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Parts and Components Reliability

Abstract

# Parts and Components Reliability Assessment: A Cost Effective Approach

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# Parts and Components Reliability Assessment: A Cost Effective Approach

System reliability assessment is a methodology which incorporates reliability analyses performed at parts and components level such as Reliability Prediction, Failure Modes and Effects Analysis (FMEA) and Fault Tree Analysis (FTA) to assess risks, perform design tradeoffs, and therefore, to ensure effective productivity and/or mission success. The system reliability is used to optimize the product design to accommodate today's mandated budget, manpower, and schedule constraints.

Standard based reliability assessment is an effective approach consisting of reliability predictions together with other reliability analyses for electronic, electrical, and electro-mechanical (EEE) complex parts and components of large systems based on failure rate estimates published by the United States (U.S.) military or commercial standards and handbooks. Many of these standards are globally accepted and recognized. The reliability assessment is especially useful during the initial stages when the system design is still in the development and hard failure data is not yet available or manufacturers are not contractually obliged by their customers to publish the reliability estimates/predictions for their parts and components. This paper presents a methodology to assess system reliability using parts and components reliability estimates to ensure effective productivity and/or mission success in an efficient manner, low cost, and tight schedule.

Reliability assessment, mostly of electronic equipment, as a part of mission assurance discipline uses heritage or published data and best practices to establish and maintain consistent methods for estimating and evaluating system reliability. Many military handbooks provide the guidance to prepare a failure rate database for piece parts and components as applicable. A prediction analysis, with understanding of its limitations, is useful to identify the design weak links by ranking the failure factors and focusing on the failure distribution of each of the components rather a particular number resulting from the system reliability calculations. By using the existing methods and standards as well as heritage data, a failure database is possibly accomplished within cost and schedule.

The limitation of a reliability prediction is due to the inaccuracy of the outdated information obtained from military or commercial handbooks and the data unavailability during the early phase of the product life cycle. The focus on the prediction is rather the benefit that it offers as a tool to identify the design weaknesses and consequences of failure occurrence than the emphasis on correctness or absolute value the final numerical results. For simplicity and time saving purposes, only the operating period of time needs to be taken into accounts and common cause failures are expected to be screened out by quality assurances as well as the testing and inspection that are imposed by the tight productivity or mission assurance requirements and standards. By utilizing the traditional

approach of parts count method identified in MIL-HDBK-217F, Reliability Prediction of Electronic Equipment, a reliability prediction is more effective if performed with close collaboration between the reliability and design teams. The analysis formulates the failure rate together with the operating time and quality factor for each of the parts and components of the system; therefore, reveals the significant contributors to the system failure.

Reliability predictions are more beneficial if initiated early in the formulation phase of product life cycles using the available failure rates of previously designed components or information of similar parts if the data from the parts lists or manufacturers are not presently available. As the design weaknesses are uncovered, certain methodologies are considered to increase the productivity or mission reliabilities including upgrading EEE parts, selective redundancies, or additional screening and testing. Depending on cost and schedule impacts, certain approaches are appropriate to achieve system reliability. The analyses are also refined as the products' success/failure criteria are better defined in the development and design phases of the system engineering process to accommodate graceful degradation and ensure performance of critical functions. The analyses continue to be updated throughout the development, design, and fabrication phases as parts lists and test data become available.

Concurrently, a Failure Modes and Effects Analysis (FMEA) is performed to identify the critical items that might cause loss or degradation of the mission and/or product performance. The FMEA also discover and analyze single point failure modes resulting in severity categories as well as determine the root cause, corresponding mitigation actions, and retention rationale. A formation of Critical Items List (CIL) is necessary as the results from the FMEA. The failure data obtained from reliability predictions, together with the reliability drivers, are then incorporated into the CIL as a combination of quantitative and qualitative approaches for effectiveness.

Reliability assessments provide valuable contributions to the productivity and/or mission success if initiated early in the design stage and incorporated both quantitative and qualitative methodologies to effectively provide recommendations to the design teams for improvements and potential design trades. The assessment is used as a tool to identify design weaknesses by performing Reliability Predictions in conjunction with other analyses such as, Failure Modes, and Effects Analysis (FMEA), Fault Tree Analysis (FTA), and/or Probabilistic Risk Assessment (PRA) to identify, quantify, and assess design, mission failure effects, and risks. Besides, reliability assessments are integrated with the design process and other assurance practices to identify alternate and degraded modes of operations. Thus, effective approaches to improve productivity and/or the probability of mission success are proficiently implemented.