DOI 10.5162/SMSI2023/A3.4

Digital approach of certification in quality infrastructure

Keerthana Nattuveettil, Carlo Tiebe, Nanine Brunner, Michael Melzer, Marcus Thomas, Sergej Johann, Patrick P Neumann, Matthias Bartholmai
Bundesanstalt für Materialforschung -und prüfung (BAM)
keerthana.nattuveettil@bam.de

Summary:

QI-Digital is a joined project aiming at digitalising Quality Infrastructure (QI) processes involving standardization, conformity assessment, accreditation, metrology, and market surveillance [1]. Federal institute of material research and testing (BAM) is working on the creation of a digital calibration certificate (DCC) to achieve digital metrological traceability and conformity assessment. The utilisation of machine readable and executable DCCs in the XML format is demonstrated on an example of a temperature measurement at a hydrogen refueling station. The certificates will be retrieved and analysed automatically at a Process Control System or at a Digital Twin.

Keywords: Quality Infrastructure, Digital Certificates, temperature calibration, digitalisation, hydrogen technology

Motivation

To ensure the quality of "Made in Germany" in the era of digitalisation, Quality Infrastructure (QI) processes are digitalised by Federal Ministry of Economic Affairs and Climate Action (BMWK) and other stakeholders of the QI-Digital project. A holistic approach to digitalise different workflows can contribute to a paper-free documentation [1]. As an accredited calibration and testing lab, the Federal Institute of Material Research and Testing (BAM) is working on the generation and implementation of digital certificates, following the good practice guidelines established by national metrological institute. Currently, the focus is on digital calibration certificates (DCC) for temperature sensors. The concept of DCC is explored within the QI-Digital project on a hydrogen refuelling station and the use-case of temperature measurement for developing novel approaches for quality assurance.

Generation of Digital Calibration Certificate

DCCs are analogous to paper-based certificates but they are machine readable, interpretable, and executable. Therefore, they need to have a harmonised structure in a language like XML. DCC structures for different measurement quantities are defined by the respective technical committees of the German forum for calibration services (DKD), within the framework of the XML Scheme for DCCs, defined by the Physikalisch-Technische Bundesanstalt (PTB). These harmonised certificates are automatically generated by a self-developed middleware using python and LabVIEW. The final XML files are digitally signed via the Public-Key-Infrastructure (PKI) provided by the German accreditation body (DAkkS), which validates the accreditation of the issuing calibration lab. To comply with the current standards, a human-readable certificate in PDF format will also be handed over to the customers.

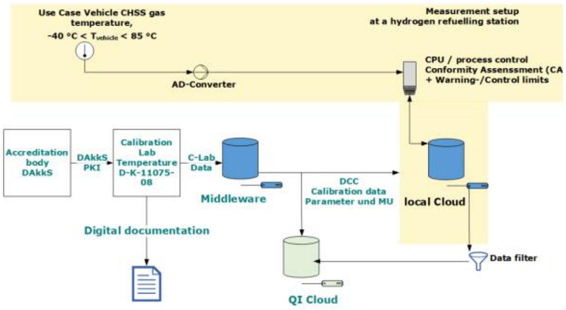

Fig. 1. Creation of calibration certificate for sensors used to measure CHSS temperature

Use of DCC in Hydrogen Refuelling Station

The DCCs generated at BAM, are transferred in a machine-interpretable XML format to a cloud which will be retrieved by Process control system (PCS) or at a Digital Twin (DT). As a practical example, the temperature measurement at

DOI 10.5162/SMSI2023/A3.4

the Compressed Hydrogen Storage System (CHSS) during the fuelling of hydrogen vehicles will be used to implement and use the DCC. The real-time temperature is measured and analysed, and a conformity assessment (CA) of the process is done in real-time by PCS or DT. The calibration and measurement uncertainty values from the DCC are retrieved automatically and analysed, in order to be taken into account for the CA decisions. The process flow is shown in figure 2. The temperature limits are set via the ISO 19880-1 standard [2].

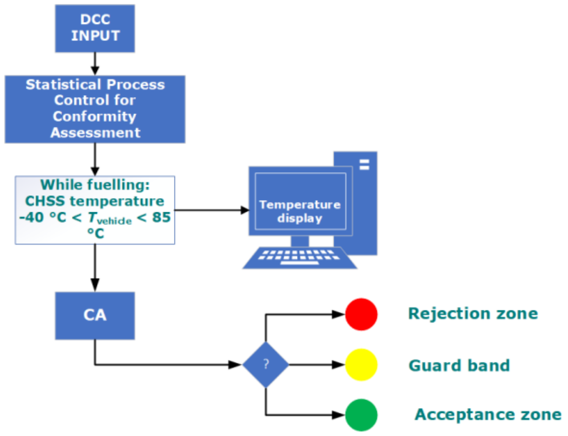

Fig. 2. Process flow diagram for conformity assessment

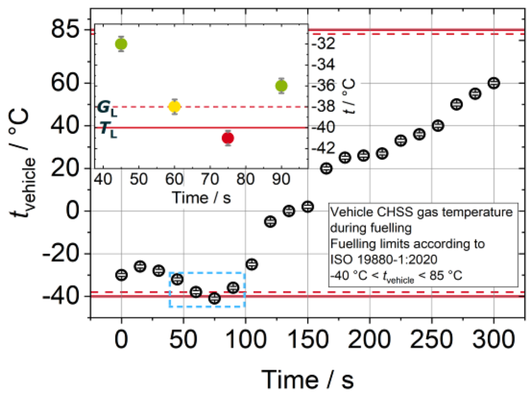

Fig. 3. Measurement data and conformity assessment results.

In figure 3, the process data acquired and the respective CA, is shown. The data is recorded at a rate of 15 seconds. The region of interest is shown in the blue box.A moving average and the standard deviation of the process are calculated. The uncertainty is derived according to DKD-R 5-1 [3].

The expanded uncertainty (k=2) of the vehicle temperature is expressed by

$$2\times\sqrt{(u(CAL)^2 + u(t\_SD)^2)} \qquad (1)$$

where u(CAL) is the uncertainty from the calibration process and $u(t_{SD})$ is the process standard deviation by means of the moving average.

The conformity is accepted if the hypothesis H_0 in equation (2) is true

$$H_0 = P\,(T_L \leq t\_vehicle \leq T_U) \geq (1-\alpha) \qquad (2)$$

Where T_L is the lower and T_U is the upper temperature limit as given in [2]. If H_0 is false, the values are rejected.

Once the probability is calculated, the values are either accepted, as indicated by green dots or they are rejected as indicated by red dots, in figure 3. The yellow values lie in the guard band, which means that the magnitude of the offset from the specification limit to the acceptance or rejection zone boundary is small.

Conclusion and Outlook

As the first step to digitalise calibration certificates, DCC for temperature sensors are generated and used in hydrogen refueling station. This will ensure digital metrological traceability and an automated conformity assessment of the processes. The use of digital signature makes it easier to validate the authenticity of the certificates. These digitalised processes will make it easier and faster to assure the quality of processes and products in general.

References

[1] S. Eichstädt, D. Hutzschenreuter, the quality infrastructure in the digital age: beyond machine-readable documents, IMEKO TC6 International Conference on Metrology and Digital Transformation (2022), https://www.m4dconf2022.ptb.de/fileadmin/documents/m4dconf2022/Material/Paper/IMEKOTC6-M4Dconf-2022-P65-EICHSTAEDT-et-al.pdf.

[2] ISO 19880-1 2020-03 Gaseous Hydrogen- Fuelling Stations -Part 1- General requirements, https://www.iso.org/standard/71940.html.

[3] DKD-R 5-1 Kalibrierung von Widerstandsthermometern 2018, https://doi.org/10.7795/550.20180828ACRU.