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Reliability Demonstration Tests – Challenges and Opportunities in the Automotive Industry

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Abstract

In the automotive industry, the reliability of products is often defined by a so-called B_{10}-value. That means, that at a defined point in time, the maximal failure probability is 10 %. Due to the fact that the B_{10}-value correlates to the required service, it is quite challenging to proof a service life expectation, for example 250.000 km for a passenger car, in a quite short time frame for testing activities within a product development project. If the test duration corresponds to the service life requirement, then 22 test specimens must pass the test procedure without failure in order to confirm the required minimum reliability. However, if the test has to be carried out in a shorter time, more test specimens must be tested without failure. Assumptions regarding the failure characteristics are then required to determine the number of test specimens. In some applications, the sample size can easily reach three-digit values and therefore often reaches the limits of feasibility. During the development of products, the proof of product reliability is therefore a challenging activity. In addition to a procedural flow of test planning, correlations between reliability requirements and various test parameters such as test duration and sample size are shown. The test quality is evaluated by the confidence level, whose dependencies are also determined. Especially uncertainties and their consequences are part of this study. One example is the estimation of the shape parameter of a Weibull distributed failure characteristic in the planning phase. Possible sources for the estimation and the consequences of uncertainties of the estimation are analyzed. After performing a reliability demonstration test, the impact of uncertainties on the results are under consideration. The effects of uncertainties of the planning phase, e.g. uncertainties of the estimation of the Weibull shape parameter, to the demonstrated reliability and the confidence level are shown. Finally, case studies give an impression of the importance of the uncertainties.

Keywords
reliability proof, zero failure testing, sample size, confidence level, test duration, Binomial distribution

Biography
Tobias Leopold is Professor at Esslingen University of applied sciences since 2019. His Research interests are reliability engineering and statistics and its usage in product development and quality engineering with a special focus on the automotive industry. Tobias Leopold gained industrial experience at Knorr-Bremse commercial vehicle systems, STIHL and BMW in the areas of reliability engineering, product development, testing and quality.
He holds a doctoral degree in reliability engineering and is Design for Six Sigma Black Belt.