18 LIFE DATA ANALYSIS

Description

Life Data Analysis is the analytical framework for determining the probability of failure of products during their lifetime and of assessing conformance to specified input requirements.

Purpose

The purpose of life data analysis is to characterize the failure probability distribution of a component, subsystem, or product so as to assess the conformance of the reliability characteristics to the specified requirements. The definition of the failure probability distribution provides a basis from which the effect of design changes can be determined.

Benefits

Life data analysis defines demonstrated reliability performance at any point during design lifetime. The shape of the curve defines the nature of failures: infant mortality, random, or wear out. The shape of the curve is also instructive as to the quality of the data and the purity of failure modes assessed. Knowledge of the failure probability distribution provides a basis for streamlined product improvement validation. A defined failure probability distribution for a number of components allows accurate prediction of the failure probability of the subsystem or product.

Implementation

Life data analysis is appropriate for a wide range of uses from assessing reliability products in the field to predicting the reliability of components under lab development. The technique is most effectively used if a single failure mode is being analyzed. Proper use of life data analysis requires a fundamental understanding of the data being analyzed. The nature of the failures (modes) and suspensions (time accumulated) must be known to apply the analysis techniques properly and to interpret the results. If the analysis techniques are not properly applied, erroneous conclusions can be drawn and ineffective corrective actions initiated. There are many potential results formats. The most suitable should be negotiated prior to analysis. Life data analysis is often used as part of degradation analysis to determine the effect of degradation on a product's failure probability distribution.

Process Flow

1. Define the test and/or data type (replacement or non, failure or time terminated, assembly or component, single or multiple failure modes).

2. Define the data sampling scheme (discrete or continuous).

3. Gather data (samples vs. life).

4. Plot failure frequency vs. life.

5. Fit data against the best model (Exponential, Weibull, Log Normal, Normal., etc.) with “goodness of fit” as acceptance criteria.

6. Perform the confidence interval estimate.

7. Perform the risk analysis.

8. Determine the nature of the data (infant mortality, random, wear out).

9. Perform corrective action as appropriate.

Example

Transmission range synchronizer performance was not meeting reliability performance objectives. A 5X reduction in failure rate was required. Lab testing determined that a design tolerance stack-up was allowing the synchronizer to engage prematurely and briefly attempt to synchronize while the gearing was still engaged. This caused rapid temperature rise and material degradation. A design change was made to correct the problem. To evaluate the effect of this design change, warranty data on all synchronizers and failure modes were collected for two months of production prior to the change and for nine months after the change. All production units that did not fail were plotted as suspensions, accounted for using the AIAG line haul mileage accumulation model (see AIAG’s *ActionLine Magazine*, September 2000,page 36). Life data were plotted. Figure 1 shows the results. A log normal distribution was found to have the best fit. The data clearly shows an improvement with the design change as the Weibull plot of the improved design has moved to the right and significantly reduced the occurrence rate for a given mileage. The original design is labeled EFMII 4/00 to 5/00. The improved design in labeled EFMII 7/00-3/01 (Narrow cl-). A before and after reliability assessment at a required 200,000 mile life indicates the following :

- Before (EFMII 4/00 to 5/00) = 95% Reliability.

- After (EFMII 7/00-3/01 (Narrow cl-)) = 99% Reliability.

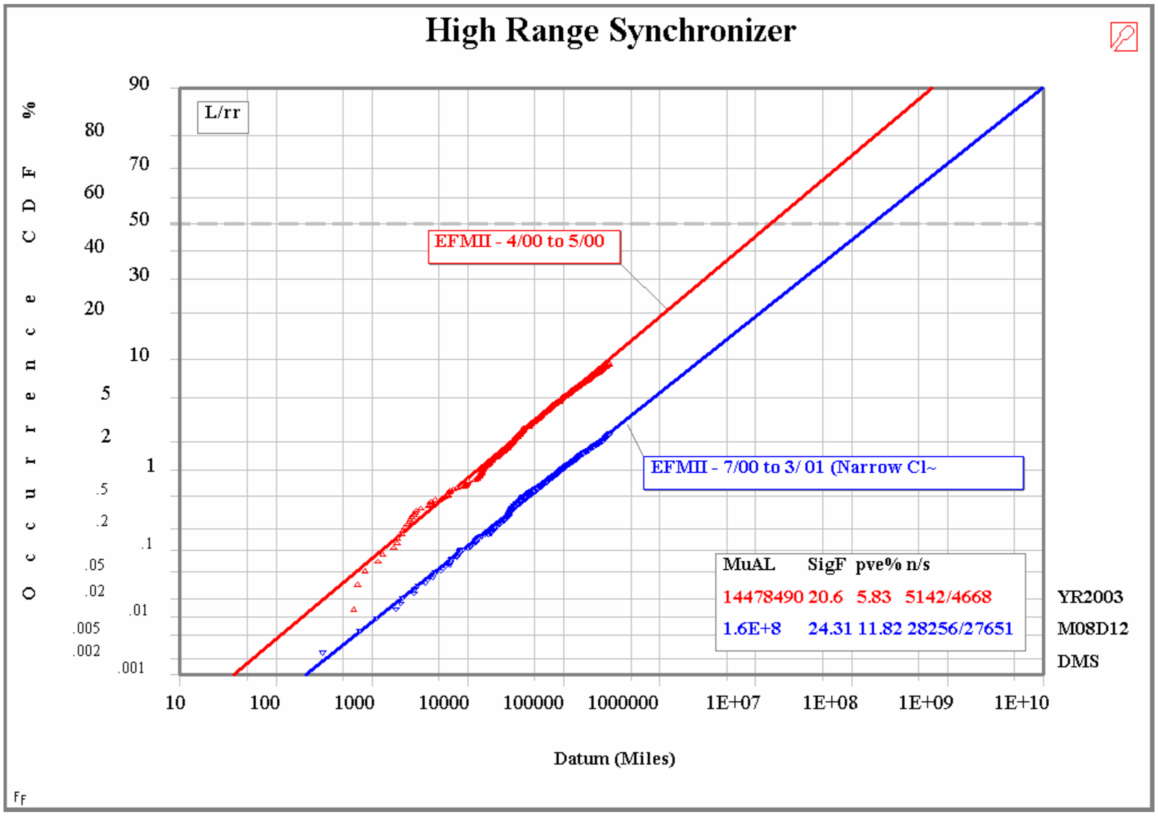

Figure 18.1. Synchronizer Life Comparison

General Comments

This tool is integral to Phases 1 through 5. In the Planning phase, relevant historical life data analysis results are used to assess risk and establish a plan to meet reliability requirements. In Phases 2 and 3 Product Design and Development activities, analysis and testing are used to compare design concepts to requirements using life data characteristics. In the Phase 4 Product and Process Test and Evaluation Stage, life data analysis is used to assess reliability against goals. Finally, life data analysis is used to track field data performance in Phase 5 Production. Results in all stages are used to trigger corrective action where appropriate.

References

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