levels

# Developmental Project Technical Readiness

## Flammability Test Method/Equipment TRLs (Derived from NASA TRL)

<b>MATURITY LEVEL</b> <b>Discovery</b>  <b>Feasibility</b>  <b>Practicality</b>  <b>Applicability</b>  <b>Production Readiness</b>	TRL 1	Basic principles/concept of test equipment and procedure defined.
	TRL 2	Test method concept formulated and defined by draft standards.
	TRL 3	Analytical and experimental critical function and/or characteristic proof-of concept (e.g. by modifying old/existing equipment)
	TRL 4	New prototype equipment validation in laboratory environment (robustness)
	TRL 5	Updated prototype equipment validation in relevant production environment (repeatability). Documented test guidance framework.
	TRL 6	Multiple prototypes validation in relevant environment (reproducibility)
	TRL 7	Finalized prototype equipment demonstration on range of production configurations. Documented test guidance defined.
	TRL 8	Final test equipment drawings released, equipment built to the standards, and “qualified” through test and demonstration. Documented test guidance finalized.
	TRL 9	Multiple production units verified by successful round robin testing.

*\*Originally presented by M. Anglin 10/2014*

# 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 (CV) 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 CV 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

# Situation

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## HR2 Development

- HR2 is now in TRL 5 - Repeatability
- Testing will be conducted in 2018 using 3 homogenous coupon types
  - Aluminum tape
  - Undecorated standard laminate panel
  - Decorated standard laminate panel
- Repeatability will be evaluated using the Coefficient of Variation
- Baseline data will be generated on a reference OSU for comparison

# TRL 5 to TRL 6

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*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 (CV) improvement vs. OSU

- 3 coupons types, 30 samples each. Coupons types chosen to reduce variability driven by coupon material and manufacturing in an attempt to isolate and characterize the machine variability.
- Criteria to be defined and evaluated relative to OSU coupon CV and be consistent with our stated goal of improving repeatability when compared to the OSU results.

## **What is CV?**

The coefficient of variation (CV) is a measure of relative variability.

It is the ratio of the standard deviation to the mean (average).

$$CV = \sigma / \mu * 100\%$$

$\sigma$  = standard deviation

$\mu$  = mean

The coefficient of variation (CV) is used to compare measurement variability in different populations.

# TRL 6 to TRL 7

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

- Gate 6 / Enter TRL 7: Individual CV and ANOVA analysis
  - Coefficient of Variation (mean / std dev) evaluated for each coupon type tested on each HR2 instrument independently - similar to TRL 5
  - Analysis of Variance (One-Way ANOVA) - one factor design addresses the question:

Does the instrument used affect the mean peak or total heat release for each coupon type?

- Two instruments minimum (FAATC Marlin, FAATC Deatak)
- 3 coupon types (recommend same type used in TRL 5 - to be discussed)
- Number of coupons per instrument (10 - 20 - 30) - sensitivity vs. margin of error

# TRL 7 to TRL 8

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*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
  - Demonstrated ability to test a range of coupon materials and configurations (thermoplastics, carpet bonded to panels, synthetic leathers, finished metals)
  - Establish HR2 pass/fail criteria that are consistent with OSU materials results\*
    - Material results may change order when compared to OSU ranking (ex. highest to lowest), but samples that historically pass OSU also pass HR2
    - Materials that meet OSU margins (55/55) also meet HR2 margins
      - PS-7 Paint Color
      - PS-9 Thermoplastic Color

\*Concern raised by R. Buoniconti during March 2018 meeting



# Target

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## TRL 5 - *Repeatability* - testing in 3Q 2018

- Build and test 3 sets of homogenous coupons (OSU/HR2)
- Conduct coupon testing on HR2 and OSU; compare CV data
- Evaluate at fall MFTWG meeting - determine ability to proceed

## TRL 6 - *Reproducibility* - entry in 4Q 2018

- Deatak HR2 instrument status at FAA TC
- Discuss target coupon types - subset of the TRL 5 plan?
- Number of coupons per coupon type

\* *To be discussed within Working Group sessions*

# Questions?

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# Breakout Session Discussion Topics

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**TRL 5 - *Repeatability*** - testing in 3Q 2018 - questions on material shared?

**TRL 6 - *Reproducibility***

- Requires at least one more HR2 to be on line
  - What does it mean to be 'on line' (minimum performance)?
  - Deatak HR2 status at the FAA TC - what is next?
  - Other sites planning to bring an HR2 on line?
- Define coupon types and number of samples
- Does a subset of the TRL 5 plan make sense?
- One-way ANOVA to determine difference in means (same population)

# Breakout Session Discussion Topics

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## TRL 7 - *Range*

Families of materials - discuss and develop

- Textile, fabrics
- Thermoplastics
- Thermosets
- Honeycomb core panels
- Aluminum panels
- Materials bonded to panels
- Finished metals
- *Others?*

**General Topic** - Timing of TRL 7, 8, 9