HR2 Development Model 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

- 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)

MATURITY LEVEL

Discovery

Feasibility

Practicality

Applicability

Production Readiness

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 demonstation on range of production configurations. Documented test guidance defined.
TRL 8	Final test equipment drawigns 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

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

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).

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

σ = standard deviation

μ = mean

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

TRL 6 to TRL 7

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

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

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?

Breakout Session Discussion Topics

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

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