

HR2 HRR APPARATUS HYDROGEN TESTING

Materials Working Forum FAATC, USA

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October, 2023

Heat Release Rate Test Apparatus
October 2023



Federal Aviation
Administration



AGENDA

- **BACKGROUND**
- **TEST SETUP**
- **DATA REVIEW & SUMMARY**
- **Q & A**



BACKGROUND

- Applicant approached FAA with interest in use of liquid hydrogen aboard aircraft (alarm to detect levels above 1%).
- Hydrogen is very explosive in concentrations above its LFL (approximately 4.7% by volume in air)
- Problem/Concern: Do concentrations below this limit increase burn rate of aircraft materials (report: Stephen Rehn VBB tests)

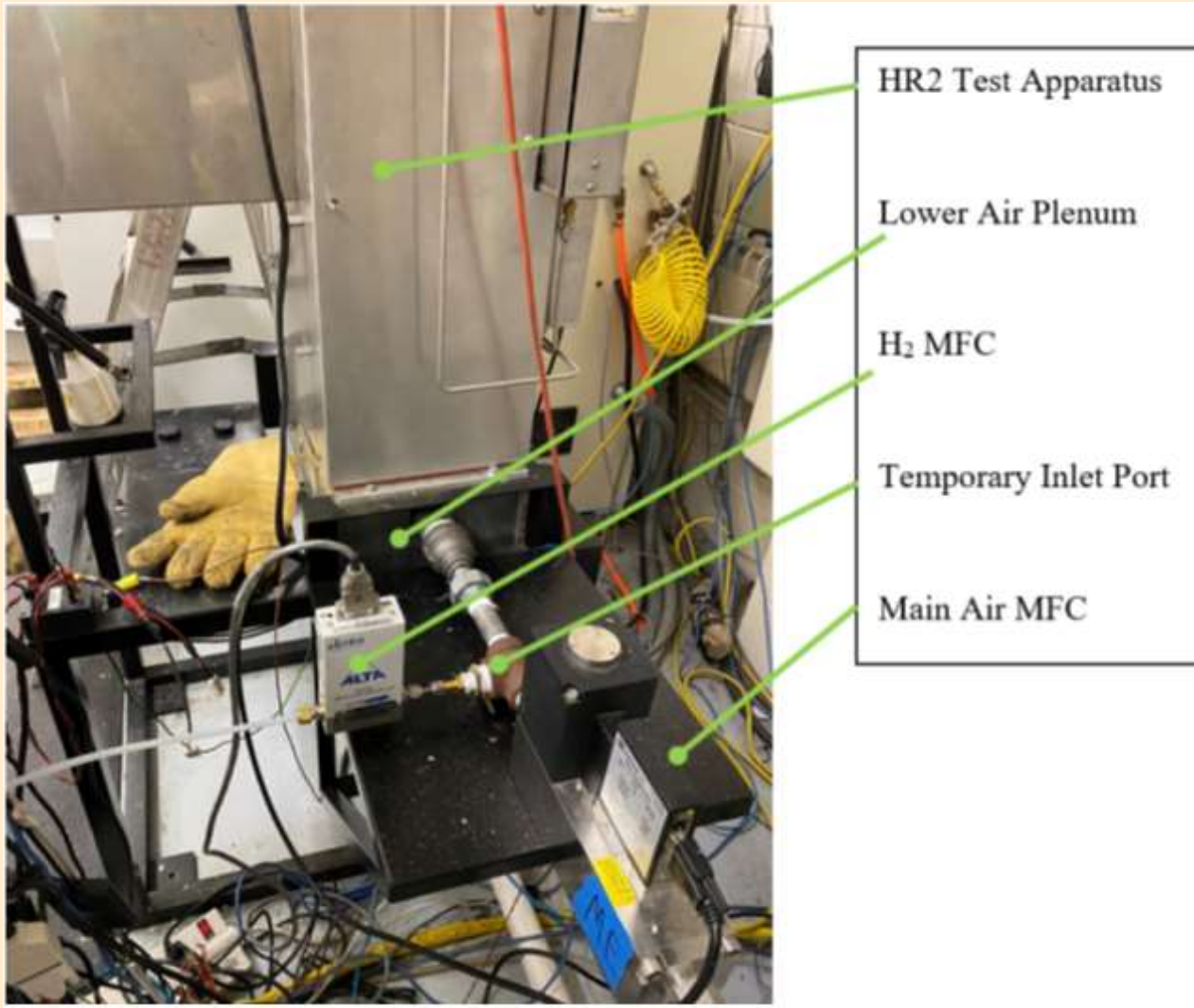


TEST SET UP

- Bottled hydrogen is plumbed into the main air supply just prior to entering the HR2 unit.
- Three series of tests were conducted: 0%, 1%, and 2% Hydrogen by volume (in air).
- Standard heat flux and airflow conditions established prior to calibration and testing.
- Calibrations conducted with and without hydrogen (modified equation).
- Four materials selected in sets of 5 (60 count).



TEST SET UP



TEST SET UP

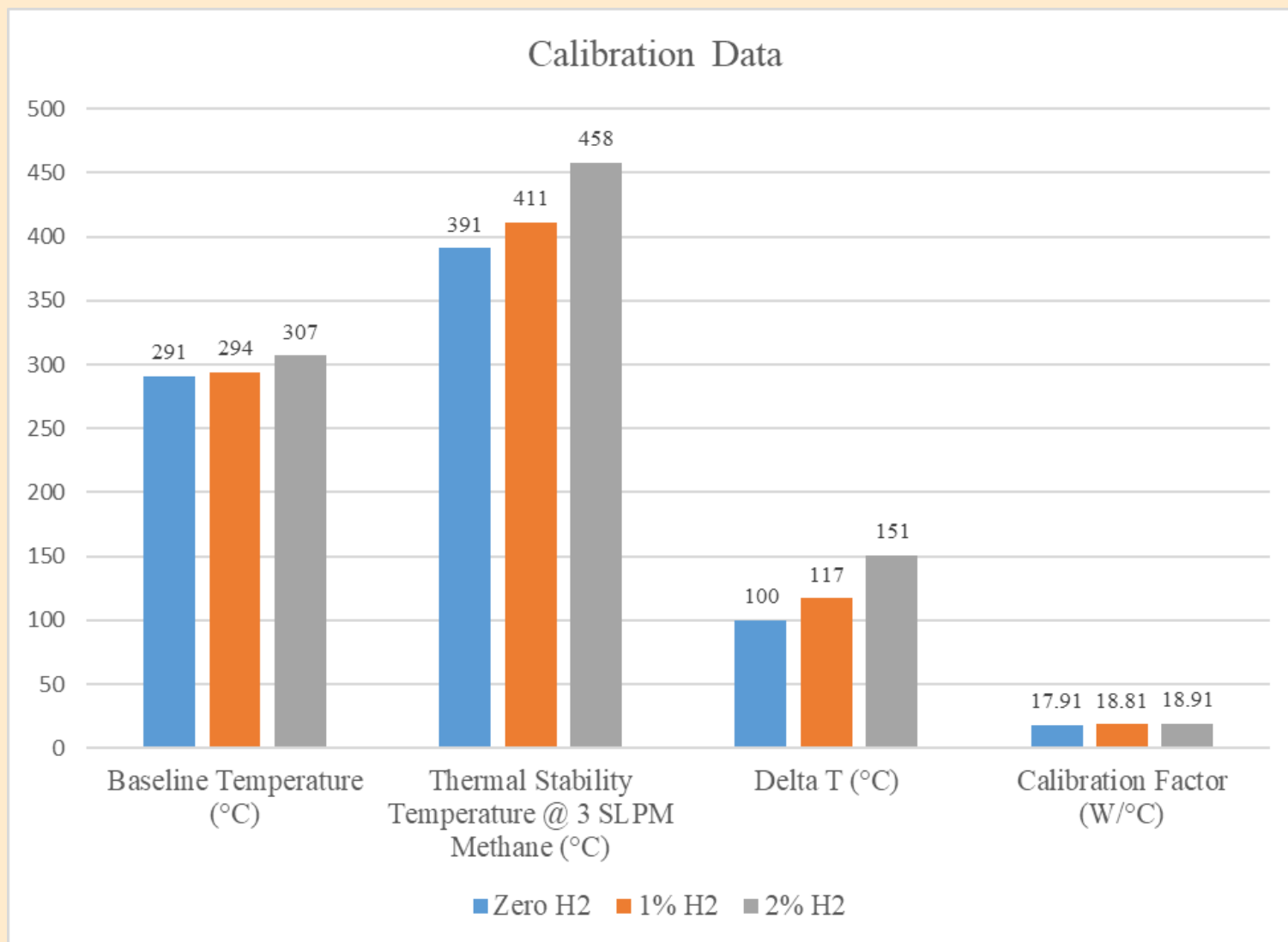


Hydrogen Sample Probe Inserted in Exhaust Stream

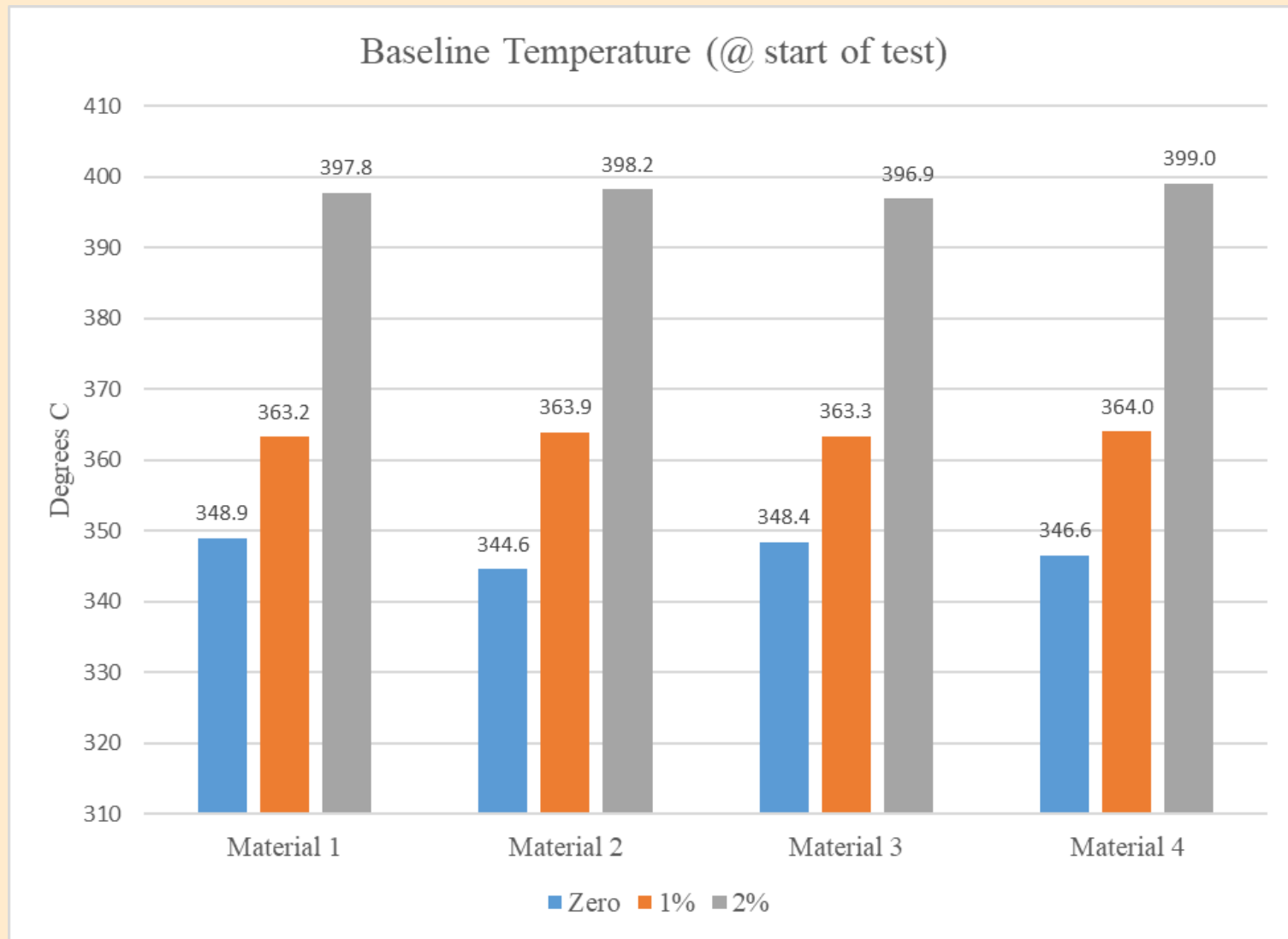


H2Scan Hydrogen Analyzer Sample System

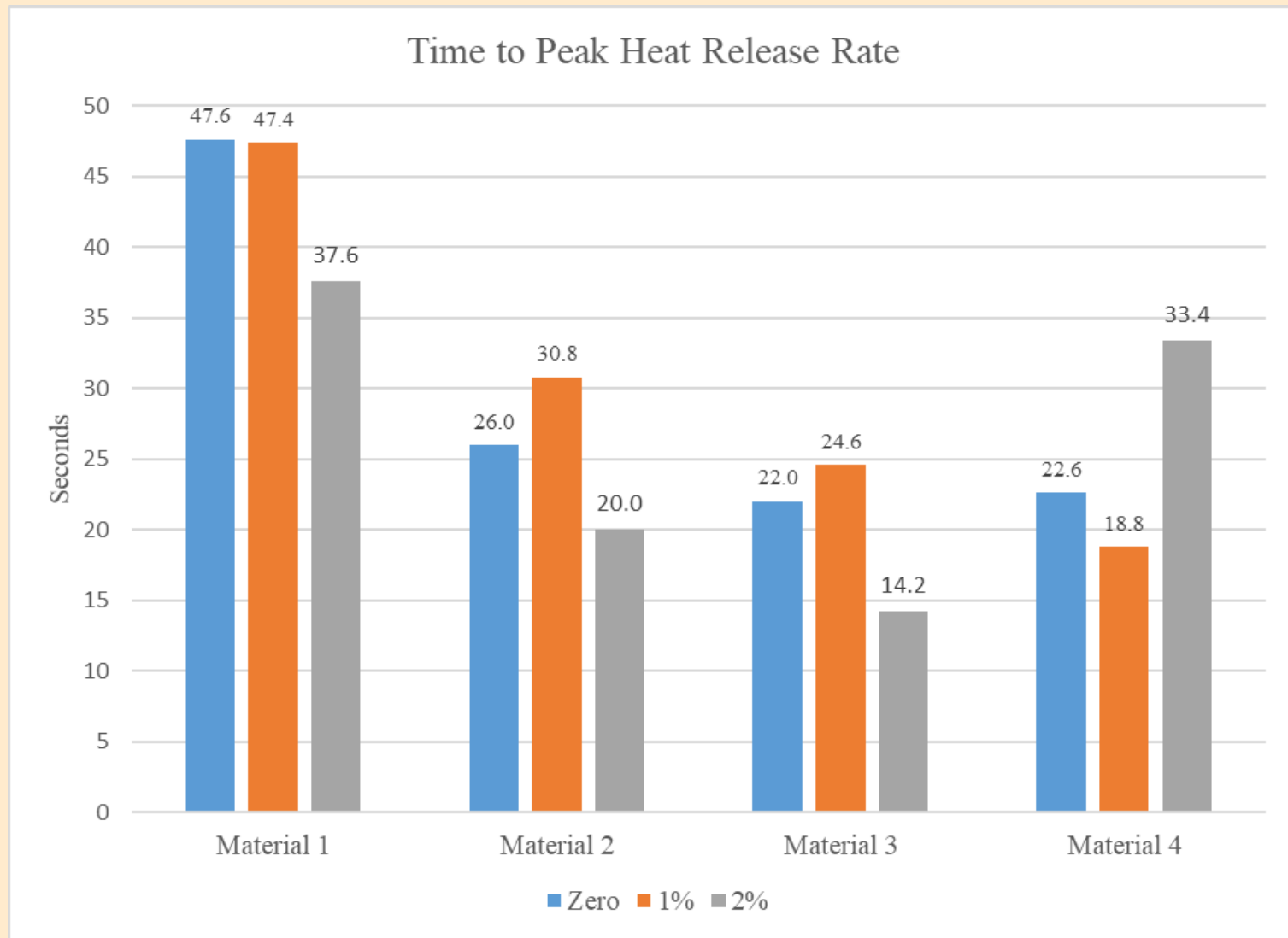
DATA REVIEW/SUMMARY



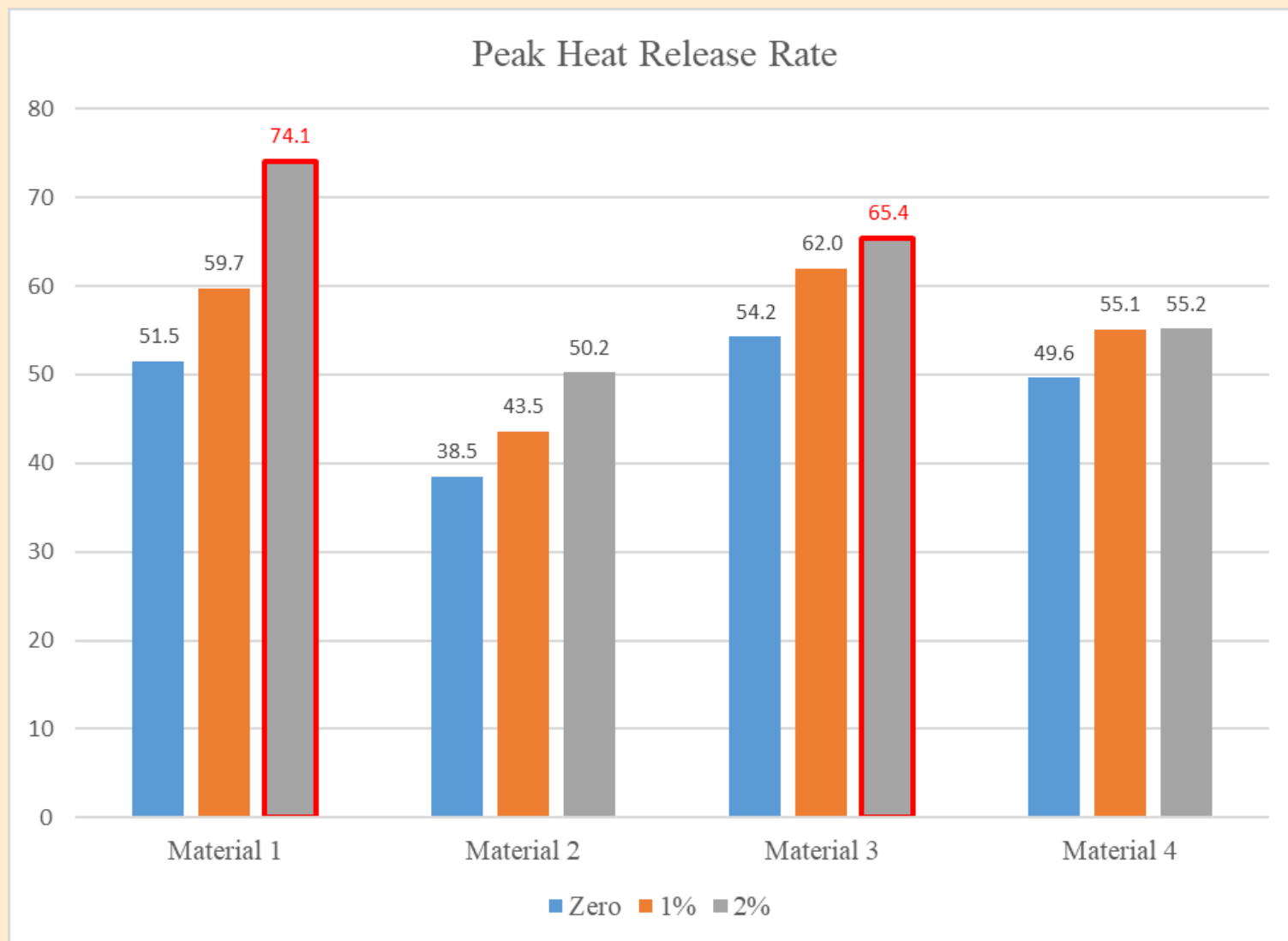
DATA REVIEW/SUMMARY



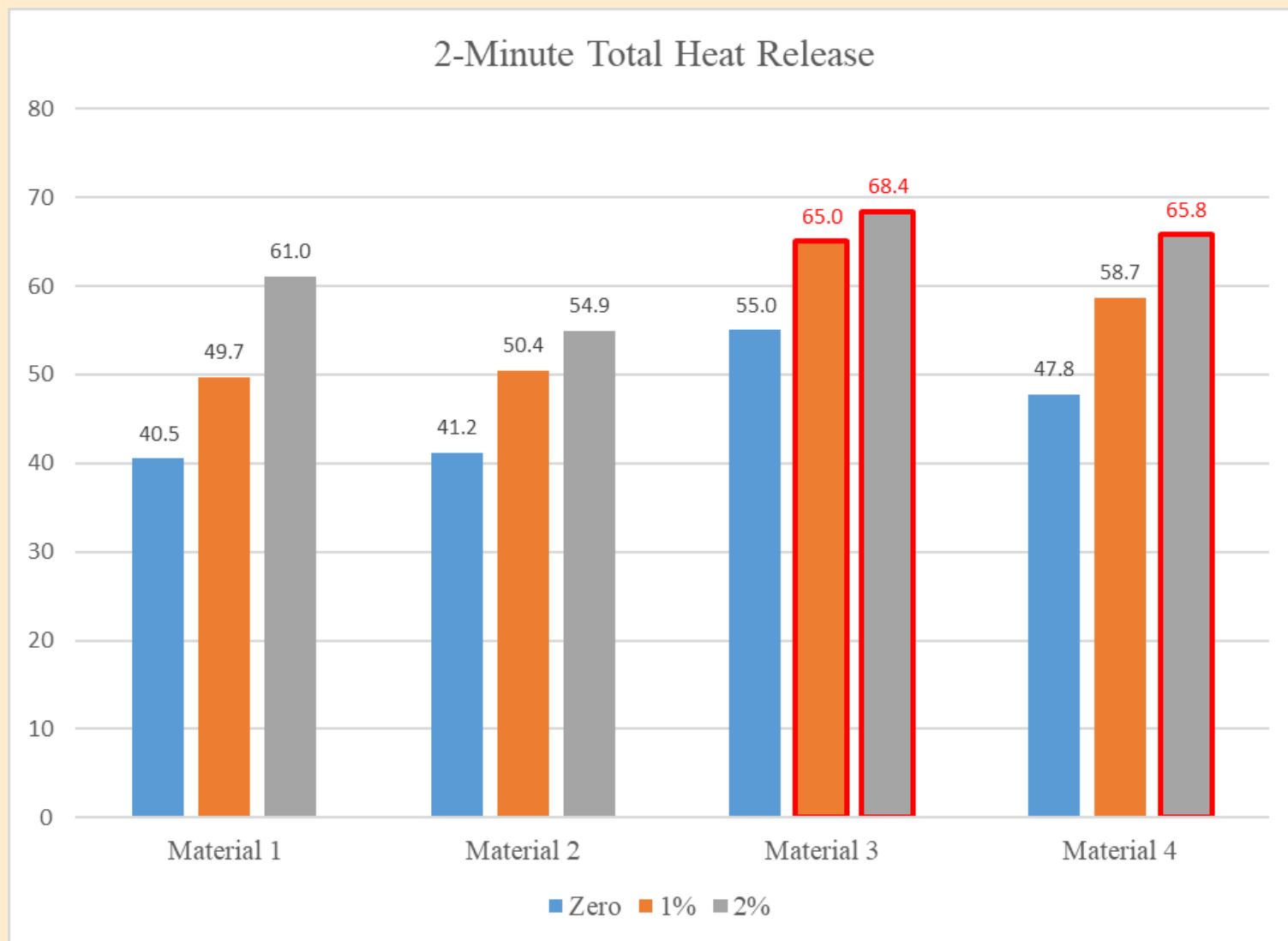
DATA REVIEW/SUMMARY



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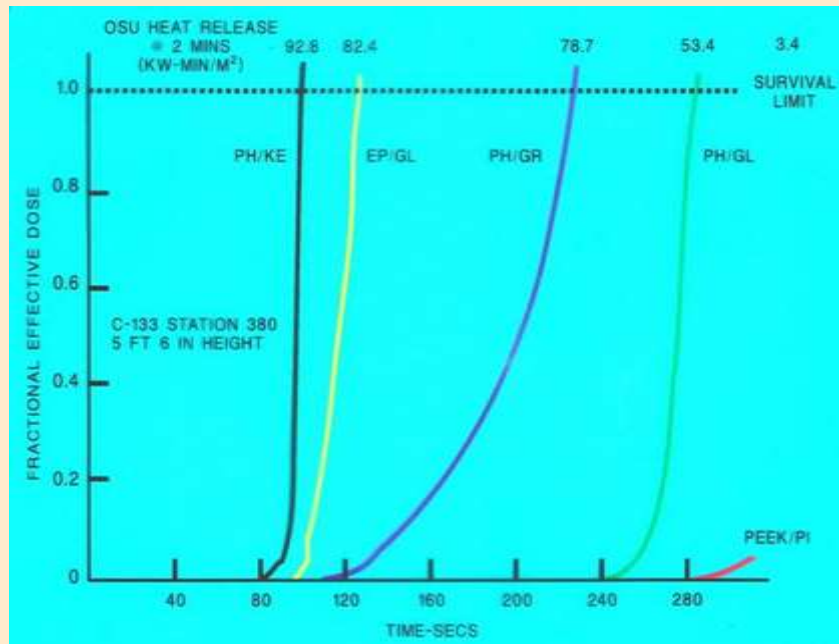


DATA REVIEW/SUMMARY

- Baseline temperature showed significant increases in temperature in the presence of hydrogen (most likely attributed to its interaction with upper and lower pilot burners).
- Calculations for the heat release rate calibration factor were modified to include increased power as a result of the presence of hydrogen gas. A fractional percentage of total power was used based on the hydrogen consumption data recorded during each calibration concentration.
- Elevated PHR, THR, and EGT were observed with increased hydrogen concentrations.
- Initial time to ignition of each material slightly decreased with increased hydrogen concentrations.



DATA REVIEW/SUMMARY



FED: Survival Model = 1.0



Photo @ 90 seconds

Phenolic fiberglass approximates THR pass/fail criteria limit @ 1 % H₂

Phenolic graphite approximates 2 % H₂ (>30% ↑ THR)

HRR / H₂ QUESTIONS?

