Reliability Estimation for Mission Extension
NASA Approach/Recommendations

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Agenda

- NASA's Goals
- Historical NASA and Industry Approaches
- Current Estimation Methodology Overview from the GSFC
- Current Estimation Methodology Description from the GSFC
- Current Estimation Methodology Path Forward

Goals

- Ensure De-orbit reliability requirements are not unnecessarily driving mission design efforts
- Prevent design and manufacturing solutions that inadvertently increase costs and risks without providing benefit to missions
- Move away from reliability estimation approaches that emphasize piece part performance estimates over component history and system-level testing results
  - Tends to drive systems away from modern approaches and successful commercial products

Historical NASA and Industry Approaches

- When sufficient comparable component historical information is available, MIL-HDBK-217 type data is updated using Weibull or Bayesian Analysis
- When sufficient comparable component historical information is unavailable, MIL-HDBK-217-type (piece-part) approaches dominate
- These approaches are still providing highly conservative results as compared to actual performance
    - Design problems or systemic part defects (which are more often caught before launch if testing is rigorous) or unforeseen radiation effects are more likely to cause a failure. Systemic part defects often affect even the highest screening level MIL-SPEC parts
- Currently working to collect past component history to work formulate more historically based predictions based on system-level attributes

Current Estimation Methodology Overview from NASA's GSFC

Benefits:

- Verifies de-orbit reliability requirements compliance without driving mission design to the extent possible
- Provides projects with risk-based post-mission disposal quantification and trade options
- Assists with mission risk mitigations from design through EOM.
- Assists with risk-based mission extension decision making

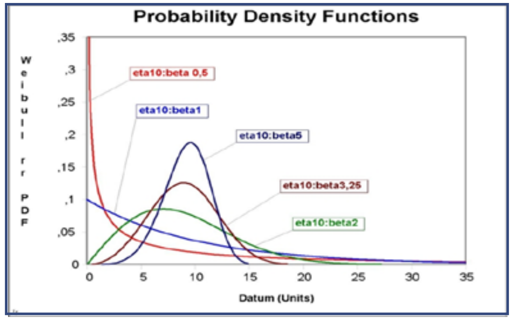
Dependencies:

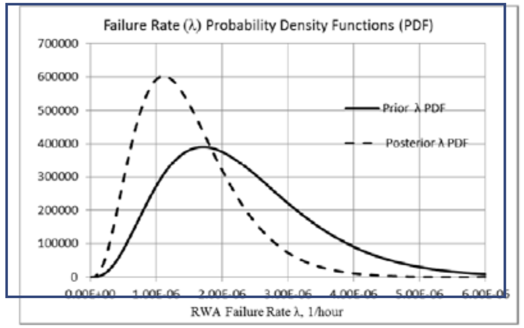
- Reference data (starting point only)
- Experience data access (mission and component)
- Accurate and current system information and de-orbit plan

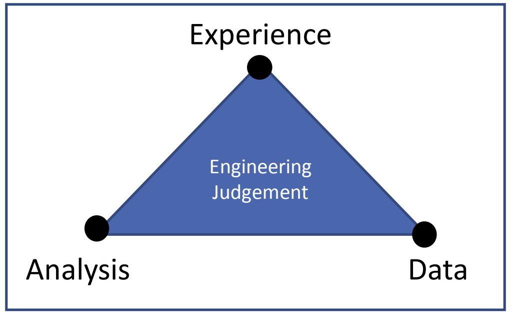
Current Estimation Methodology Description from the GSFC

Reference Information (Hnbk/Databases/Etc.)

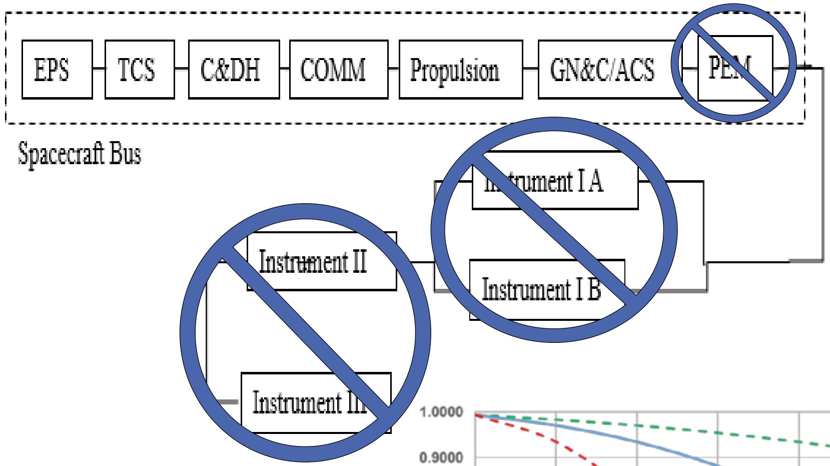
Anomaly, Test, & Performance Data

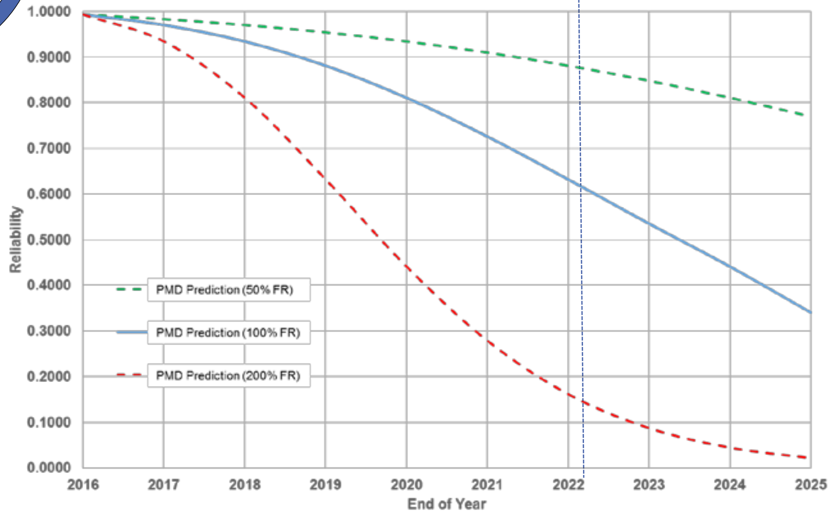






Tailored RBD for Extension or Disposal Required Elements





PATH FORWARD

- Move-away/eliminate reliance on out-dated Handbooks. Explore alternative references, methods & their use (e.g., Bayesian, Physics of Failure, IEEE Working Group 1413, FIDES)
- Increase data sharing (globally) to enable more accurate probability predictions of standard components based more on flight history/ application while continuing local failure rate updating.
- Modernize component and piece part acceptance and reliability formulation approaches to remove unnecessary ambiguity.
- Promote and support retrieval technologies and strategies to increase PMD trade space for all missions.
- Investigate if current NASA PMD probability requirements are correct metrics to ensure space usability and human safety. Could these be ensured with a well defined plan with multiple levels of contingencies and end state probabilities?