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Accreditation of Calibration Procedures for Specialised Measuring Instruments Utilized in Railway Transport; Selected Issues

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Summary
The paper presents issues associated with the calibration and supervision of railway specific measuring instruments. It starts with considerations regarding the benefits associated with the measuring instruments calibration, especially regarding calibration performed by accredited laboratories. Attention is paid to the importance of maintaining traceability and keeping knowledge about measuring instruments' errors in the context of railway transport safety. It analyses why the number of metrological laboratories offering accredited calibration of railway specific instruments in Poland is insufficient. The paper makes use of the experience of the Railway Institute Metrological Laboratory. In particular, it uses experience gained in 2017 during the accreditation of AC resistance measurements, which are utilized for accredited measurements of the resistance of slippers with fastening systems, wheel wear profile measurements with analogue callipers, buffer centre line height over rails running surface measurements and wheel tread diameter measurements based on two contact-points.

Keywords: calibration, accreditation, measuring instruments

1. Introduction

Currently, nearly all companies, including those in the railway transport domain, support their activities with quality management systems. Although the use of such systems is voluntary, market and client requirements have already pushed companies to accept such systems as a standard. The necessity for the supervision of the measuring instruments belongs to the wide range of consequences of implementing quality management systems. Such supervision covers, among others, periodic calibration.

There is no formal requirement to calibrate instruments in laboratories which have competences proven by the Polish Centre for Accreditation (PCA) or a respective foreign entity. However, using such laboratories, thanks to accreditation, provides a guarantee of high-quality calibration laboratory services and a high credibility of obtained results, which is especially important in the case of instruments utilized for measurements crucial for safety and/or people's health and personal safety. Moreover, it is worth pointing out, especially for companies offering services abroad, that calibration certificates issued by accredited laboratories are accepted internationally.

It is not difficult to find laboratories offering accredited calibration of common instruments, such as callipers or micrometers. However, until recently there was no entity in Poland which was able to perform accredited calibration of specialised railway instruments. In 2017, such accreditation was obtained by the Railway Institute Metrological Laboratory, as the first calibration laboratory in Poland.

2. The essence of calibration

Calibration is a set of activities, which enables the determination of a relationship between the measurement standard (master), which represents a reference value, and the measuring instrument, which is being calibrated [3]. If this relationship is determined, information about the metrological characteristics of the instrument is obtained, which reflects the technical state of the instrument and enables the decision to continue using the instrument or to withdraw it from use to be taken. Moreover, calibration by an accredited laboratory is regarded by all metrological institutions as a basic activity for maintaining traceability, in other words, referencing to national or international measurement standards (masters) [2].

Thanks to information about instrument errors and the uncertainty of performed calibration, users of the instrument can estimate the uncertainty of the measurements being made. Data concerning errors collected regularly at constant intervals constitutes a source of

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information about measuring instrument stability and the metrological characteristics over the time of wear.

The benefits from performing measuring instruments calibration, which are mentioned above, are especially important for measurements of the railway infrastructure components. It is obvious that all errors which occur during the production of railway vehicles or construction of railway tracks may lead to danger for passengers' health and personal safety. Therefore, it is necessary to continuously improve measurement accuracy and minimize the value of uncertainty.

3. Accredited calibration laboratories

The European Parliament, on the basis of Regulation 765/2008 dated 9 July 2008 [5], have introduced rules aimed at the homogenization of EU Member State regulatory frameworks focused on putting products on the common market. Products which are put on the market, disregarding the type or state of origin, have to be characterised by equally high quality, the fulfilment of equal, high requirements regarding health protection, safety and environmental protection, and public interest for ensuring the free movement of goods. The organisation of an international accreditation system, ensuring high competencies of entities providing the assessment of products conformity with requirements, is the main tool used for meeting the above-mentioned goal. Products certification bodies, personnel certification bodies, test and medical and calibration laboratories belong to such entities. Introduction of the above-mentioned regulation was aimed at giving special attention to the essence of product quality and at the harmonisation of rules already worked out by individual member states over the years.

The very beginnings of accreditation appeared in the 1950s, when interest in quality management was growing. The aim was to produce higher quality products and minimise the percentage of defective products. New solutions for reaching this goal were necessary. Attention was paid to standardisation of the requirements and assessment of conformity of products. The year 1958 is considered as the beginning of accreditation in Poland, as the Council of Ministers accepted an act dedicated to marking products with a quality mark [6].

Accreditation is voluntary both for the calibration laboratories and for the consumers. There is no document which would require the use of only services offered by accredited laboratories. However, using such laboratories is associated with many benefits. Each accredited laboratory fulfils the requirements of the currently applicable issue of PN EN ISO 17025 [4] standard. This means, in practice, that the laboratory:

- has qualified and experienced staff, which permanently improve their competencies,
- uses high quality measurement standards (masters), which are continuously supervised thanks to periodic checks and calibrations for maintaining traceability,
- uses procedures which are consistent with actual national and international standards,
- is involved in national and international interlaboratory comparisons aimed at proving the credibility of obtained results and appropriate estimation of values of uncertainty
- permanently improves its management system,
- has appropriate procedures ensuring impartiality and confidentiality,
- subjects itself to annual assessment by the Polish Centre for Accreditation auditors.

All the above aspects ensure clients receive the highest quality of services and obtained results.

4. Accreditation in the railway transport domain

Although there are over 100 actively working accredited calibration laboratories, until recently none of them could show confirmation of their competences in the calibration of instruments utilized for railway applications. Organizations which wanted services from accredited laboratories were forced to search for such entities abroad. That was a result of many factors, which are analysed below in this article.

As the most important reason for the above-mentioned situation, one could highlight the still low metrological awareness of people using or supervising measuring instruments, and the consecutive thoughtless view regarding the costs of calibration, instead of focusing on the quality of the obtained results. The experience of Railway Institute Metrological Laboratory employees shows that the main reason why clients contract the calibration of instruments is not their willingness to check the instrument, obtain metrological characteristics and further analyse the obtained data, but necessity forced by quality management systems accepted and introduced in organizations. As long as clients are focused on obtaining a certificate proving the fact that calibration has been performed, disregarding the substantive worth of such a document, the cost will stay as the main determinant for choosing a calibration laboratory. From that point of view, laboratories without accreditation have better offers. They do not bear the costs associated with involvement in a national accreditation system. They decide themselves how they supervise their measurement standards (masters), and how they are calibrated. Moreover, they are not required to be involved in interlaboratory comparisons. As a result, their costs are significantly lower and therefore they can afford to offer lower prices. Unfortunately, a low price is frequently linked with low service qual-

ity (e.g. calibration based on too few measuring points, giving results without the uncertainty of calibration) which makes such a service worthless.

The next aspect, although also associated with low metrological awareness, is the way measuring instruments are used, maintained and stored. Railway Institute employees repeatedly received measuring instruments for calibration in a very bad technical state. These included incomplete accessories, rust preventing the movement of movable parts and reading of the indicators, as well as measuring surfaces worn out so much that the instrument should be withdrawn from use and not given for calibration. Those are only some examples of how measuring instruments are treated. Clients are aware that performing accredited calibration for such instruments creates a risk, that the instrument would not fulfil metrological requirements, due to calibration uncertainty usually much lower than that in laboratories not working according to standards, and that there would be a need to replace it. As in the case described above, the economic aspect dominates.

There is also an additional problem associated with costs, however, this time costs which are borne by calibration laboratories. Credible calibration of instruments utilized for specialised measurements frequently requires the design and construction of a dedicated calibration stand, which enables the most efficient reproduction of real conditions in the case of measurements performed with a measuring instrument being calibrated. Construction of a specialised measurement stand is not only associated with high financial input, but also with a long return of investment. Measuring instruments utilized for railway applications, which are calibrated, frequently have an individual character and intervals between consecutive calibrations are lengthened as much as possible and usually equal 3 years. Moreover, the design and construction of dedicated calibration stands and the preparation of methodologies for checking instruments requires highly competent staff, with knowledge not only of metrological aspects but also regarding railway transport.

For new calibration methodologies for railway instruments, there is additionally a problem of performing validation, which is a pre-condition for accreditation. The usual way of validating the new methodology is a bidirectional comparison of the obtained calibration results with the results of calibration of the same instrument, which was performed by another accredited laboratory with at least the same value of uncertainty CMC (Calibration and Measurement Capability – the lowest uncertainty of calibration for a specific measuring instrument that a laboratory can achieve) [1]. In the case of Poland, there is a lack of laboratories having accreditation for the calibration of such types of instruments, and therefore bidirectional comparison should be done with a foreign laboratory. This, however, is associated with costs disproportionately high in comparison to the expected profits. The only possibility is to additionally elaborate the methodology for validation, which will ensure maintaining traceability.

5. Railway Institute activities

The Railway Institute Metrological Laboratory was created in 1998. Since the year 2000, it is an accredited calibration laboratory (certificate of accreditation AP 024). Employees of the laboratory, aside from calibration covered by the scope of accreditation, have for many years also handled non-accredited calibration of many instruments, among others, instruments utilized for the measurements of wheelsets, measurements of rolling stock parameters as well as measurements of railway infrastructure. Moreover, they know the construction history of most instruments utilized in railway applications and have their complete technical documentation, as they were designed by Railway Institute employees (then the Research and Development Centre for Railway Technology).

In the year 2017, the Polish Centre for Accreditation accepted the enlargement of the scope of laboratory accreditation by adding wheel wear profile measurements with analogue callipers, buffer centre line height over rails running surface measurements and wheel tread diameter measurements based on two contact-points (see Figure 1). As a result, the Laboratory became the first entity in Poland with accreditation for the calibration of specialised railway instruments.

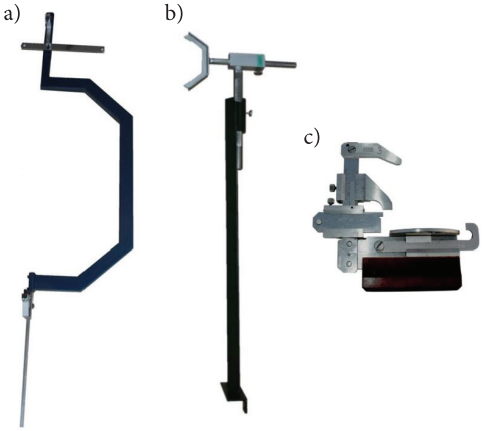

Fig. 1. Main instruments utilized for measurements for railway applications: a) instrument for wheel tread diameter measurements, b) instrument for buffer centre line height over rails running surface measurements, c) calliper for outer wheel wear profile and outer wheel rim wear profile measurements (for monoblock wheels and for rims utilized for wheels without tyres)[2]

[2] Source: Asco Rail Ltd. catalogue available at www.ascorail.pl/download/katalog-urzadzen-i-przyrzadow-pomiarowych.pdf, [access: 12 November 2017].

To obtain accreditation for the calibration of instruments measuring buffer centre line height over rails running surface, a special stand was constructed by the Laboratory according to its own design (see Figures 2 and 3). Validation was obtained by comparison between the results of calibration achieved with the constructed stand and the measuring arm.

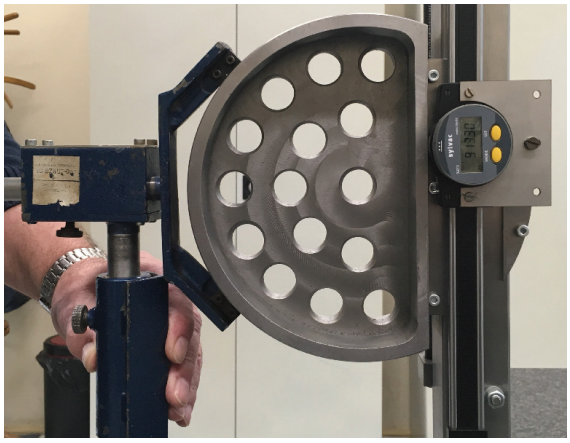

Fig. 2. Calibration methodology for instruments for measuring buffer centre line height over rails running surface [own photo]

Fig. 3. Stand for calibration of instruments for measuring buffer centre line height over rails running surface [own photo]

Moreover, the Laboratory obtained accreditation for AC resistance measurements, thanks to which it is able to perform accredited measurements of the resistance of slippers (see Figures 4 and 5).

Fig. 4. Stand for measuring the resistance of slippers with fastening systems [photo: Włodzimierz Surmak]

Fig. 5. Performing rail slipper resistance measurement [photo: Włodzimierz Surmak]

In the immediate future, the Laboratory will aim at further enlargement of the scope of accreditation for the calibration of instruments for railway applications. At first, the Laboratory wants to undertake elaboration of the accredited methodology for the calibration of instruments for measuring the distance between inner surfaces of wheels in wheelsets and instruments for measuring the diameters of wheels in wheelsets, which is based on three contact-points. It is also planned to construct a semi-automatic stand for calibration of manual and self-propelled track geometry trolleys.

6. Conclusions

Entities in the railway transport domain should aim at the continuous improvement of passenger

safety. Their health and personal safety are invaluable. Without any doubt, one of the ways to reach that goal is the appropriate monitoring of the quality and technical state of vehicles and infrastructure. To properly do this, all measurements enabling the technical state to be assessed should be performed with the highest precision and realisable lowest uncertainty.

Increasing precision with the minimisation of uncertainty is possible thanks to the use of measuring instruments which are in good technical state, periodically checked and calibrated. Calibration should be contracted to competent bodies – to accredited calibration laboratories. Data obtained during calibration concerning the metrological characteristics of the instruments should be properly analysed. Measuring instruments should be properly stored and maintained.

The present situation would not change significantly if the metrological awareness of railway workers does not increase. It is essential to understand the goal of appropriate management, utilization and maintenance of measuring instruments. Otherwise, entities would still focus only on possessing appropriate documents, proving the fulfilment of assumptions of management systems, instead of whether such documents provide any substantial worth. Entities acting in the railway transport domain should invest in basic metrological training for their workers.

The demand for calibration performed by accredited laboratories will increase together with an increase in metrological awareness. This will stimulate laboratories to enlarge their scopes of accreditation by elaborating appropriate calibration methodologies for the increasing number of instruments and to minimise uncertainty.

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