Engineering, Test & Technology
Boeing Research & Technology

HR 2 TRL 6 Status Update

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Fire Test Forum - June 10th, 2020

Agenda

- TRL 6 Objective
- Status of Equipment / Labs
- Schedule (Prior / Current)
- Prototype HR 2 Assessment for TRL 6
- Production / Certification Unit Assessment
- Summary

TRL 6 Objective

Conduct unit response and material test assessment to evaluate the reproducibility of Heat Release Rate (HR2) test method

- 4 units, 3 locations
  - Unit 1, Unit 2 – FAA Tech Center (Mike Burns)
  - Unit 3 – Airbus (Christian Thomas)
  - Unit 4 – Boeing (Yaw Agyei, Brian Johnson)
  - Unit 5…..

Status of Instruments / Labs

FAA Tech Center

- Unit 1 operational, unit assessment complete
- Unit 2 operational, unit assessment on-going (40% complete)
  - Tech center closed

Airbus

- Unit 3 requires hardware and software upgrades

Boeing

- Unit 4 – in capital procurement process

TRL 6 Schedule (COVID19 Impact)

TRL 6 was scheduled to start in April 2020, completed by October 2020, shared with Task Group at Fall Meeting

- Heavily impacted by COVID19 – budget, execution

Activity	Prior ECD	Current ECD
Unit 1 – FAA Tech Center	April 2020	TBD
Unit 2 – FAA Tech Center	April 2020	TBD
Unit 3 - Airbus	August 2020	TBD
Unit 4 – Boeing	October 2020	TBD

Activities includes unit response assessment and material testing

TRL 6 Units Response Assessment

(1) Operating Response Limits set using Unit 1 – HR 2 prototype

- 102 data points, conducted over 6 month period
  - Baseline temperature, thermal stability temperature, calibration factor
- 99-95% tolerance interval to set recommended limits
  - 95% confidence 99% of distribution falls within the range

(2) TRL 6 units assessment

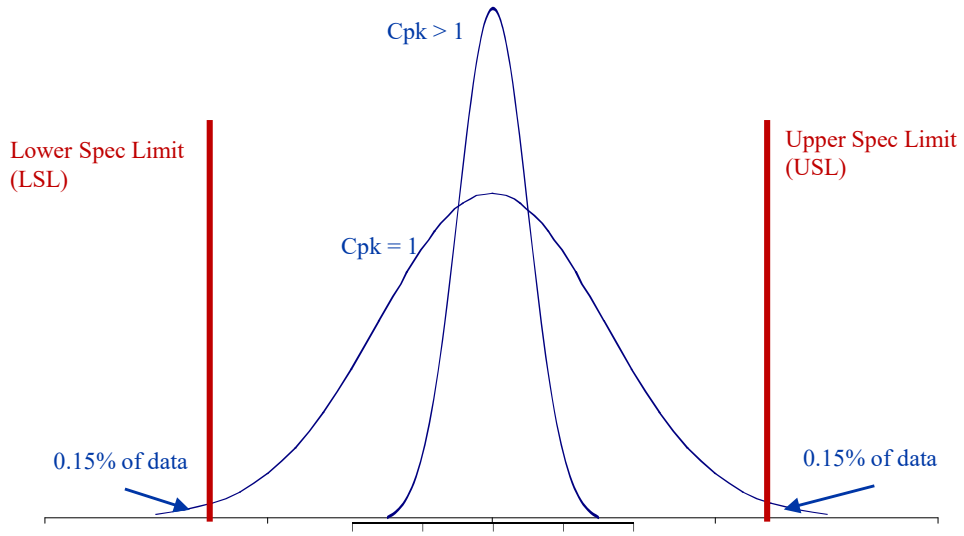
- 100 data points
- Data must be normally distributed (Anderson-Darling test)
- Responses falls within 99-95% tolerance interval

Production Unit Assessment (Proposal)

New units for production / certification capability assessed using Process Capability Index (CpK)

- CpK – provides a measure of the quality of the distribution with respect to the specification limits. Assesses process centering as well as variability
  - High CpK → Low Fallout Rates
  - CpK calculation based on a normal distribution
  - HR 2 operating response specification limits set using TRL 6 units response data

$$\text{Cpk} = \min\left(\frac{\bar{x} - \text{LSL}}{3s}, \frac{\text{USL} - \bar{x}}{3s}\right)$$



Provided by Katy Wrenn, Boeing Applied Math

Production Unit Assessment (Proposal)

Assessing New Units with Cpk

- Determine acceptable fall-out rate – set desired CpK
- Compute required CpK – based on sample size
- Compare desired, required CpKs
  - Required CpK ensures desired CpK is met with 90/95% confidence

Cpk Requirement for CpK = 1

n	fall_out_perc	cpk	cpk_req_90	cpk_req_95
20	0.27	1	1.298	1.399
30	0.27	1	1.229	1.303
50	0.27	1	1.167	1.220
70	0.27	1	1.137	1.179
100	0.27	1	1.112	1.146

Provided by Katy Wrenn, Boeing Applied Math

Summary

- TRL 6 activity is to assess the reproducibility of the HR 2 test method using a minimum of 4 units
- COVID-19 has had significant impact on TRL 6 activity – budget, execution
  - Slide to all activities, schedule TBD
- Participating units operating responses must meet recommended limits set using prototype HR 2
- Verify capability of new production / certification units using the Process Capability Index (CpK)