



# HR2 Development Model and Plan

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March 2017 FTWG

# Introduction

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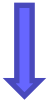

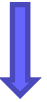
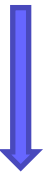
- HR2 Goal: Define a robust method to determine peak and total heat release that improves repeatability and reproducibility when compared with OSU.
- Prototype development [presentation](#) by Mike Burns at the October Triennial indicates recent apparatus and procedural changes made to reduce variation.

## *Recommendations*

- Adopt the Technical Readiness Level (TRL) framework & establish gate criteria to assess development progress and ensure technical maturity
- Repeat DOE phase 1 using tightened air and methane flows
- Focus 2017 activity on moving HR2 from TRL 4 to TRL 5

# 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

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**TRL 4 - *Robustness*** - apparatus, calibration method, equipment, procedures. Evaluate calibration factor variation using methane only / no coupons.

➔ Gate 4 / Enter **TRL 5**: Calibration factor variation (< 5%)

**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**: Test result variation (< X%)\*

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

➔ Gate 6 / Enter **TRL 7**: Test result variation (< X%)\*

**TRL 7 - *Range*** - demonstrated ability to test a range of coupon materials and configurations. Establish pass/fail criteria for HR2 total and peak heat release.

➔ Gate 7 / Enter **TRL 8**: Results over a range of sample types that are consistent with OSU empirical results\*

\*Open to discussion in the Task Group.

# Situation

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- HR2 is currently at **TRL 4** - *Robustness*
- Marlin engineering prototype in use at the FAA Tech Center
- Deatak machine coming on line
- Phase 1 DOE produced high calibration factor variation (~6%)

Parameter	DESCRIPTION	Min.	Avg.	Max.
System Air Flow rates	SCFM	19	20	21
Heat Flux (W/cm <sup>2</sup> )	Center	3.60	3.65	3.70
Upper Pilot	Air (SLPM)	0.98	1.0	1.2
	Methane (SLPM)	1.3	1.5	1.7

- Changes recommended in the October triennial to decrease variation
  - Tighter control of air and methane flow
  - Use of a Mass Flow Controller to control inlet flows
  - Changing calibration method from Step to Ramp

# TRL 4 to TRL 5

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- Incorporate recent updates and characterize variation without coupons
- Repeat phase one DOE testing - tighter flows, new calibration, and MFC's
  - Determine calibration factor variation with flows at nominal
  - Determine calibration factor variation over range of flows conditions
- Generate data and assess calibration factor variation (5% limit)
- If acceptable, move forward to coupon testing (TRL 5)
  - Agree on standard panel configuration and variation criteria
  - Calibrate and test at nominal new parameter values
  - Minimize all sources of variation possible
  - Test as many coupons as possible
- If unacceptable, assess additional sources of variation

# Target

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## **TRL 5 - *Repeatability* - Entry by the end of 2017**

- Define standard coupon material
  - Minimize variation
  - Homogenous, minimal production steps
- Define repeatability criteria and threshold
- Conduct testing and analysis

## **TRL 6 - *Reproducibility* - 2018**

- Requires additional instruments to be on line
- Define target number of machines, samples to achieve
- Define reproducibility variation criteria

# Schedule

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- Finalize ramp calibration method (March 2017)
- Repeat Phase 1 with tighter flows, new calibration, and MFC's (April 2017)
- Present results and recommendation at June meeting (June 2017)
  - Ability to move to TRL 5 or additional steps required within TRL 4
- Determine standard panel composition and sourcing (July 2017)
- Propose panel test conditions and repeatability targets (September 2017)
  - Establish gate criteria to move into TRL 6
- Kickoff standard panel testing (October 2017)
- Present standard panel test results at December meeting (December 2017)
- Solidify plan for additional HR2 use for next phase - Reproducibility



# Summary

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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.

## *Recommendations*

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➡ Questions?