

Breakout #2: Mission Assurance Strategies to Minimize Quality Escapes



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Traditional Quality Role

To ensure the delivery of a quality product



- What role is/should quality play to reduce design escapes?
 - *Example up-front quality focus opportunities*
 - Design review exit/entrance criteria
 - RAMS
 - PMP and manufacturing
 - Systems engineering and test

Leading Metric/Indicators

- What are the key metrics or leading indicators necessary to ensure quality improvement?
 - *Example quality metrics*
 - Defect rate/test failure trending
 - Requirements traced to verification steps
 - Returns or out of sequence rework

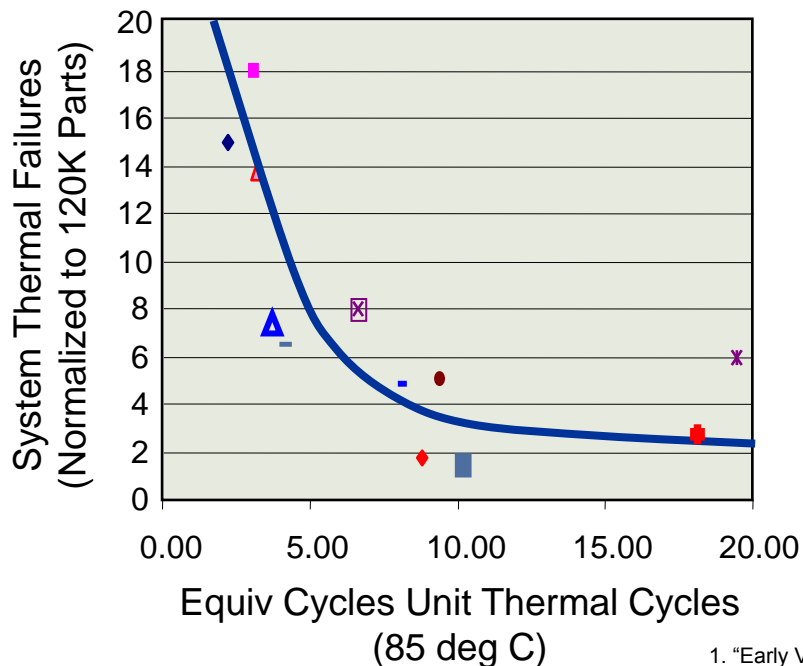
Mission Assurance for Additive Manufacturing (AM) of Metals

- The “known unknowns” for mission assurance of AM metal parts:
 - *Part quality is controlled by:*
 - The input material: powder size, size distribution, chemistry and purity
 - The process controls: absorbed power, spatial distribution of temperature, feed rate, traverse rate, and deposition spacing
 - Challenges for Mission Assurance for AM:
 - *Variations in quality on the same production machine, from machine-to-machine, and across production types (e-beam vs. laser fusion)*
 - *Current knowledge gap in material properties, process control and NDT*
 - *Currently, properties and processes are proprietary and may not be shared*
 - Suggestions on the path to AM qualification?
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Best Practices: *Experience-based and Data-driven*

- Too few unit thermal cycles delays discovery of problems to system thermal testing or later
- Finding unit defects during system test can be an order of magnitude more costly

Unit Test Impact on System Failures¹



Failure	Cost (FY02\$)
Unit level	\$30-60k +
System level	\$200-500k +
<i>Schedule delays</i>	<i>\$1M / week or day</i>
<i>Prog G: 16 boxes, 7 months</i>	<i>\$100M</i>
Orbital failure (Prog E)	~\$1.3 Billion

1. "Early Verification Planning: Best Practices and Pitfalls Related to Testing", W.F. Tosney, Mechanical, Materials, and Structures Symposium 2011 – Raytheon, October 2011

➤ ***Effective verification planning is cost-beneficial especially in cases of proven heritage application***