Katy Klauenberg and Clemens Elster
Physikalisch-Technische Bundesanstalt, Braunschweig and Berlin

Abstract

Title:
Sampling for assurance of future reliability – exemplified by utility meter surveillance

German law newly requires assurance of reliability also for future usage of utility meters. To quantify the confidence in or the probability of future reliability on the basis of sampling plans, methods from reliability demonstration can be applied - e.g. the prevailing Weibull binomial model. We adapt the binomial model to be applicable to sampling without replacement and simplify the Weibull model.

In a first frequentist approach, sampling plans based on such a model can be determined on the basis of existing ISO standards - no software is needed, and legal metrology authorities and calibration laboratories can apply similar tables as under the previous regulation. However, such a simple, table-based approach is not capable of including all available information.

The Bayesian framework offers a more efficient and also more interpretable solution to ensure that a specified percentage of a population functions in the future. We describe available prior information for the analysis stage and the design stage, and demonstrate their benefit for utility meter surveillance.

Nevertheless, the required sample sizes are costly especially at the first inspection of meters, because reliability levels close to one need to be demonstrated. In order to allow considerably smaller sample sizes also for high reliability levels, we prove under certain distributional assumptions the following relation: If 100q% of a population fulfill a more stringent specification Δ, then at least 100p% of the population fulfill the original specification $\gamma \cdot \Delta$ (for $p>q$ and $\gamma>1$). In the light of utility meter surveillance, we demonstrate the importance and the effect of this relation.

Also beyond surveillance of utility meters, the developed approaches, the particular sampling plans and the above relation can be useful, e.g. for time-based quality statements, conformity assessments and other verifications.