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Measurement related to traffic

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■ Editorial

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Les mesures liées au trafic routier

La métrologie légale promeut la sécurité publique, la protection de l'environnement, le commerce équitable, et l'innovation. Les articles publiés dans cette édition du Bulletin de l'OIML illustrent de manière très intéressante comment le travail des métrologues légaux peut contribuer à ces objectifs dans le domaine du contrôle du trafic routier.

Malheureusement, le nombre de décès dans le monde dus aux accidents de la route reste permanent à un niveau élevé. En 2020, les Nations Unies ont lancé une deuxième « décennie d'action pour la sécurité routière », les pays s'engageant à réduire de moitié le nombre de tués et de blessés d'ici à 2030. La sécurité routière est un aspect essentiel de la sécurité publique et peut être améliorée de manière significative grâce à une série de mesures efficaces et ciblées, notamment la législation et l'application de la loi pour pénaliser la conduite sous l'influence de l'alcool, ainsi que les excès de vitesse.

Les mesures jouent bien sûr un rôle crucial dans le contexte de la pénalisation des excès de vitesse, et à cette fin, il est essentiel que les instruments de mesure de la vitesse répondent aux exigences formelles et métrologiques en termes d'exactitude. L'une des contributions à cette édition traite du cadre établi pour la mesure de la vitesse, ainsi que de l'état d'avancement de l'OIML TC 7/SC 4/p3 pour la révision de la Recommandation R 91 *Cinémomètres radar pour la mesure de la vitesse des véhicules*.

En outre, deux articles illustrent la manière dont l'exactitude et la précision de la mesure de la vitesse peuvent être testées. L'une de ces contributions explique comment une comparaison de mesures d'instruments de référence a été réalisée pour la vitesse des véhicules entre trois instituts nationaux de métrologie, démontrant que l'incertitude de mesure est suffisamment faible. Le deuxième article présente la comparaison de mesure de vitesse entre le compteur de référence METAS à base piézoélectrique et un capteur de vitesse à base GPS monté sur le véhicule de mesure.

Outre les excès de vitesse, il est également bien établi que l'alcool au volant est un autre facteur de risque important pour la sécurité routière. De nombreux pays ont donc mis en place une législation sur l'alcool au volant. Cependant, des éthylomètres précis sont indispensables pour une application efficace de la loi dans ce contexte. Cette édition comprend un article présentant les changements reflétés dans la révision de la Recommandation OIML R 126 sur les éthylomètres, et fournissant des conseils sur sa mise en œuvre dans la législation nationale.

En outre, vous trouverez également des articles mettant en vue la contribution de la métrologie légale à la protection de l'environnement et l'innovation dans le domaine du trafic. Le trafic routier est une source importante de pollution atmosphérique, c'est pourquoi de nombreux pays ont modifié leur réglementation en matière d'environnement et de transport. Un axe principal de ce changement de stratégie concerne la promotion croissante des voitures électriques. Toutefois, la percée de la conduite électrique ne se produira que s'il y a une infrastructure technique pour les stations de recharge des véhicules électriques qui satisfait également aux exigences métrologiques. L'un des articles de cette édition aborde donc ce sujet, décrivant les défis et suggérant des approches pour promouvoir un cadre métrologique cohérent et pratique, respectant les principes du commerce équitable.

Enfin, parallèlement à l'évolution vers la conduite électrique, la conduite autonome gagne également en attention et en importance; une contribution est incluse qui donne un aperçu du domaine de la conduite autonome et invite à poursuivre la discussion sur la question du rôle de la métrologie légale dans le domaine des méthodes de validation émergentes pour les véhicules autonomes.

Les nombreux articles inclus dans cette édition couvrent un large éventail de sujets liés à la mesure dans le trafic, offrant ainsi de nombreuses pistes de réflexion. J'espère que vous apprécierez cette édition du Bulletin. ■

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Measurement related to traffic

Legal metrology promotes public safety, protection of the environment, fair trade, and innovation. The articles in this edition of the OIML Bulletin illustrate in a very engaging way, how the work of legal metrologists can contribute to these goals in the area of road traffic control.

Sadly, the number of deaths worldwide due to traffic accidents remains at a persistently high level. In 2020, the United Nations launched a second "decade of action for road safety", with countries committing to halving the number of fatalities and injuries by 2030. Road safety is an essential aspect of public safety and can be improved significantly through a range of effective, targeted measures, including legislation and law enforcement to penalise driving under the influence of alcohol, as well as speeding.

Measurements play a crucial part, of course, in the context of penalising speeding, and for this purpose it is essential that speed measuring instruments meet formal and metrological requirements in terms of accuracy. One of the contributions in this edition therefore discusses the established speed measurement framework, together with the progress of OIML TC 7/SC 4/p3 for the revision of R 91 *Radar equipment for the measurement of the speed of vehicles*.

In addition, there are two articles illustrating how the correctness and accuracy of the speed measurement can be tested. One of these contributions explains how a measurement comparison of reference instruments was performed for vehicle speed between three National Metrology Institutes, demonstrating that the measurement uncertainty is sufficiently small. The second article presents the speed measurement comparison between the piezo-based METAS reference speed meter and a GPS-based speed sensor mounted on measuring vehicle.

In addition to speeding, it is also well established that drinking and driving is another key road-safety risk factor. Many countries have therefore implemented drink-driving legislation. However, accurate evidential breath alcohol analysers are crucial for effective law enforcement in this context. This edition includes an article presenting the changes reflected in the revision of OIML R 126 *Evidential breath analysers*, and providing guidance on its implementation into national law.

In addition, you will also find articles shedding light on legal metrology's contribution to the protection of the environment and innovation in the area of traffic. Road traffic is a major source of air pollution, and many countries have therefore changed their environment and transport regulation. One main axis of this strategy shift involves the increasing promotion of electric cars. However, the breakthrough for electric driving will only happen if there is a technical infrastructure for electric vehicle charging stations that also fulfills the metrological requirements. One of the articles in this edition therefore addresses this topic, describing the challenges and suggesting approaches to promote a consistent and practical metrology framework, adhering to fair trade principles.

Finally, alongside the shift towards electric driving, autonomous driving is also gaining increasing attention and importance; a contribution is included that provided an overview of the field of autonomous driving and invites further discussion on the question of the role of legal metrology in the area of emerging validation methods for autonomous vehicles.

The numerous articles included in this edition cover a wide array of topics related to measurement in traffic, providing much food for thought. I hope you will enjoy this edition of the Bulletin. ■

TRAFFIC

Measurement comparison between the national road vehicle speed standards of Germany, Austria and Switzerland

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Abstract

In this paper we report on a measurement comparison between different reference installations for the measurement of road vehicle speed. The mobile reference systems of the Federal Institute of Metrology (METAS) in a first step and of the Federal Office of Metrology and Surveying (BEV) in a second step were installed in parallel along each of the two fixed reference systems of the Physikalisch-Technische Bundesanstalt (PTB), one on a rural road, another on a motorway. All the devices were found to be fully in pairwise agreement with each other, with offsets much smaller than the combined measurement uncertainty of the devices.

1 Introduction

In view of the fact that there are more than 1.25 million road deaths worldwide per year [1, 2] it is an important task for public authorities to implement suitable measures for traffic safety. To save lives, several fields of action are involved: inherently safe construction of roads and roadsides, safer cars (to avoid accidents and to reduce the severity of injuries), better emergency assistance infrastructures, effective education of drivers about proper behavior, and enforcement of traffic rules by the police or other authorities [3–5]. A particularly prominent role is played by speed enforcement because about one third of all road deaths are due to inappropriate or excessive speed [2, 6, 7].

Each country has its own rules for traffic enforcement. In general, speed measuring instruments must fulfill formal and metrological requirements, for instance inspired by OIML R 91:1990 *Radar equipment for the measurement of the speed of vehicles* [8]. An obvious requirement for a speed measuring instrument is the correctness of the speed value that is displayed. This can be tested by setting up the device under test next to a reference speed measuring instrument and comparing the outputs. Performing this test on a public road offers the advantage that the full spectrum of vehicle types (cars, trucks, motorcycles, etc.) and vehicle makes is present.

Implicit in this strategy is the fact that the reference instrument has a sufficiently small measurement uncertainty and that it is metrologically traceable to the International System of Units (SI). An important component of a traceability strategy is a measurement comparison with a reference instrument of a different institution [9]. Here we report on a metrological comparison of reference instruments for vehicle speed, performed between the mobile system of METAS, the mobile system of BEV, and the fixed systems of the PTB.

2 The reference installations

2.1 The PTB fixed reference installations

PTB operates two fixed reference installations for measuring vehicle speed. One is installed on a rural road (one lane in each direction, speed limit 70 km/h), the other one is on a motorway. Up to 2018, a section of the A39 motorway was used (two lanes in the same direction, no speed limit). When the A39 sensors were lost due to roadworks, a new site was chosen on the A2 motorway (three lanes in the same direction, dynamically changing speed limits, sometimes no limit at all).

On the rural road and on the A39, the system consists of two sets of four piezoelectric sensors mounted flush with the road surface; one set each on neighboring lanes. Within each set the sensors are

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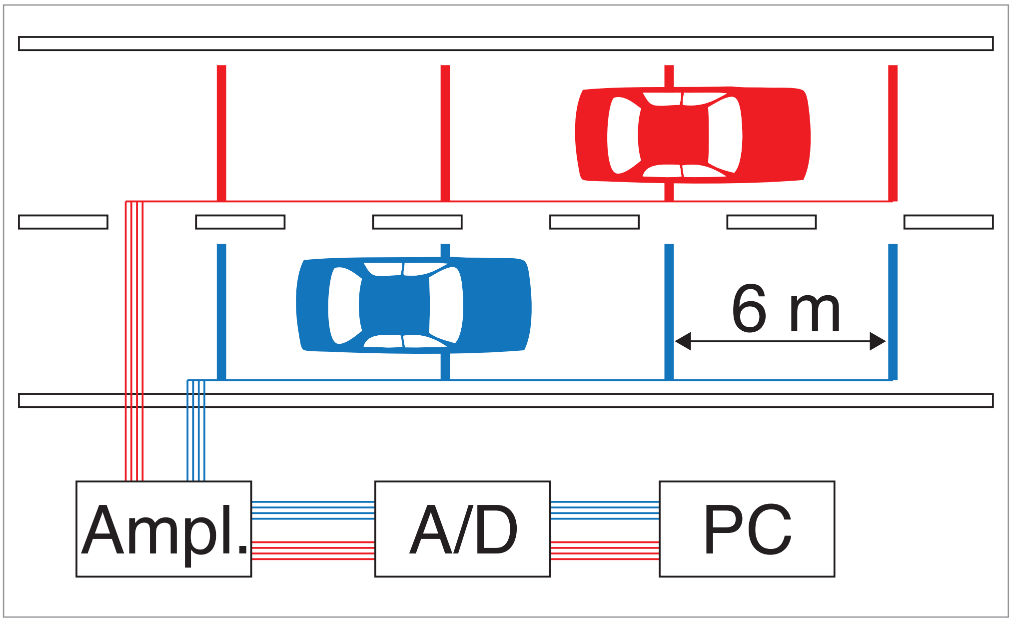

Figure 1: Setup of a stationary PTB reference facility for the measurement of road vehicle speed (not to scale). In each of two lanes a set of four piezoelectric sensors is mounted flush with the road surface, with a nominal spacing of 6 m between the sensors within each group of four.

separated by 6 m from each other (see Fig. 1). When the tyres on one axle of a passing car apply pressure on a sensor, an electrical signal is generated. When this signal passes a threshold a time stamp is registered. A passing car triggers the sensors in sequence. From the time difference between successive events for the same axle of the car its velocity can be computed. Using the four sensors one can generate six velocity measurements for each axle of a passing car, which gives an indication of whether the speed of the car was constant during its passage across the sensor field. However, in the measurements reported here, only the two innermost sensors were used for the detection of speed, i.e. a measurement base of length 6 m, because this gives the highest possible spatial overlap over the measurement regions of the METAS and BEV mobile devices.

In principle, the system is capable of eliminating those measurements where the vehicle accelerated strongly, as indicated by adjacent pairs of sensors giving different velocities. However, for the measurements discussed here, no such automatic discrimination was applied because the METAS and BEV devices were set up in the center between the innermost sensors so that any velocity changes during the measurement show up in a very similar way for all the devices.

On the new A2 motorway site the system is similar, but contains more than 20 sensors (some piezoelectric, some fiber-optic) distributed over the three lanes, with mutual separations ranging from 0.5 m to 45 m, so that for each commercial speed-enforcement device a suitable reference sensor separation can be chosen. For the comparison with BEV, a sensor pair with a 5 m separation was chosen, so that here the PTB uncertainty on the A2 motorway site is correspondingly larger than on the rural site or on the A39 motorway site.

The uncertainty of the PTB fixed installations has been formally evaluated according to the GUM rules [10, 11]. It is inversely proportional to the distance between the two sensors and roughly proportional to speed. For the section length of 6 m an uncertainty of 0.056 m/s (0.20 km/h) has been determined for a speed of 30 m/s (108 km/h) (coverage factor k = 2). For a section length of 5 m, the uncertainty increases to 0.068 m/s (0.24 km/h). The systems have been validated against a high-performance GNSS/inertial-sensor combination installed in a PTB test vehicle that was repeatedly driven across the sensor fields with speeds of up to 280 km/h [11].

2.2 The METAS mobile reference system

For the comparison the METAS mobile reference called "ESO 4" was used. It is a commercial device of the type "ES 7.0" manufactured by eso GmbH (now Kistler Instrumente AG). It was used as delivered by the manufacturer, without any modifications, and its velocity output values were used directly. The device consists of three differential-illumination sensors separated by 25 cm each and aligned at 90° to the nominal driving direction. The sensor outputs are cross-

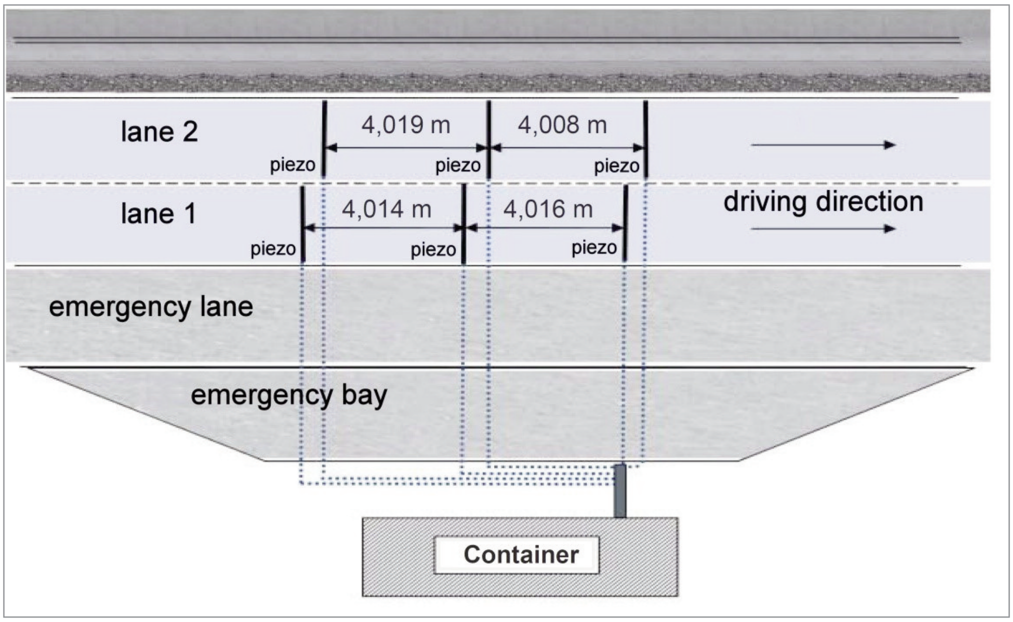

Figure 2: Sketch of the BEV stationary reference installation on a motorway near Vienna

correlated with respect to time to determine the speed of vehicles passing in front of the device. Two more sensors, aligned at 89.6° and 90.4°, serve to determine the distance of the vehicle to the sensor unit, thus allowing discrimination between lanes.

The mobile reference is subject to a yearly measurement comparison with the METAS stationary reference installation. For details about the METAS piezo-based stationary reference installation, we refer to [12]. Each comparison includes about 400 measurements of vehicles with speeds in the range from 75 km/h to 135 km/h. In the five measurement comparisons carried out since August 2016, the mean differences were in the range from −0.09 % to 0.05 % and the standard deviations were in the range from 0.13 % to 0.24 %. A complete evaluation of the measurement uncertainty is not available. For the comparison described here, the following expanded uncertainty (k = 2) was estimated:

$$U_{\mathrm{METAS}}(v) = \begin{cases} 0.7\ \mathrm{km/h} & \text{for } v < 100\ \mathrm{km/h} \\ 0.7\ \% \times v & \text{for } v \geq 100\ \mathrm{km/h}\,. \end{cases}$$

2.3 The BEV mobile reference system

The BEV mobile reference system is a commercial ES 8.0 device manufactured by eso GmbH (now Kistler Instrumente AG). It consists of a sensing unit with five differential-illumination sensors and a laser distance measuring unit. As in the “ESO 4” device used by METAS, three of the five optical sensors are aligned in parallel and are used for the speed determination while the other two determine the distance between the vehicle and the sensor unit, i.e. they facilitate a discrimination between the lanes. The laser supports the triggering of the measurement, the distance determination, and the cancellation of measurements in unclear situations.

The mobile reference device was calibrated at BEV’s fixed reference installation, based on piezoelectric sensors buried in the road surface, by placing it in the emergency stopping lane next to the central piezo sensor in lane 1 (Fig. 2). For each lane, two velocity measurement values are obtained: from the first and second sensors, and from the second and third sensors. Calibration is obtained by comparing the velocity of passing vehicles as measured by both devices.

The uncertainty u_s of the distance s of the piezo sensors of the stationary reference installation is estimated as u_s = 0.0620 %, the timing uncertainty is u_t = 0.0014 %. During calibration of the mobile reference device the type A uncertainty [10] σ_r of the difference between v_{12} and v_{23} is σ_r = 0.0250 %.

The mean offset of the mobile device from the stationary device was not corrected, which results in a contribution of u_{corr} = 0.0358 % to the measurement uncertainty. During the calibration of the mobile reference device the type A uncertainty σ of the difference of the velocity values measured by the stationary and the mobile device was $\sigma = 0.2465\ \%$. This results in a total calibration uncertainty u_{BEV} of the mobile reference device of $u_{BEV} = 0.2580\ \%$. The expanded uncertainty is $U_{BEV} = 2 \cdot u_{BEV} = 0.52\ \%$.

This measurement uncertainty was determined using speeds greater than 80 km/h. In analogy to the two regimes defined for the permissible validation errors of speed measuring devices [13] this results in the following (conservative) estimate for the expanded uncertainty ($k = 2$) of the mobile reference device, rounded up to the next 0.1 km/h:

$$U_{\mathrm{BEV}}(v) = \begin{cases} 0.6\ \mathrm{km/h} & \text{for } v < 100\ \mathrm{km/h} \\ 0.6\ \% \times v & \text{for } v \geq 100\ \mathrm{km/h} \end{cases} .$$

2.4 Uncertainty of the comparison measurements

In the measurement comparisons described here, the uncertainties of the two devices that are compared are considered to be statistically independent, giving a combined expanded uncertainty ($k = 2$) of

$$U_{\Delta v} = \sqrt{U_{\mathrm{PTB}}^2 + U_{\mathrm{BEV}}^2}$$

for the PTB-BEV comparison, and similarly for the PTB-METAS comparison.

In the experimental results, it is therefore to be expected that about 5 % of all values fall outside the limits of the combined $k = 2$ uncertainty.

2.5 Comparison measurements

The measurements were performed in two sets of two measurement days each. In May 2017 the METAS ES4 device was set up at PTB's rural road site and the next day at PTB's A39 site.

In November 2019 the BEV ES 8.0 device was set up at the rural road site and the next day at the new A2 site. Each time, the mobile device was placed on the grassy shoulder of the road, facing perpendicularly to the travel direction. Data was recorded for a period of 1–2 hours each, with both devices recording their own data.

Each system aimed to measure the speed of each car passing in the targeted lane within the normal flow of public traffic. No discrimination was made in the data with regard to vehicle type. Not all vehicles could be measured by all the systems. For instance, while the two mobile systems can measure the velocity of cars in either of the two lanes, they cannot measure both vehicles separately when they pass the sensor at the same time, unlike the PTB fixed sensors.

Data processing was carried out offline and separately for each of the mobile devices in combination with the PTB stationary device. In a first step, an automated routine matched the data records of the PTB device with that of the respective METAS or BEV device, based on the time stamps that each device stored together with the velocity data. In dense traffic, and particularly in multi-lane traffic, it can happen that the automated routine cannot decide which of two successive vehicles should be matched to the time stamp of the other device. The matching routine indicates such a possible mismatch by flagging the respective measurement. These cases are then examined manually by checking the video recording of the traffic scene. Only the correctly matched pair is retained.

In the next step, for each matched pair of speed data the difference of the measured velocities is computed. The series of velocity differences of a measurement run is examined for obvious outliers, defined as a velocity difference exceeding the expanded uncertainty in section 2.4. For each of those outlier cases, the video recording is examined. The data point is excluded from further analysis when one of the following conditions is true:

- the devices have measured vehicles in different lanes;
- two vehicles in the same lane are present at the same time in the space between the two innermost sensors of the PTB device;
- a vehicle changes lane while within the PTB measurement section.

We are aware that in principle one should check every pair of velocities for the presence of one of these annulment criteria, to exclude data points where an accidental cancellation of error conditions leads to a velocity difference that is too small to be noticed as an outlier. However, this check was not performed because of the huge effort this would require for thousands of vehicle passes, given that the calculation of the average velocity difference would not be affected much by such a rare and hypothetical event.

2.6 Results

Table 1 and Figure 3 present the key data of the various data runs. The terms "near" and "far" refer to the lane of interest. On the rural road, speeds and traffic composition are in principle the same in both lanes whereas on the motorway sites the "far" lane is the fast lane (lane 2 on the A39 and lane 3 on the A2) and the near lane is used mostly by heavy goods vehicles.

Table 1: Results of the comparisons

Data run	METAS @ rural near	METAS @ rural far	METAS @ A39 near	METAS @ A39 far	BEV @ rural near	BEV @ rural far	BEV @ A2 near	BEV @ A2 far
No. of vehicles	1316	571	1577	1189	756	814	1178	1119
v_{min} / (km/h)	27	24	52	65	26	21	51	86
v_{max} / (km/h)	88	88	187	232	104	88	132	191
mean of differences / (km/h)	0.019	–0.027	0.107	0.086	0.015	–0.049	–0.015	–0.003
standard deviation of differences / (km/h)	0.16	0.18	0.23	0.36	0.14	0.17	0.16	0.32
minimum deviation / (km/h)	–0.83	–1.47	–1.47	–1.45	–0.71	–0.69	–0.80	–1.25
maximum deviation / (km/h)	1.09	0.90	1.07	1.36	0.73	0.73	0.80	1.58
combined uncertainty range / (km/h)	0.70 to 0.72	0.70 to 0.72	0.70 to 1.37	0.71 to 1.70	0.60 to 0.66	0.60 to 0.62	0.61 to 0.85	0.63 to 1.24
Fraction outside combined uncertainty	0.2 %	0.5 %	1.0 %	2.0 %	0.4 %	1.2 %	0.4 %	1.7 %
G_{crit}	4.11	3.90	4.15	4.08	3.97	3.99	4.08	4.07
max(|G|)	3.04	2.73	3.63	3.95	2.36	2.55	2.57	3.93

In each case, the mean value of the velocity differences Δv is negligibly small compared to the combined measurement uncertainty. The fraction of values outside the interval of the combined uncertainty, however, is substantially smaller than 5 %.

In a second step, it was examined whether the data is compatible with the assumption of a Gaussian distribution of the Δv and whether there are statistical outliers.

The test statistics according to Grubbs [14, 15] were used. The value $G(\Delta v)$ is calculated as

$$G(\Delta v) = \frac{(\Delta v - \overline{\Delta v})}{\frac{1}{2}U_{\Delta v}}.$$

Its absolute value must not exceed the critical value, as determined from a t distribution. Otherwise, a statistical outlier is identified. In the 8520 measurements, no such statistical outlier was found.

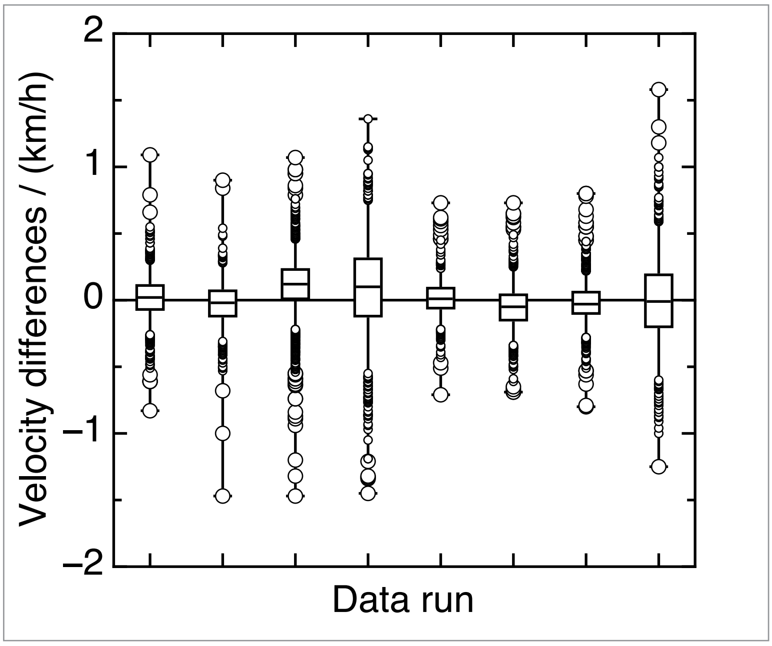

Figure 3: Box plot of the eight data runs, in the same order as the columns of Table 1. The lower and upper edges of the box correspond to the lower and upper quartiles, the horizontal bar in the box is the median, and the small and large circles are the close (< 3 times the inter-quartile range) and far outliers.

3 Conclusion

At all measurement sites and for all devices a very good agreement of the measured vehicle speeds was found. The results therefore cross-validated the stationary and mobile reference installations and devices for road vehicle speed in the national metrology institutes of Germany, Austria, and Switzerland (D-A-CH).

4 Acknowledgement

The PTB authors wish to express their thanks to A. Borchers for experimental assistance with the A39 measurements. ■

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TRAFFIC

Validation of the METAS reference speed meter using a GPS-based speed sensor

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Abstract

A speed measurement comparison between the piezo-based METAS reference speed meter and a GPS-based speed sensor mounted on a measuring vehicle was performed in February 2022. An excellent agreement within the combined uncertainty of both measuring instruments was observed. The mean deviation of eight measurement runs was 0.008 % ± 0.030 % (coverage factor k = 2) and the standard deviation was 0.018 %.

1 Introduction

Traffic speed meters measure the speed of target vehicles for the purpose of law enforcement. When used on busy roads, an instrument performs about 20 000 measurements per day, which adds up to more than 7 million measurements per year. The purpose of metrological control is to ensure that all the measurement results are within the legally prescribed error limits. The control procedures consist of a variety of field and laboratory tests conducted under different conditions. For field testing using large numbers of target vehicles, highly accurate and reliable references for real traffic are a basic requirement. At METAS our most accurate reference is a piezoelectric speed meter which is locally fixed on a motorway and which is described in Section 2. As part of the quality control, we validated the METAS reference speed meter using a vehicle equipped with a GPS-based speed sensor and a camera (see Section 3).

2 Piezo-based METAS reference speed meter

The METAS reference speed meter is permanently installed on the A6 national motorway approximately halfway between the cities of Bern and Thun. It is based on six piezoelectric sensor wires, which consist of a silver plated copper core and a piezoelectrically active spiral-wrapped PVDF film. The piezo sensors are embedded in a polyurethane-based casting compound about 10 mm below the road surface at nominal distances of 6 m (see Fig. 1).

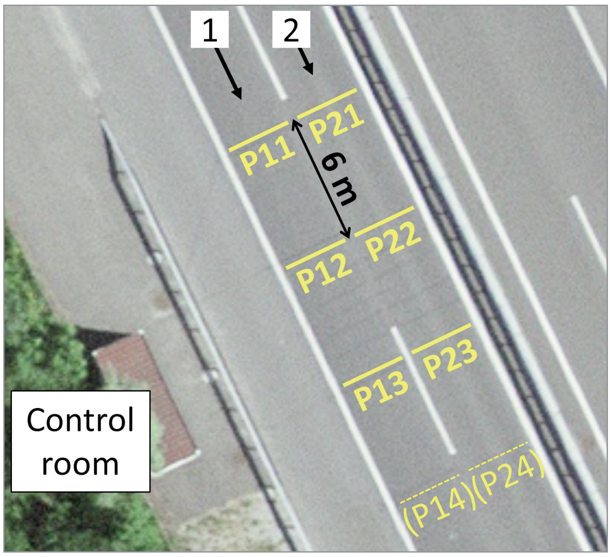

Fig. 1 Orthoimage of the METAS reference speed meter with markings of the piezo sensors. The last sensor on each lane (labelled P14 and P24) are not in use.

At the time of installation in July 2015 a total of eight sensors (four on each lane) were installed. Shortly after, the passive signal cable to the last sensor on lane 2 became damaged. It was decided not to repair the cable because the uncertainty of speed measurements when using three sensors on a section length of 12 m still met our requirements (see the uncertainty budget in Table 1). Furthermore, a section length of 12 m is often closer to the measurement regions of typical speed meters under test.

Vehicles driving over the sensors generate electric signal pulses which are amplified using a self-built charge amplifier and digitized using a National Instruments 9223 C Series module. The detection of the time of passage of the vehicles at the sensors (on the basis of the rising edge of the pulses generated by the first axle of the vehicle) and the derivation of the speed is carried out online with a LabVIEW program developed for this purpose.

Table 1 Uncertainty budget for the METAS reference speed meter with a section length of 12 m valid for speeds in the range from 15 km/h to 240 km/h.

Contribution	Expanded uncertainty ($k = 2$)
Tape measure (calibration and thermal expansion)	0.013 %
Sensor spacing variation	0.042 %
Tire tread effect	0.058 %
Time measurement	0.004 %
Combined	**0.073 %**

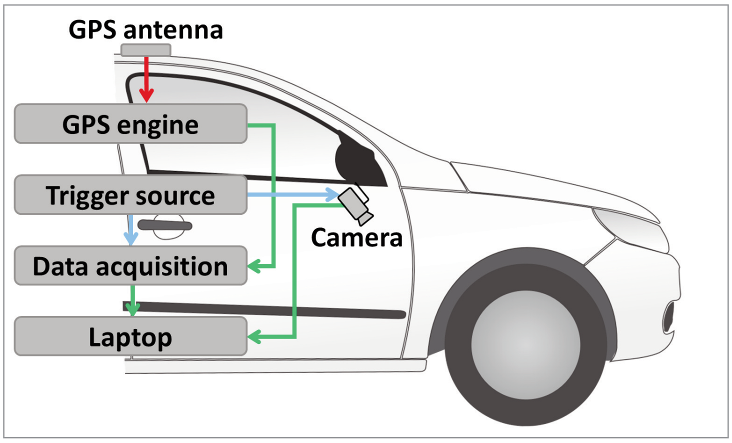

Fig. 2 Schematic diagram of the measuring vehicle used for validation (not to scale). Digital, analogue and triggering signals are represented as green, red and blue arrows, respectively.

Many national metrology institutes use very similar reference speed meters [1–3] and our uncertainty budget given in Table 1 is also similar. For details about the contributions to the uncertainty budget we refer to the most complete discussion of this subject given by Wynands *et al.* [1]. Note that Table 1 only contains contributions which are proportional to the measured speed. The only contribution that is independent of speed is the contribution from the rounding error which is 0.0005 km/h (rectangular distribution) and therefore contributes less than 0.004 % for speeds above 15 km/h. The only contribution which has a quadratic dependence on speed is the digitization error which is 1 µs (rectangular distribution) and therefore contributes less than 0.004 % for speeds below 240 km/h.

3 Validation procedure

Validation usually includes a statistical analysis of a series of observations. As the speed of a vehicle is not an inherent and reproducible property, a statistical analysis is only possible when a suitable reference is available. Validation of reference speed meters at a high level of accuracy is possible when based on the measurement of the ego speed of a measuring vehicle [1]. A schematic diagram of the measuring vehicle used for this study is depicted in Fig. 2. The ego speed of the measuring vehicle is measured using a GPS-based speed sensor, which is based on Doppler frequency demodulation of microwave signals received from GPS satellites (Racelogic VBOX 3i Single Antenna). A video recording at a frame rate of 100 Hz is made synchronously with the speed measurement data. The video camera is mounted outside the measuring vehicle and is directed towards the front wheels of the vehicle in order to detect the time of passage of the front axle at the piezo sensors.

The GPS-based speed sensor has a specified speed accuracy of 0.1 km/h (when averaged over sufficient samples to reduce the digitization error below this level) and a specified latency of 8.5 ms ± 1 ms. As for any GPS-based measurement, the performance is dependent on the GPS signal quality. The location of the METAS reference speed meter is suited for GPS-based measurements, as no large object blocks the direct path to the sky. The signals from at least seven GPS satellites were received during the measurements.

An average speed calibration procedure of the GPS-based speed sensor was applied during each of the eight measurement runs. The details of the calibration procedure will be described in detail in [4], currently in preparation. In short, a reference section of length 528.674 m ± 0.042 m ($k = 2$) was set up. The start and end points of the reference sections were chosen such that the piezo sensors are located approximately in the centre of the reference section. During each measurement run the time of travel from the start to the end point of the reference section was measured using the camera and the data acquisition unit of the measuring vehicle (see Fig. 2). The reference average speed between the start and end point of the reference section is calculated by dividing the known length of the reference section by the measured time of travel. The calibration consists of comparing the average speed measured by the GPS-based speed sensor to this reference average speed. The calibration resulted in an expanded measurement uncertainty of the GPS-based speed sensor of 0.036 km/h ($k = 2$).

The measurement vehicle was driven over the METAS reference speed meter eight times on 3 February 2022 at speeds in the range between 84 km/h and 114 km/h. The cruise control of the vehicle was activated to keep the speed as constant as possible. An exemplary

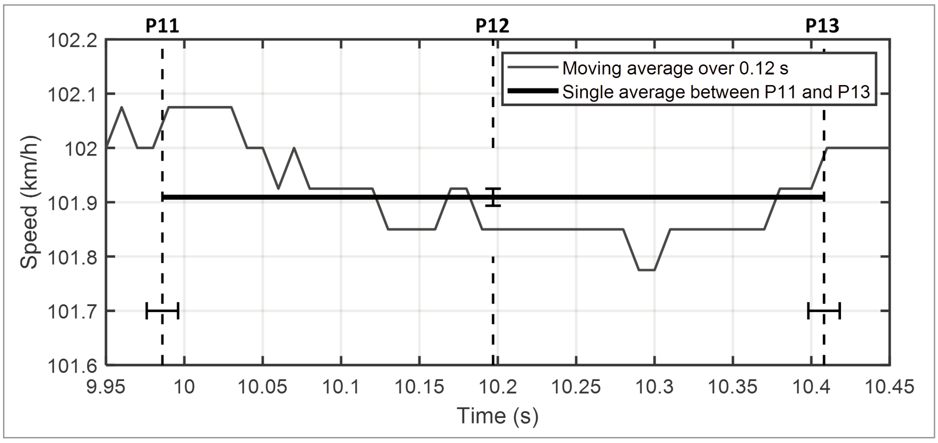

Fig. 3 Graphical representation of the speed during the seventh run measured by the GPS-based speed sensor. The vertical dashed lines represent the time of the passage of the front axle at the piezo sensors P11, P12 and P13 as determined from the video recording.

speed profile is graphically depicted in Fig. 3. The thick horizontal bar in Fig. 3 is a representation of the average speed between the piezo sensors P11 and P13, referred to as v_{GPS} in the following. Two contributions to the uncertainty of v_{GPS} were considered. The first contribution is the calibration uncertainty of the GPS-based speed sensor given above. The second contribution comes from the uncertainty of the determination of the time of passage at the piezo sensors (see vertical dashed lines in Fig. 3), which amounts to 0.01 s (rectangular distribution). For each measurement drive, the measured speed data was used to determine the propagated uncertainty contribution for v_{GPS}. The resulting uncertainty contribution for the example depicted in Fig. 3 was 0.016 km/h (k = 2).

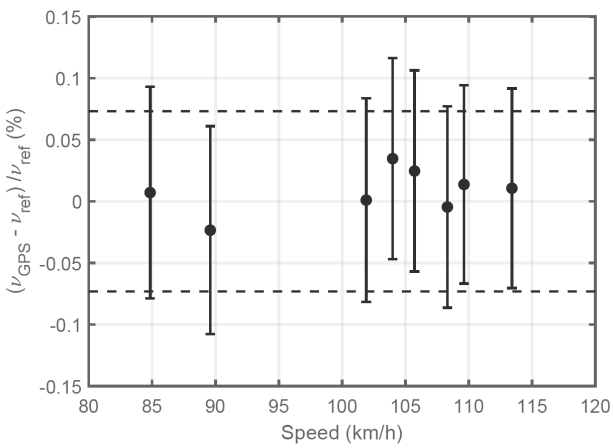

Fig. 4 Graphical comparison of the speed values measured using the GPS-based speed sensors with the results of the METAS reference speed meter. The error bars represent the combined uncertainty (k = 2). The dashed lines represent the uncertainty (k = 2) of the METAS reference speed meter.

The result of the validation is summarized in Fig. 4. The mean of the relative deviations $(v_{GPS} - v_{ref}) / v_{ref}$ is 0.008 % ± 0.030 % (k = 2) and the standard deviation is 0.018 %.

4 Conclusions and discussion

The two main conclusions of the validation are:

1) The mean deviation of 0.008 % ± 0.030 % (k = 2) between the METAS reference speed meter and the GPS-based speed sensor is consistent with zero deviation.

2) The observed standard deviation of 0.018 % implies that the standard deviation of the METAS reference speed meter is below this value.

These two conclusions support the uncertainty budget presented in Table 1.

Compared to the similar validation procedure described in [1] our method achieves a higher level of validation, mainly because we use a GPS-based speed sensor which uses the Doppler demodulation method. Compared to the position derivation method applied in [1], the Doppler demodulation method is better suited to detect dynamic speed changes of vehicles [5].

The calibration of GPS-based speed sensors is a challenging problem in metrology [5, 6]. During each of the measurement runs we applied an average speed calibration, thereby ensuring the performance of the GPS-based speed sensor at an accuracy level of 0.036 km/h (k = 2). The manuscript which describes the average speed calibration in detail is in preparation [4].

The METAS reference speed meter is a key instrument for the traffic laboratory, therefore quality control of the measurement results is of uttermost importance. While electronic parts can be readily checked using pulse generators, checking the performance of piezo sensors embedded in the road is more challenging. But it is precisely these sensors and their environment (casting compound) that are exposed to harsh conditions and could therefore no longer behave as expected over time. By periodically performing the validation procedure presented in this article we are able to detect even very slight declines in performance. ■

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TRAFFIC

Autonomous driving – Overview and challenges

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*Imagine you are sitting alone in your car,
enjoying your favorite book,
while your car smoothly navigates
through traffic-filled roads
and takes you safely home...*

1 Introduction

Considering the current developments in the field of autonomous driving, it is not unlikely that a scenario such as this will become reality within the next few years. But on the path to a successful market introduction there are various non-technical questions of ethical and legal dimensions. The discussions and answers to these questions will be instrumental for a broad acceptance of this emerging technology.

2 The taxonomy and current state of autonomous driving systems

Assisted driving functions such as lane centering (LC) or adaptive cruise control (ACC) have been in use for over two decades. A taxonomy of the different levels of automation was defined by SAE International (formerly the Society of Automotive Engineers, SAE) in their Standard J3016 [1]. It differentiates between Level 0 (no driving automation), Level 1 (driver assistance, e.g., LC and ACC), Level 2 (partial driving automation), Level 3 (conditional driving automation), Level 4 (high driving automation), and Level 5 (full driving automation).

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Driving automation systems for restricted operational domains are beginning to appear in production vehicles. The first type approval of a Level 3 system was granted to Mercedes-Benz's Drive-Pilot in 2021 in Germany [2]. The scope of the system is the guidance of the vehicle on a motorway at velocities up to 60 km/h. Earlier that year, the UNECE Working Party 29 (WP.29) Regulation No. 157 - Automated Lane Keeping Systems (ALKS) [3] became effective, providing a harmonized basis for the type approval of such systems.

Equivalent international regulations are currently being developed for vehicles with Level 4 systems [4]. On a national scope, in July 2021 Germany passed the Act on Autonomous Driving [5, 6], which represents the first legal framework for the (national) introduction of highly automated vehicles worldwide.

3 The systemic dimension of autonomous driving

Autonomous driving (AD) functions are based on a complex system consisting of a multitude of different sensors, software components (such as Artificial Intelligence (AI) and algorithms), and actuator technology. The AI components responsible for vehicle guidance are of particular interest in safety-related contexts.

Machine-learning techniques are commonly used in the field of autonomous driving. This category of AI learns correlations between an input and an interpretation based on training data. The trained component is validated by a separate set of test data. A challenge for machine learning is the preparation of correct, representative, and non-discriminating sets of training and test data. Because it is very difficult to trace and understand the decision-making of the trained AI system, trust in its decisions relies on the quality of the training data set. The high number of different sensors utilized in AD systems and the fusion of their respective data streams adds to the complexity of this endeavor.

This same fusion of data from various sources represents a strong point of many AD vehicle designs. Sensors such as cameras, radars, lidars, ultrasonic sensors, inertial sensors (IMUs), satellite navigation (GNSS), and V2X-connectors (car to everything) present different advantages and disadvantages. For example, the performance of a camera is reduced in rain, fog, and snow. These conditions, however, have negligible impact on the operation of radar sensors. In turn, radars cannot obtain detailed information on an object's shape and texture. While many vehicle designs rely on cameras and radars, lidar sensors can add complementary capabilities. Reference [7] provides a technical overview of sensor data fusion.

4 Validation of autonomous driving functions

Validation concepts for ADAS/AD vehicles (especially those of Levels 4 and 5) must accommodate the complexity that is inherent in an inhomogeneous set of sensors. Current approval guidelines for non-automated vehicles assume that in real traffic conditions everyone in possession of a driver's license can master the scenarios examined during vehicle validation. Consequently, the test cases exclusively focus on the validation of the vehicle under test. However, for autonomous systems the vehicle-guiding AD functions must also be tested as part of the complete system. Therefore, new test concepts must be established.

Current testing methods verify the safety of vehicles by focusing on the quality of AI training data and on demonstrations of the vehicle's safety by driving millions of accident-free (virtual) test kilometers. The WP.29 Regulation tackles the challenge with a multi-pillar approach. In [4] a combination of scenarios-catalogue-based virtual testing, physical testing on tracks and in real-world traffic, as well as audits and assessments of the testing strategies themselves are proposed. The testing methods are complemented by in-service monitoring and reporting to gain insights from field data, such as failures and accidents. The actual translation of these concepts into legal requirements also raises interesting research questions from a metrological point of view.

5 Open questions

Recent studies conclude that the number of accidents – especially fatal ones – in urban and interurban areas will be significantly reduced by the introduction of autonomous vehicles. It is expected that approximately half of the accidents in both domains will be prevented following a complete transition towards autonomous vehicles [8]. So, ethics alone already mandates the introduction of autonomous vehicles.

Nevertheless, situations in which people will be injured are inevitable. This raises another ethical question. We can assume that future vehicles will be able to react faster than any human driver and will in addition have a more comprehensive perception of the situation. But how shall an autonomous vehicle react in a situation where an accident can no longer be prevented or avoided? Especially situations in which an evasive action might save one person but cause fatal harm to another. How should the vehicle react when there are different numbers of potential victims involved in each action's prospect? Will the safety of the vehicle's passengers be rated more highly by the vehicle? Is it possible to anticipate these situations on an abstract level and pre-decide them on a technical level? Should this even be done? These moral dilemmas are the focus of complex ethical discussions [9] and cannot be answered in this article. However, they are crucially important for the future development of legislation and also to ensure public acceptance of this new technology. An example of a law which addresses these situations is given in the German Act on Autonomous Driving which states that the vehicle's system must not take any personal attributes into account when deciding on a course of action ([5] Section 1e, Paragraph 2 (2c)).

In addition to these ethical questions, there are also legal aspects to be considered. The international acceptance of vehicle type approvals rests on the 1968 Vienna Convention on Road Traffic [10]. It stipulates that every vehicle shall have a driver in control of the vehicle. The German law therefore requires a technical supervisor (in the vehicle or in a remote location) who can control the vehicle if needed [5], but one could argue that in the long run maybe the Convention needs to be adapted to allow fully driverless operation. Traditionally, the driver carries a large part of the responsibility regarding liability. But who will assume this responsibility in the case of accidents involving vehicles driven in fully autonomous mode? The vehicle's owner, the manufacturer as a company, or the programmer who developed the algorithms guiding the vehicle?

Finally, we would like to raise a question that is intended to encourage discussion among the readers of this edition of the OIML Bulletin and indeed among all OIML stakeholders:

What can or should be the role of legal metrology (and therefore of the OIML) in the context of the emerging validation methods for autonomous vehicles?

From the point of view of (systemic) metrology, there are many possibilities to contribute to the development of precise, reproducible, and reliable validation methods. The question of explainable AIs could benefit from our experience in the field of traceability. Is that sufficient (or necessary) to derive a mandate for the inclusion of automated vehicles into the realm of legal metrology?

The authors welcome feedback on this article and are keen to learn the experiences of readers in this field. ■

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Photo: PTB

OIML R 126

Revision of OIML R 126 Evidential Breath Analysers - Achievements and application

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Abstract

The 2021 edition of OIML R 126 *Evidential breath analysers* contains significant changes not only in the requirements but also in the concept of its application and the background information provided. This article describes the major changes in the Recommendation and offers guidance for its implementation in national legislation.

1 Introduction

Evidential Breath alcohol Analysers (EBA) are used worldwide in professional applications such as law enforcement, road safety, and occupational safety. Test results can have serious consequences for all concerned.

The first version of R 126 was published in 1998. The following edition, published in 2012, was under revision between 2013 and 2021 by a Project Group managed by a co-convenership (LNE-PTB). This Project Group included representatives of legal metrology institutions, laboratories, manufacturers, and users from 38 OIML Member States.

For over 8 years, meetings, exchanges and decisions took place on how to find a consensus and to draft a document that the majority of OIML Members could apply.

To guarantee the care and attention this complex issue warranted, much background information was collated and analysed to serve as basis for well-founded decisions for the revision of R 126.

In the 2021 edition, the gas generation was reviewed and clarified, and new tests were added or completely revised. Additionally, more possibilities to customise the requirements on EBAs to cater for differing national demands are given, and the optional clauses are arranged together to facilitate reading and handling.

The final draft was approved by the CIML in 2021 and the revision of R 126 was published in December 2021.

2 State of the art of evidential breath analysis

When analysing the worldwide application of breath alcohol measurements, it becomes evident that almost every country has its own approach.

Breath alcohol measurement for legal purposes is not only a matter of metrology but also raises issues of national jurisdiction as well as the biology of the human body.

Examples of such different national approaches are:

- The legal limit for driving under influence varies greatly around the world, as does the unit in which the breath alcohol concentration shall be expressed.
- Breath alcohol values sometimes have to be converted into blood alcohol values to fit into the national juridical system and the definition of the legal limits.
- The number of breath samples needed for a valid result varies between countries and sometimes even depends on the measured result in relation to the national legal limit for driving under influence.
- Depending on the geographic region, instruments shall withstand more or less severe environmental conditions such as rain, salt mist or dust.
- The question of how similar the test gases used have to be to human breath samples is treated quite differently. Some countries demand only so-called dry gases (ethanol in air) for all laboratory tests, some countries prescribe that test gases shall be as similar to breath as possible, i.e. to be saturated with water vapour and to contain 5 % CO_2, and some countries use something in between these two approaches.

To learn more about the different needs and demands in the various countries, two surveys were carried out within the members of OIML TC 17/SC 7/p3 for the revision of R 126.

The first survey in 2013 asked basic questions such as legal limits, units used in jurisdiction and in metrology, MPE, re-verification periods, long-term stability, and test gas prerequisites. 14 countries participated in this survey and this enabled the Project Group to identify a number of issues which needed be discussed in anticipation of the revision. The need for more background information regarding breath profiles and test gas generators became especially evident.

The second survey in 2015 focused on the verification regulations to identify commonalities which could be incorporated into R 126 as basic verification procedures. 19 countries from all regions in the world participated, which provided very useful and valuable information.

All the issues identified in the surveys were discussed in the course of the revision process, and wherever possible, a consensus solution was presented.

Analysing all this information, it became apparent that the classic approach of OIML Recommendations, i.e. to define one uniform set of requirements which is equally valid all over the world, is not suitable for EBAs.

3 Review of R 126: Major changes in the 2021 edition

The project to revise R 126 took over eight years. The long list of issues, as well as the sometimes divergent interests of the Project Group members, took their toll in terms of both time and workload. In addition to the annual meetings, various online consultations were held to discuss and decide specific topics; these consultations proved to be an effective tool. Since they were held independently of a meeting, the proposals for changes could be explained in written form with added background information if necessary, and the participating members could take their time to make well-founded decisions.

The most important changes implemented in this revision are explained in the following clauses.

3.1 Generation of test gases similar human breath

One of the main objectives of the Project Group was to define how to generate a gas mixture that is most representative of human breath (air, ethanol, humidity, CO_2, etc.) and how to mimic the dynamics of different lung capacities (volume, exhalation time, dead volume, etc.) and breathing techniques.

To achieve comparable test performances in different laboratories, the test gas generation has to be standardised as far as possible. Especially, the simulation of the dynamics of breathing needed to be clarified.

To establish a common basis, the Recommendation now defines the relevant characteristics of human breath in the context of R 126. These characteristics not only include temperature, humidity and CO_2 content but the evolution of flowrates and alcohol concentration during the exhalation process as well.

The next step was to define the test gas characteristics and to provide guidelines on how to generate these test gases. The nominal values and associated allowed deviation are specified for all characteristics of the test gases, including alcohol and flow rate profiles as well as for the ambient test gas conditions.

To show the differences between human and artificial breath profiles, Figures 1 and 2 from R 126-2, Annex A are presented below.

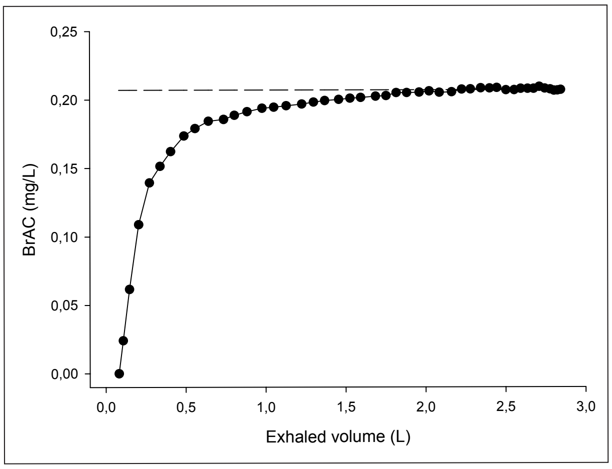

Figure 1: Example of a volumetric expirogram of breath alcohol concentration.
Source: David Grubb, Lars Lindberg: *Exhalation profile and elimination kinetics of mouth alcohol*, Blutalkohol Vol 48/2011, p. 57–66

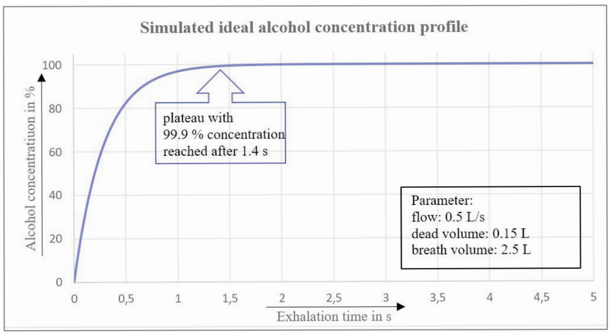

Figure 2: Example for a calculated alcohol concentration profile of a test gas generator

3.2 Test gas generators

The clauses on test gas generators also needed to be revised and extended. In the current edition, the capabilities of the different test gas generator types are

Figure 3: LNE test bench ethylometer (type 2 generator)

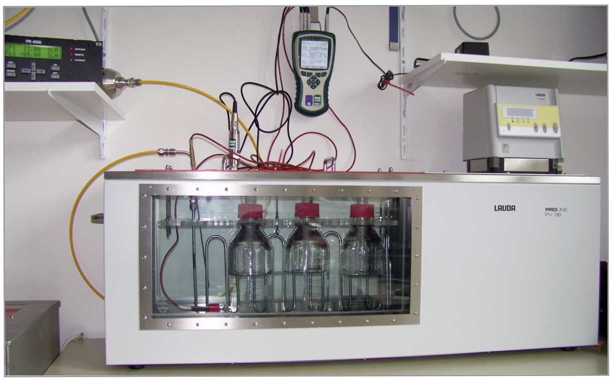

Figure 4: PTB bubble train (type 1 generator)

explained with more detail and the distinction of generators with simplified features is clarified. Additionally, guidelines for the use of compressed dry gases are now included.

It is also better described why a generator capable of creating a test gas with all the characteristics is indispensable for the full test program of R 126-2, and why for certain tests the use of test gases derived from more simplified means (e.g. the absence of CO_2 in test gases, constant mass concentration during injection, compressed dry gases) is allowed.

A table in R 126-2:2021 shows an overview of which test gas generator type (simplified means) is allowed to be used for each test.

Schematic sketches for test gas generators are included in Annex A of R 126-2:2021, as was the case in the 1998 edition, but they are now accompanied with more background information. The photos in Figures 3 and 4 show test gas generators used by LNE and PTB.

3.3 New test of water vapour

In the former versions of R 126, there was no specific test to test the effect of water vapour condensation from breath samples inside the sampling system of the EBA.

Portable and transportable EBAs shall be able to function correctly even at ambient temperatures below 0 °C. Since a human breath sample will always be warm with a temperature of ~34 °C, a rather high temperature differential might occur, and condensation might form within the mouthpiece and the sampling system. Condensation will have an adverse effect on the analytical result. Even when the mouthpiece is discarded and replaced with a new one for the following measurement, this obviously removes only the condensation created within the mouthpiece, but unfortunately this does not remove the condensation that might have formed within the sampling system. Portable EBAs often do not perform further cleaning steps such as purging, which carries the risk that any remaining condensation might then absorb alcohol out of the next breath sample.

If this issue is not taken into account during the design and development of the instrument, this may lead to a reduction of up to 20 % of the indicated measurement result when operated at cold temperatures.

For EBAs which incorporate a completely heated sampling system, this condensation issue was never a problem. However, with the recent development of more portable EBAs entering the evidential arena it was important that R 126 adopts a "condensation test" to ensure that all instruments meet the basic requirements.

There was broad agreement within the Project Group to include a condensation test to ensure that any measurement of an EBA is not affected by condensed water, which might remain within the sampling system from previous measurements.

3.4 Alignment of generic tests to OIML D 11 [1]

To keep the requirement and tests for generic influence quantities (Climate, Mechanical and Electronic) harmonised to the current edition of OIML D 11 [1], a review and amendment of the relevant clauses were necessary.

For this task, a subgroup consisting of experts from various countries was created within the Project Group and worked for three years to update the relevant requirements and tests. The proposals developed by the subgroup were discussed in the plenary meeting before incorporating them into R 126:2021.

The main issue was to complete the list of tests on immunity to influence quantities and to establish satisfactory test levels.

Some of the tests were reviewed to clarify a number of details (e.g. temperature tests, low voltage for internal battery).

A new approach was established to resolve difficulties in the performance of some tests, introducing alternative test schemes which allow special test modes of the EBA for the tests for conducted currents generated by RF EM fields and radiated RF electromagnetic fields.

New tests were added which were hitherto not included in R 126:2012 but were considered necessary in accordance with OIML D 11 [1] and by the Project Group.

3.5 Physiological influence quantities reviewed

Since the topic of physiological influence substances was always an important and much discussed issue, a subgroup was also created and worked on physiological influence substances for over three years with the following goals:

- collect scientific information about concentration levels in blood and breath of the respective substances which are physiologically relevant and can be found in human beings;
- based on the collected data, summarise which substances are likely to influence a breath alcohol measurement; and
- clarify the requirement on interfering substances and review the test for them.

For most of the substances, the data basis was quite clear and the decision on what to do about it could be reached unanimously.

For acetaldehyde, the data basis was not that clear for a few very specific circumstances. Although all the experts consulted did not consider acetaldehyde as a relevant interfering substance, there were many discussions within the Project Group and strong arguments for and against were presented. Unfortunately, it was not possible to find a compromise that would satisfy all sides, so the final decision had to be made by voting on this issue in a consultation text.

Since there was no 2/3 majority for a change in the list of substances, acetaldehyde was not re-introduced into the list of interfering substances to be tested in R 126:2021. This issue was recorded by the secretariat to be picked up again in a future revision.

Intense discussions took place about the meaning and interpretation of the requirements and limits for the physiological influence quantities and the basic principle of the test procedures.

Since the hitherto existing fixed limit for all interfering substances does not take into account the ratio between the amount of interfering substance and the amount of ethanol also present in the sample, it was decided to switch to the concept of sensitivity instead.

Sensitivity is defined as the "quotient of the change in an indication of a measuring system and the corresponding change in a value of a quantity being measured. Sensitivity of a measuring system can depend on the value of the quantity being measured. The change considered in a value of a quantity being measured must be large compared with the resolution." [2]

This means that for the tests, the anticipated change should be large compared to the resolution. This is the reason why relatively high concentrations of interfering substances are prescribed for the tests.

This does not mean that these prescribed concentrations are physiologically relevant. This may be correct for some of the listed substances, but for others clearly not.

So, the allowed influence for the interfering substance was changed from a fixed value to a sensitivity value, changing it therefore from a fixed to a dynamic value, aligned to the actual ethanol concentration.

3.6 New possibilities to customise the requirements

Already in former editions of R 126 certain requirements were only optional, but due to the prescribed structure for OIML Recommendations, they were not all grouped together.

In R 126:2021 some more possibilities to customise the requirements on EBAs to national demands are given, and the optional clauses are arranged together to facilitate reading and handling. National authorities may now define optional disturbances as expected in specific environmental conditions as well as optional technical requirements.

As optional disturbances, new environmental tests were added to simulate specific climatic conditions:

- sandy or dusty environmental conditions similar to the conditions in dusty warehouses, production of concrete and dusty outdoor regions;
- salt misty environmental conditions similar to those on board sea-going vessels; and
- water and moist outdoor conditions including light or heavy rain or occasional splashes of water similar to those on board smaller boats.

The prescribed test procedures are in accordance with OIML D 11 [1]. For harmonisation with international standards, the requirements for protection against water are related to the IP-code classification (degrees of protection provided by enclosures) of IEC 60529 [3].

As optional technical requirements, the revised requirements for durable recording of measurement results were assembled together with the requirements for the new option of redundancy:

- Durable recording of measurement results with:
  - Printing device: The printer was already classified as optional in the former editions of R 126. Now, the list of required information to be printed is extended and the requirements for data transmission to external printers are clarified.
  - Storage and transmission of data: These clauses were updated to conform to the requirements specified in OIML D 31 [4].
- Redundancy:
  - This is a new clause to include the requirements for redundant breath samples and redundant measuring sensors.

    "Redundant breath samples" means that two or more gas samples will be taken and analysed for a standard measurement cycle, either consisting of repeated breath samples or a check with a test gas as part of the measurement cycle.

    "Redundant measuring sensors" means that the EBA will be equipped with two independent measuring systems for alcohol and other parameters.

    These redundancy options can be applied independently or in combination, and they might fulfil various purposes, e.g. juridical demands as well as detection of residual alcohol in the upper respiratory tracts.

3.7 Definition of a maximum allowed deviation of the test gas concentration

In former versions of R 126, ethanol concentration was defined with a limit for the uncertainty only, whereas other nominal values of the test gas parameters were mostly specified as a variation range (= maximum allowed deviation).

First, to avoid any misunderstandings, the difference between the terms variation and uncertainty needs to be explained for our context:

Variation: this describes how exact a value must be respected for a specific test or, in other words, the range in within a value is acceptable.

E.g. for the delivered volume, the nominal value is 2.0 L, with a variation of 0± 0.3 L. This means that a test is acceptable when it is performed with a volume between 1.7 L and 2.3 L.

But this does not specify how well the volume has to be determined.

Uncertainty: this describes how well an actual value is or has to be known or, in other words, the quality of the determination of the value.

E.g. for an ethanol concentration of a nominal value of 0.400 mg/L, the given uncertainty limits of 1/3 MPE demands that you have to know for certain that the real gas concentration is between 0.393 mg/L and 0.407 mg/L.

But this does not resolve the question of whether if it is acceptable to use a test gas with the required uncertainties but with an actual concentration that differs from the prescribed nominal value for that test. For example, the question of whether it is allowed to use a test gas concentration of e.g. 0.395 mg/L (with U = ± 0.007 mg/L) when the test procedure prescribes 0.400 mg/L (with U = ± 0.007 mg/L).

In the case of the ethanol concentration, a defined limit of variation together with an uncertainty limit will cover the following issues:

- For commercially available dry test gases in bottles, the gas suppliers typically offer a manufacturing tolerance from ±3 % to ± 5 % from the nominal value.

  The test lab now needs clear regulations to decide whether to use a purchased gas or to reject it.

- Regarding the OIML Certification System, there is also a need for a clear regulation concerning whether a test report can be accepted or not if a certain test is performed with a nominal concentration that slightly differs from the one specified in the test description.

Guided by existing prescriptions for variations in other OIML Recommendations, the following equation for the variation limit of ethanol was proposed:

For an ethanol concentration β the deviation to the nominal β_0 shall be plus/minus the (maximal permissible error *MPE* – Uncertainty *U*):

$$\beta_0 - (MPE - U) \leq \beta \leq \beta_0 + (MPE - U)$$

After some lively discussions, the Project Group decided to incorporate the equation into R 126-2:2021 in the simplified form of: *"nominal value with a deviation from the target value of* ± *(⅔ MPE)"*.

3.8 Verification procedure not prescribed, guideline to define own procedures

The result of the survey concerning the verification regulations taught the Project Group that even among the 19 responses received, hardly any common procedures could be identified. Not only the number of tests and the test gas concentrations varied, but also the test gas source and the parameters, which have to be checked separately from the alcohol sensor.

Therefore, since it was simply not possible to identify a common basic verification procedure for worldwide application, it was decided to design the clauses on initial and subsequent verification only as a guideline for developing test procedures for verification rather than prescribing a fixed method which is difficult to apply.

In the respective clauses, all the points which have to be considered are listed, from the visual examination, test gas prerequisites, metrological examination to verification marks and documentation. The responsibility to define a certain procedure is up to the national authorities.

3.9 Renewed annexes with more background information

The Annexes in R 126 were also part of the revision process. Although only classified as “informative” they provide important know-how for the test laboratories.

When introducing breath alcohol measurement to the scope of a laboratory, the same questions consistently become relevant. To clarify these questions within the context of R 126, the basic knowledge of how to produce a wet test gas is now presented in Part 2, Annex A “General examples for test gas generators”.

As requested by the Project Group members, the schematic sketches of test gas generators have been re-introduced, accompanied by an explanation of the physics behind them. Additionally, the generation of breath profiles for flow and concentration has been explained with more references to natural human breath profiles.

It might be puzzling that Part 2, Annex B “Examples of detection of alcohol in upper respiratory tracts” is classified as an “informative” Annex since it is mandatory that the EBA is equipped with such a function (see R 126-1:2021, 7.1.8). But for this function various technical solutions are possible, and as a fundamental rule, OIML Recommendations never prescribe a certain technique. So, Annex B just describes the most common methods, from which national authorities may choose one or more to render it mandatory for their country. However, it is not the intention of this Annex to prevent any new innovative solutions from being used for the detection of alcohol in the upper respiratory tracts.

Meanwhile, the test descriptions for the existing solutions have been revised and now some more information and the same layout as in the main document can be found.

Newly introduced as Annexes to Parts 1 and 2 are comparison tables which show the differences between the 2012 and 2021 editions of R 126.

From these tables it can be traced where each clause is placed in both editions, and, where necessary, short explanations about the applied changes are also included.

Since this revision was a complete overhaul of R 126, these tables will be useful to facilitate a transition of the requirements from the 2012 basis to the new 2021 edition.

4 Application of the revised R 126 - advantages and obligations

For the application of R 126:2021, the advantages of an increased choice of optional requirements are:

- each country can adapt the requirements on EBAs to fit their specific needs without leaving the framework of the OIML;
- the tests for specific requirements are now harmonised with reference to international basic standards; and
- manufacturers will be able to better cover the various worldwide requirements with reference to the OIML.

However, this enhanced possibility of choices clearly also demands the obligation to choose.

Apart from the clauses concerning the optional disturbances and requirements, there are a number of issues where national authorities may (or even have to) decide how to handle them before implementing evidential breath analysers and R 126 into national laws and regulations. Due to the context, these issues to be decided are still dispersed throughout the complete Recommendation.

The tables shown at the end of this article will provide some assistance on which issues should be covered as a minimum in a national regulation about EBAs based on R 126. This list of issues is written without any claim to completeness, since there might be additional issues to consider which might not be covered by R 126 but which are important within specific national conditions.

5 Conclusions

With the 2021 edition, R 126 now offers a better the chance to harmonise the prescriptions of different countries and make it easier for manufacturers to serve the worldwide market.

We look forward to seeing the new edition of R 126 used in practice. Time will tell how this new approach is applicable and which experiences will be encountered by manufacturers and national authorities.

The R 126 secretariat would like to take this opportunity to again thank all the participants in the Project Group who dedicated their knowledge and time to this revision. Without their contributions and dedication, we never would have been able to realise this project. ■

6 Tables of issues to be decided by national authorities

In the following tables, the issues to be decided are classified into two categories:

- Category A: Crucial issues, a regulation on the national level is indispensable.
- Category B: Optional issues, a regulation on the national level is required only if considered as relevant.

Table 1
Category A - crucial issues

General crucial issue to prepare for the application of EBA		
	Issue	**Necessary steps by national authorities**
A	**Unit of legal limit and applicability on breath alcohol measurements** It may be the case that in the national regulations of a respective country a certain limit already exists for driving or working under the influence of alcohol. Often, drink-driving limits are based on blood alcohol measurements and the given limits are not directly applicable on breath alcohol measurements.	Examination - how the legal limit is defined and in which unit it is given, - if the given legal limit is directly applicable to breath alcohol measurements. If the legal limit is defined as the concentration of ethanol in blood (e.g. as a ‰) it is indispensable to: - either specify a conversion factor for the expression of breath alcohol concentration in blood alcohol units (e.g. from mg/L into ‰), or - set a specific legal limit for breath alcohol concentration in adequate measurement units (e.g. in mg/L)

Crucial issues of OIML R 126:2021			
	Clause of R 126	**Relevant text of R 126**	**Necessary steps by national authorities**
A	R 126-1, 4.5	Depending on national regulations, a complete measurement cycle may consist of one or more breath samples.	Definition of a measurement cycle with the number of breath samples and, if applicable, the calculation of the result
A	R 126-1, 5	The use of an equivalent unit of measurement is possible if the indication is in conformity with the SI units.	Decision on the unit of measurement.
A	R 126-1, 6.5	The verification period is defined under the responsibility of the national Authorities (subsequent verifications).	Specification of the verification period
A	R 126-1, 9.1	Type approval mark according to national regulations;	Specification of the type approval mark
A	R 126-2, 2.5.8.1 and 2.5.8.2	Test schemes A or B: The procedure provided by the manufacturer must be approved by the national authority	Approval of the procedure applied
A	R 126-2, 3.1 to 3.4	According to national laws and regulations, individual EBAs … may require initial verification … and/or may require subsequent verification when in service	Decision, if initial and/ or subsequent verification shall be prescribed. Decision on the procedures for initial and/ or subsequent verification Decision on the type of test gases to be used. Decision on the additional tests Decision on verification marks, seals and documentation
A	R 126-2, A.1	Upon requirements by national Authorities, other formulas such as Harger's formula might be prescribed to use	When wet gases are used: Decision on the application of an equation for the calculation of the ethanol content

Table 2 – Category B – optional issues

	Clause	Relevant text	Necessary action by national authorities
B	R 126-1, 2	National authorities may require that EBAs be equipped with special features (mandating the inclusion of a printing device, prohibiting or requiring the displaying of some information in addition to the final measurement results, etc.)	Specification of special features
B	R 126-1, 6.2	National authorities may require a masking function which indicates 0.00 mg/L for measured mass concentrations equal to or less than a given value	Decision if a measurement result shall be indicated as "0.00" if the result is below a certain low value. Specification of the limit value for masking
B	R 126-1, 6.6.1	National regulations may require that the MPE as specified in 6.6.1 shall also apply for verification after repair or for mandatory periodic verification.	Only if the MPE of 6.6.2 shall not be applied: Specification which MPE shall be applied instead for verification after repair and periodic verification
B	R 126-1, 6.11.2	National regulations may require additional substances to be tested.	Specification of additional substances to be tested
B	R 126-1, 6.11.3	For EBAs to be used in specific environmental conditions …, national authorities may request additional performance criteria concerning the specific conditions.	Specification if and which of the optional disturbances of 6.11.3 shall be required
B	R 126-1, 7.1.10.7, a)	If a raised risk level (Level B) is required by national authorities, the source code shall be made available to the type evaluation authority.	Decision if the software of the EBA needs to be examined on a raised risk level (level B) according to OIML D 31[4]
B	R 126-1, 7.2	EBA may be fitted with one or more of the following options:	Decision, if and which of the options of the following subclauses are to be applied
B	R 126-1, 7.2.1.1	The EBA may be fitted with a printing device (internal or external)	Specification: - if a printer shall be mandatory, - if a printer shall be considered as legally relevant - of the details of personal data required on the printout; - of the number of required printouts
B	R 126-1, 7.2.1.2	The EBA may store measurement data for further legally relevant applications or transmit measurement data before they are used for legal purposes, according to national regulations. The EBA shall have sufficient permanency to store the data until it is no longer legally required, according to national regulations. General national regulations may contain strict limitations for the deletion of stored measurement data. If data is transmitted from the EBA (secure environment) to an external environment, national authorities shall decide on the risk level according to OIML D 31 [4] for the transmission and storage of data.	Specifications, if and how the EBA shall provide retrievable measurement data regarding: - internal storage of data, - transmission of data, - storage time or storage capacity, - deletion of data, - risk level according to OIML D 31 [4] for transmission and storage of data.

	Clause	Relevant text	Necessary action by national authorities
B	R 126-1, 7.2.2	National regulations may - define a measurement cycle with more than one breath sample, or - demand redundant measuring sensors within an EBA.	Specifications of - measurement cycle with more than one gas sample, or - redundant measuring sensors within an EBA.
B	R 126-1, 7.2.2.1	National authorities may require - two independent measuring systems, or - two or more measurements for a standard measurement cycle, either consisting of repeated breath samples or a check with a test gas as part of the measurement cycle.	Specification of - redundant measuring sensors within an EBA and their usage depending on the defined measurement cycle, - use of certified test gas to check the proper operation of the EBA, - measurement cycle with more than one breath sample.
	R 126-1, 7.2.2.2, c)	If the EBA is configured with multiple breath samples for a measurement cycle: National regulations shall define the limits for the allowed variation between the breath samples regarding concentration, volume and exhalation time. National regulations shall prescribe the number of breath samples to be measured and how the final result is determined out of the measurement result for each breath sample. National regulations shall prescribe which details of the multiple measurements shall be given on the printout.	Prescription of - limits for variation between repeated breath samples regarding volume and exhalation time, - number of breath samples to be measured, - how to determine the final result for the complete measurement cycle, - which details of the multiple measurements shall be stored and/or printed.
B	R 126-1, 8.1	The instruction manual shall be in the official language(s) of the country (or another accepted language according to national legislation).	Prescription of accepted language(s) for the instruction manual
B	R 126-1, 8.2	The EBA shall conform to the relevant national regulations and standards for electrical safety and, where appropriate, for compressed gases. Verification of compliance with these regulations and standards is not within the scope of this Recommendation.	If applicable: Prescription of national regulations and standards for electrical safety.
B	R 126-2, 2.3.2	National regulations may require higher levels for the validation and examination steps.	Prescription of a raised risk level B for the software validation.
B	R 126-2, 2.5.1	If permitted by national authorities, before starting the process of type evaluation the EBA may be adjusted, if necessary, in order to minimise the initial intrinsic error.	Specification of how to handle adjustments before the type evaluation process starts.
B	R 126-2, 2.5.6.1 f)	t_{min} shall be 3 s as defined in R 126-1, 6.10.2, or a value between 3 s and 5 s according to the manufacturer and to national regulations.	Specification of a different value for the minimum exhalation time than the given value.

	Clause	Relevant text	Necessary action by national authorities
B	R 126-2, 2.5.6.2 and Annex B	National authorities may choose one, two or all of the following solutions to detect and/or exclude alcohol in the upper respiratory tracts.	Prescription of a certain solution for detection of alcohol in the upper respiratory tracts. For each solution, further details then need to be specified. (Note: The EBA has to have a function to detect this (see R 126.1, 7.1.8); this prescription may only limit the applied technique).
B	R 126-2, Annex A	If required by national legislation, national authorities may be required to use other formulas such as Harger's formula.	Prescription of formulas for the calculation of ethanol in the gaseous phase.
B	R 126-2, Annex B, B.2.1	Two-measurement cycle - first method: National authorities may define that the measurement cycle shall then be stopped automatically after the first measurement and may require the unique available result to be indicated.	Prescription of cycle.
B	R 126-2, Annex B, B.2.3	National authorities shall specify how the final result of both measurements shall be obtained (e.g. lower result, mean of both results, or both results). National authorities may specify smaller differences than required here.	Definition of the final result to be displayed.
B	R 126-2, Annex B, B.3	Delay before measurement: National regulations may demand a mandatory observation period before each measurement in the field.	Prescription of a delay before measurement.

7 References

[1] OIML D 11:2013 *General requirements for measuring instruments – Environmental conditions*

[2] OIML V 2-200:2012 *International Vocabulary of Metrology - Basic and General Concepts and Associated Terms (VIM),* 3rd Edition

[3] IEC 60529:1989+AMD1:1999+AMD2:2013 *Degrees of protection provided by enclosures (IP Code)*

[4] OIML D 31:2019 *General requirements for software-controlled measuring instruments*

TRAFFIC

E-vehicle charging

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Abstract

Demand for electric cars has risen sharply in recent years. From a metrological point of view, a number of questions remain unanswered, such as how electricity meters in charging stations should be conformity assessed and with reference to which requirements. Various organisations, including OIML TC 12 *Instruments for measuring electrical quantities*, are active in this rapidly evolving domain of legal metrology.

1 Introduction

The market share of electric cars is growing at an ever faster rate. Electric vehicles (EVs) need charging stations to charge their batteries. The availability of public charging stations is one of the most important success factors for the acceptance of electric cars [1]. Consumers are used to the trustworthy measurement of volumes of petrol (gasoline) or diesel when they refuel their traditional car and so they expect the same level of trustworthiness from the measurement of electrical energy when they recharge their electric car.

However, while legislation for petrol (gasoline) stations is well established, this is not yet the case for regulations for electric vehicle supply equipment (EVSE). To harmonise the approach and use knowledge available in different OIML Member States, OIML TC 12 received a mandate to work on this matter in 2016 and a subgroup was set up within Project Group p 1 working on a revision of R 46 *Active electrical energy meters* [2]. Given the enormously rapid pace at which the EV charging infrastructure is developing worldwide, an increasing number of individual economies is recognising an urgent need to develop national or regional metrology regulations for EV charging. To prevent initiatives from diverging, and to support international harmonisation of metrological requirements, an OIML publication on this topic will be needed very soon.

EVSE at a government office in Zwolle, The Netherlands.

There is an increasing need for electric car charging infrastructures in many places worldwide.
The OIML is playing a key role in ensuring trustworthy measurements of electrical energy transferred.

The time pressure made it unpractical for the EV charging subgroup to proceed as part of the R 46 revision project. Notably, the latter is a task of considerable breadth and extent even if EV charging is left out of the equation. Consequently, a new project group p 3 *Electric vehicle charging stations* was set up in 2021 [3] in order to prepare a stand-alone Guide rather than an annex to R 46.

2 OIML Guide *Electric vehicle supply equipment*

While the measurand in EVSE is the same as in utility applications, i.e. active electrical energy, the EVSE use case differs from traditional utility measurements. An individual document can account for these differences much better than an annex to a Recommendation for meters used in utility applications. The main differences are:

- EVSE transactions are more similar to direct sales than to utility applications;
- EVSE are designed for very specific operating conditions, e.g. when in use they are always connected to a vehicle using a standardised interface;
- EVSE are usually exposed to the elements, including sunlight, while in many OIML Member States utility meters are usually mounted indoors, often in cellars;
- all utility meters can be verified individually while the metering function in EVSE might be integrated into the electronics of the EVSE;
- EVSE show the measurement result on a purpose-built client interface – even if there is a physical display inside, e.g. on a separately approved meter, it is not visible to the trading parties, whereas a physical display is part of most utility meters; and
- testing can be very efficient when phantom power is used, but manufacturers may not be aware of this design constraint.

R 46 requires the meter to be a multi-purpose meter, suitable for use with any load – heaters, lamps, motors, PCs, etc. – connected to the electricity grid. This implies a large variety of operating conditions to be tested. Since those meters are designed for connection to the electricity grid, they shall withstand disturbances such as overcurrent caused by lightning. Since they are traditionally read once a year only, without remote communication, they must continue to measure correctly after the disturbance.

The interface between the EVSE and the vehicle, in turn, is standardised. For instance, the power factor must be close to unity, either because DC is used or because the vehicle's AC/DC converter is required to operate at unity power factor. The cable between the EVSE and the vehicle is very short compared to the electricity grid, so remote lightning strikes are not possible. Direct lightning strikes on the cable are unlikely, but if they happen, they are unlikely to affect only the measurement and not the control electronics. When such an event renders the EVSE completely dysfunctional, the consumer may be unhappy, but a correct metering function will have become irrelevant. Therefore, the requirements and tests may be adapted without adversely affecting the confidence the trading parties have in the measurement.

This, then, is the prime advantage of having a stand-alone, self-consistent document with 'blueprint' requirements and test procedures aimed at EVSE. It allows TC 12/p 3 to define requirements and associated test procedures that support the trustworthiness of the measurement of energy transferred through an EVSE; and to shed the burden of requirements and test procedures that are only needed in 'classical' utility applications, but that are not appropriate for the EV charging application. At the same time, this project is taking the opportunity to include requirements – albeit in rudimentary form – for the fastest growing side of the EV charging market: 'fast charging' stations delivering energy in DC form.

The OIML TC 12/p 3 Project Group aims to finalise the Guide on EVSE within a few months, to be used as a model for OIML Member States who wish to implement local regulations for measuring energy transferred to and from electric vehicles. Immediately after the publication of the Guide, the same Project Group will start working on the Recommendation that will, once published, replace the Guide.

3 Activities in other organisations

3.1 IEC

Standards on electrical power and energy transfer systems for electrically propelled road vehicles and industrial trucks with rechargeable batteries are prepared by IEC TC 69. These include the IEC 61851 series for conductive charging, the IEC 61980 series for wireless power transfer (WPT) and the ISO 15118 series for vehicle to grid communication. Standards of the IEC 62051 to IEC 62059 series in the field of electrical energy measurement, also for use in EVSE, are being prepared by IEC TC 13. One of the most recent standards is IEC 62053-41 for DC active electrical energy meters; its first edition was published in 2021 [4].

3.2 European Union (EU)

3.2.1 Measuring Instruments Directive, mandate M/541

In the EU, national metrology law for active electrical energy meters is harmonised by the Measuring Instruments Directive (MID) [5]. Since the MID is intended to specify performance requirements rather than detailed technical specifications (Recital 25 MID), the level of abstraction is high. The result is that the MID is technology-independent and does not impede technical progress, but is difficult to apply for manufacturers and conformity assessment bodies. Therefore, the MID allows for harmonised standards that are published in the Official Journal of the EU to give presumption of conformity (Art. 14 MID). Those standards are prepared by the European standardisation organisations in response to a mandate issued by the European Commission, which checks them for compliance before publishing the reference in the Official Journal of the EU. In 2015, the EU Commission requested such standards "containing technical specifications concerning the legal metrological control of delivery to the public of AC and/or DC electricity, also for onboard metering, for use in electrical means of transport" with reference to the MID by 31 December 2017 by means of the standardisation mandate M/541 [6].

3.2.2 Alternative fuels infrastructure: AFID, AFIR

In 2014, the Directive 2014/94/EU on the deployment of alternative fuels infrastructure (AFID) [7] set out a framework of common measures in the EU. Its scope includes all alternative fuels with practical relevance, such as hydrogen, and it also covers means of transport other than road vehicles, e.g. ships. It does not cover metrology. The Directive required Member States to set up national policy frameworks to establish markets for alternative fuels and to ensure that recharging and refuelling stations are publicly available in sufficient number. Relevant to the design and operation of EVSE are restrictions on the types of connectors that are to be used for connecting vehicles to EVSE and requirements on the transparency in communicating the unit price prior to the start of a charging session. However, the implementation lacked "ambition, consistency and coherence" [8]. The lack of interoperable, easy-to-use recharging and refuelling infrastructure risked becoming a barrier to the uptake of low- and zero-emission road vehicles, vessels and stationary aircraft, which is fundamental to the European Green Deal, a major European policy aiming for the reduction of greenhouse gas emissions. Therefore, the European Commission proposes to replace the AFID by a regulation (AFIR) [8]. A *Directive*, on one hand, is addressed to Member States and is binding as to the results to be achieved only; the choice of form and methods is left to the Member States. A *Regulation*, on the other hand, is binding in its entirety and directly applicable in all Member States [9].

3.3 DKE

Seeing the need for a standard that can give presumption of conformity with legal metrology requirements, the German Commission for Electrical, Electronic and Information Technologies (DKE) prepared VDE-AR-E 2418-3-100 [10], a standard for measuring systems for EVSE, and published it in November 2020. This standard includes system aspects, mainly related to data processing, storage and communication, as well as metrology aspects such as requirements for the active electrical energy meter, AC or DC, used in the EVSE.

3.4 CENELEC

In principle, IEC standards are transformed into CENELEC standards without modification. However, standards are commonly used as a means to show compliance with EU legislation such as the Measuring Instruments Directive (MID) [5]: If a product complies with a standard that is listed in the official journal of the EU, the manufacturer may presume compliance with the relevant EU legislation. Therefore, the relevant standards must be adapted to fulfil the requirements of the relevant regulation. In many cases, this means only that a European Annex ZZ is added. This annex establishes a link between the individual articles of the EU legislation and the clauses and subclauses of the standard. In some cases, however, a dedicated European standard has to be prepared. In the context of active electrical energy meters, the most relevant example is the EN 50470 series. At present, CENELEC TC 13 is preparing a new standard for DC active electrical energy meters, EN 50470-4; work started at the end of 2021. This standard is prepared in response to the European Commission's mandate M/541 [6] and intended for giving presumption of conformity with the requirements of the MID.

The decision of CENELEC TC 13 to start working on EN 50470-4 in response to the European Commission's mandate M/541 was taken after the start of the LegalEVcharge project and the NordCharge activities explained below. Therefore, the LegalEVcharge and

NordCharge consortia jointly prepared a provisional standard. Once EN 50470-4 is published, the provisional standard will become redundant. Since the common basis for both standards is the MID and the consortia are well represented in CENELEC TC 13, EN 50470-4 is expected to be very similar to the provisional standard. Should meters that are compliant with the provisional standard need to be modified to make them compliant with the future EN 50470-4, the modification will most likely be minimal.

3.5 EURAMET TCEM: LegalEVcharge

In order to prepare the technical infrastructure for an EVSE legal metrology framework, in December 2020 a number of metrology institutes from different European countries decided to set up the joint project LegalEVcharge (EURAMET TCEM project no 1539) [11].

The European Directive 2014/32/EU (MID) is applicable in all participating countries and is therefore taken as the basis for the work. As a first step, the consortium analysed the existing legal framework and provided guidance; the result is published online [11].

To make sure the proposals are practically viable and pragmatic, systems for laboratory and on-site verification will be set up and tested. The project provides a platform for exchange of ideas and experience, both with technical and legal implementation questions. For instance, the principle of proportionality calls for transitional provisions to be chosen carefully: On the one hand, the regulation to be prepared needs to come into force as soon as possible; on the other hand, previous investment in charging infrastructures must be protected.

The project consortium reached out to e-vehicle charging stakeholders to ensure that the proposed solutions are useful and practical.

3.6 NordCharge

NordCharge, the Nordic co-operation on charging stations for electric vehicles working on metrological regulation, started work in early 2021. The consortium closely co-operates with LegalEVcharge; some documents were issued jointly. In addition, NordCharge prepared guidance for making EVSE available on the market. The guidance is based on existing legal requirements such as the MID. Given the principle of mutual recognition, this guidance cannot be enforced as such by legal metrology legislation. However, its content is based on the MID, which is enforceable. The guidance explains the obligations of EVSE manufacturers, importers and charge point operators, which are often new to the legal metrology environment.

3.7 WELMEC

To exchange information on metrology regulations for EVSE between WELMEC members, WELMEC WG 11 subgroup electricity set up the Ad Hoc Group 3 (WG11/SGe/ahg3) in March 2021. This group is now working on a common view on which of the MID requirements apply to public EVSE. While waiting for EN 50470-4 in response to the European Commission's mandate M/541 [6], the AHG will also prepare a common view on the use of DC active electrical meters in EVSE. To make regulations easier to find (especially for manufacturers and charge point operators) the group will prepare an overview of regulations in the different Member States. Further, the AHG will provide guidance to test laboratories assessing EVSE in coherence with applicable legal metrology requirements. This guidance is supported by a broad group of WELMEC Member States, including most members of NordCharge and LegalEVcharge. In addition to existing results from the latter two projects, the WELMEC guidance will also take into account the work of the OIML, IEC, CENELEC, and the German standardisation committee DKE.

4 Legal framework

4.1 European Union (EU)

Free movement of goods is one of the four freedoms of the EU and its single market. In the context of legal metrology, two different mechanisms are relevant: harmonisation and mutual recognition. Harmonisation is achieved through common requirements, for example set out in a European Directive. Since all requirements across the Union are the same, goods can move freely. Mutual recognition (commonly referred to as the "Cassis de Dijon principle"), in turn, requires all Member States to accept goods lawfully marketed in another Member State and applies only in the absence of harmonisation. In this case, the requirements are not identical, but considered equivalent. A short list of legitimate public interest grounds for exceptions from the principle of mutual recognition is defined in Regulation (EU) 2019/515 [12].

In the EU, metrology law is the responsibility of the individual Member States. However, the provisions for certain measuring instruments are harmonised by the EU's Measuring Instruments Directive (MID) [5]. Countries may prescribe the use of these instruments, in which case they must adopt the provisions of the MID and deviations are not permitted. This Directive thereby removes barriers to trade on the EU market by defining common requirements. It applies to measuring instruments placed on the market or put into service for the first time.

National regulations for the active electrical energy metering function of EVSE are harmonised under the MID, regardless of whether the EVSE contains a conformity-assessed meter or is conformity assessed as a measuring instrument. Any other legal metrology regulation for EVSE is not harmonised and therefore subject to Regulation (EU) 2019/515.

4.2 USA

In the United States, to promote the development of uniform laws, regulations and methods of practice, co-ordination and collaboration is initiated at the national level. Important considerations in legal metrology include traceability to the International System of Units (SI) and harmonisation with international standards. Commercial measurement standards are published in NIST Handbooks once adopted at the national level. The States adopt handbook requirements in part or entirety and enforce them. Multiple states have also enacted legislation to recognise the fact that the sale of electricity dispensed as a vehicle fuel is not subject to regulation as a utility. The method of sale of electricity, by the kilowatt-hour when sold as a vehicle fuel and other fees related to that sale, were published in NIST Handbook 130 in 2014 [13]. The NIST Handbook 44 EVSE requirements are the basis for type evaluation; the first edition was published in 2016, and the current in 2022 [14]. An EVSE submitted for type evaluation must include documentation of the certification of the system's design and construction compliance with relevant current electrical safety standards by nationally recognised testing laboratories.

4.3 Canada

In Canada, all trade measurements are governed by federal legislation under the *Weights and Measures Act* and Regulations, and the *Electricity and Gas Inspection Act* and Regulations. National requirements are developed where internationally recognised standards are either not available or not appropriate for the Canadian marketplace. OIML Recommendations are adopted as much as possible. For the electricity measurement discipline, only Canadian standards are currently being used. Canada is developing standards for EVSE. Elements of the US Handbook 44 and the OIML Draft Guide are being used to develop the Canadian requirements. It is expected that Canada will adopt OIML Recommendations for EVSE when they are completed.

5 Conclusion

In the context of the ever increasing urgency of the global energy transition, the topic of electric vehicle charging has been steadily gaining interest over the past years. In this article, we summarise ongoing and recent activities in the domain of legal metrology for EVSE. It is in the interest of legislators, manufacturers, users, and customers – and indeed society as a whole – that any requirements defined are as convergent as possible between countries and regions. In terms of international harmonisation of legal metrology requirements for EVSE, the OIML has a special role in the landscape of actors. In an attempt not to be overtaken by the high-speed rollout of charging infrastructures in various places worldwide, the OIML is developing the EVSE Guide at a pace that is untypical in the world of international standardisation. ■

6 References

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[2] OIML R 46-1/-2:2012 *Active electrical energy meters*

[3] Working draft OIML EVSE version 020, Reference no TC 12_p3_N008, issued on 22 December 2021

[4] IEC 62053-41:2021 *Electricity metering equipment – Particular requirements - Part 41: Static meters for DC energy (classes 0,5 and 1)*

[5] Directive 2014/32/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of measuring instruments (recast)

[6] M/541: Commission implementing decision of 15.12.2015 on a standardisation request to the European Committee for Standardisation, to the European Committee for Electrotechnical Standardisation and to the European Telecommunica-

tions Standards Institute pursuant to Regulation (EU) No 1025/2012 of the European Parliament and of the Council as regards certain measuring instruments

[7] Directive 2014/94/EU of the European Parliament and of the Council on the deployment of alternative fuels infrastructure, OJ L 307, 28.10.2014, p. 1–20

[8] Proposal for a Regulation of the European Parliament and of the Council on the deployment of the alternative fuels infrastructure, and repealing Directive 2014/94/EU of the European Parliament and of the Council, COM(2021) 559, 14 July 2021

[9] Treaty on the Functioning of the European Union, OJ C 326, 26.10.2012, p. 47–390

[10] VDE-AR-E 2418-3-100:2020-11 *Electric mobility – Measuring systems for charging stations*

[11] LegalEVcharge: *Practical legal metrology framework for electric vehicle charging station*s, EURAMET TCEM project no 1539, www.metas.ch/legalevcharge

[12] Regulation (EU) 2019/515 of the European Parliament and of the Council of 19 March 2019 on the mutual recognition of goods lawfully marketed in another Member State and repealing Regulation (EC) No 764/2008, OJ L 91, 29.3.2019, p. 1–18

[13] NIST Handbook 130 – *Uniform Laws and Regulations in the Areas of Legal Metrology and Fuel Quality* as adopted by the 106th National Conference on Weights and Measures 2021 (version 2022)

[14] NIST Handbook 44 – *Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices* as adopted by the 106th National Conference on Weights and Measures 2021 (version 2022)

TRAFFIC

OIML TC 7/SC 4/p3 Project Group – OIML R 91 Revision

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Introduction: Why is speed enforcement necessary?

Speed enforcement and speed meters are very relevant in the field of legal metrology. Sometimes, citizens refer to them as "cash machines" used by the government to generate revenue, but their role is much more important than that. They save lives, and they aim to counter one of the main causes of road accidents – driving over the speed limit. On the other hand, when speed enforcement is applied, it has an impact on our lives in the form of expensive and often unpleasant fines and penalty points. The loss of a driving license can change an offending driver's life or even their relatives' lives in the most dramatic ways.

Speed meters should therefore be regulated in order to provide accurate and trustworthy speed measurements, which may subsequently be used in a court of law as unchallenged evidence. Speed enforcement should be fair to both sides, and unambiguously respected.

Missed opportunities

OIML R 91 *Radar equipment for the measurement of the speed of vehicles* could be called a Recommendation of "missed opportunities". Its main shortcoming is the fact that it has not been revised over the last 30 years, which is a very long period during which speed enforcement technology has significantly moved forward and progress has been notable.

Speed meters have become increasingly software-based and rely wholly on information technology. Additionally, several new technologies applying new physical principles have emerged such as LIDAR (an acronym for "light detection and ranging"), stereo cameras, tracking Doppler radars and average speed meters, to mention a few examples. OIML R 91 has not been revised to take into account common requirements and this has forced participating countries to introduce their own requirements in national regulations. For example, some countries have prohibited specific new technologies such as tracking Doppler radars. Various stakeholders have also developed their own technical terms and expressions, so that nowadays it is challenging when we talk about terms such as "section", "sector", "average speed meter", "tracking", "2D", "3D" and even "4D Doppler radar" speed meters. In the context of speed meters, they are all the same, but they have been allocated different technical terms.

OIML R 91 should therefore be revised more frequently; we suggest that it should be reviewed every five years to avoid the risk of missing opportunities, to harmonise legal and technical requirements, and to make use of new emerging technologies.

The story of two conveners

In 2014 the OIML established a new project under TC 7/ SC 4/p 3 for the revision of R 91, but the challenges mentioned above have made progress difficult. Over the last 30 years, the countries participating in the project have developed quite different and non-harmonised views on various topics, for example the acceptance criteria for influence factor testing, the approach to take in software testing, and the proportion of field tests vs simulation tests. Fortunately, it was quickly recognised that the challenge and workload due to having only one Project Group convener had to be firmly addressed. The amount of editing work that is necessary to cover all the different aspects would have required too much time for one sole convener, and the quality could also have suffered significantly.

Thanks to the introduction of a second Project Group convener these drawbacks have been alleviated. For the sake of good communication and good cooperation, a weekly rotation and video-based meetings have been established, which has dramatically increased the development process of the R 91 revision. Two conveners means two sets of eyes with different views on problems, bottlenecks, ideas, and good self-discipline regarding the deadlines.

Requirements in touch with the real world

A big challenge is how to generalise the requirements in OIML R 91, which reflect the knowledge and experience from the past while taking into account a good basis for the future development of speed meter requirements. For example, it was (and still is) a challenge how to formulate requirements and testing procedures for moving speed meters, which are used under more challenging conditions than stationary speed meters. Another example is how to perform a field test with a large number of target vehicles when the patrol vehicle is moving.

The difficulty here is how to prevent the revised OIML R 91 from prescribing requirements which cannot be fulfilled in real life.

The revision project has focused on checking all the derived requirements for all the newest possible technologies. For this, the PG conveners established contacts with a number of manufactures, who provided information about the latest technologies used in the field of speed enforcement.

An important principle to bear in mind is that when a new or revised OIML Recommendation is being drafted it is necessary to test it in the context of recent technology.

Parts 1 and 2 of OIML R 91 have been directly tested against such types of speed meters: 77 GHz Doppler-based RADAR technology, average speed meters with an option to be portable and which have self-alignment capability, speed meters to enforce checks from moving patrol cars, and new scanning LIDAR concepts. Certain OIML R 91 requirements have been updated, some have been completely revised, and some had to be abandoned due to lack of experience in the field.

OIML R 91 outlook

The Project Group's current goal is to finish Parts 1 and 2 of the revision of OIML R 91 as fast as possible. The main challenge is to harmonise the different points of view of the document structure and technical details provided by key PG members.

The major ongoing discussion points are:

- the level of detail of the test procedure descriptions for influence factor testing;
- symmetrical and asymmetrical handling of maximum permissible errors for stationary and moving speed measurements;
- proportion and error limits of simulation tests; and
- different views regarding speed measurements from moving patrol vehicles and their testing.

The Project Group has decided to resolve these key issues by means of two surveys, which will enable requirements and solutions to be found which are most likely to be accepted by the majority of P-members of the Project Group. By May 2022, the Project Group plans to have the Fourth Working Draft (4 WD) ready, and then move to the first Committee Draft (1 CD) stage. ■

Photo: Pixabay

OIML Certification System (OIML-CS)

Introduction

The OIML-CS is a system for issuing, registering and using OIML Certificates and their associated OIML type evaluation reports for types of measuring instruments (including families of measuring instruments, modules, or families of modules), based on the requirements of OIML Recommendations.

The OIML-CS comprises two Schemes: Scheme A and Scheme B. Competence of the OIML Issuing Authorities and their Test Laboratories is demonstrated through self-declaration under Scheme B and accreditation or peer assessment under Scheme A.

The aim of the OIML-CS is to facilitate, accelerate and harmonize the work of national and regional bodies that are responsible for type evaluation and approval of measuring instruments subject to legal metrological control. In the same way, instrument manufacturers, who are required to obtain type approval in some countries in which they wish to sell their products, should benefit from the OIML-CS as it will provide evidence that their instrument type complies with the requirements of the relevant OIML Recommendation(s).

It is a voluntary system and OIML Member States and Corresponding Members are free to participate. Participating in the OIML-CS commits, in principle, the signatories to abide by the rules of the OIML-CS that are established in OIML B 18:2018 *Framework for the OIML Certification System (OIML-CS)*. Signatories voluntarily accept and utilize OIML type evaluation and test reports, when associated with an OIML Certificate issued by an OIML Issuing Authority, for type approval or recognition in their national or regional metrological controls.

The OIML-CS was launched on 1 January 2018 and has replaced the former OIML Basic Certificate System and the OIML Mutual Acceptance Arrangement (MAA).

OIML certificates

OIML certificates issued under Scheme A and Scheme B can be downloaded from the database on the OIML website at https://www.oiml.org/en/oiml-cs/certificat_view.

The database also includes certificates issued under the former OIML Basic Certificate System and the MAA. Although these two systems are no longer in operation, the certificates remain valid.

OIML Issuing Authorities, Utilizers and Associates

A summary of the approved OIML Issuing Authorities is published on the next page, followed by a summary of those Utilizers and Associates that have declared that they will accept OIML certificates and/or OIML type evaluation reports as the basis for a national or regional approval.

OIML-CS Management Committee meeting

The Seventh OIML-CS Management Committee Meeting was held as an online meeting on 22-23 March 2022 (see meeting account in this edition of the Bulletin).

More information

For enquiries regarding the OIML-CS, please contact the OIML-CS Executive Secretary Mr Paul Dixon (executive.secretary@oiml.org). Visit the OIML website:

https://www.oiml.org/en/oiml-cs

OIML Certification System (OIML-CS)

List of OIML Issuing Authorities and their scopes

The list of OIML Issuing Authorities is published in each issue of the OIML Bulletin and can be downloaded at www.oiml.org/oiml-cs/oiml-issuing-authorities

Updated: 2022-03-31

		R 21:2007	R 46:2012	R 49:2006	R 49:2013	R 50:2014	R 51:2006	R 60:2000	R 60:2017	R 61:2004	R 61:2017	R 75:2002	R 76:1992	R 76:2006	R 85:2008	R 99:2008	R 106:2011	R 107:2007	R 117:1995	R 117:2007	R 117:2019	R 126:1998	R 129:2000	R 134:2006	R 137:2012	R 139:2014	R 139:2018
AU1	National Measurement Institute Australia (NMIA)					■							■	■													
CH1	Federal Institute of Metrology (METAS)							■						■													
CN2	National Institute of Metrology, China (NIM)						■	■	■	■	■		■	■													
CZ1	Czech Metrology Institute (CMI)				■		■				■			■	■					■	■			■	■		■
DE1	Physikalisch-Technische Bundesanstalt (PTB)				■		■	■	■	■		■		■													
DK2	FORCE Certification A/S				■	■	■	■	■	■	■			■			■	■					■	■	■	■	■
FR2	Laboratoire National de Métrologie et d'Essais (LNE)			■	■		■	■	■					■								■					
GB1	NMO				■		■	■	■				■	■						■	■						
JP1	NMIJ/AIST							■	■				■	■					■	■	■						
NL1	NMi Certin B.V.	■	■	■	■	■	■	■	■	■	■		■	■	■		■	■	■	■	■		■	■	■	■	■
SE1	Research Institutes of Sweden (RISE)						■	■	■	■	■			■	■				■	■	■						
SK1	Slovak Legal Metrology (SLM)			■	■									■													

OIML Certification System (OIML-CS)

List of Utilizers, Associates and their scopes

The list of Utilizer and Associate scopes is published in each issue of the OIML Bulletin and can be downloaded at www.oiml.org/oiml-cs/utilizers-and-associates

Updated: 2022-03-31

1 = Scheme A only
2 = Scheme A and MAA
3 = Scheme A and B
4 = Scheme A, B and MAA
5 = Scheme B only

		R 21:2007	R 35:2007	R 46:2012	R 49:2006	R 49:2013	R 50:2014	R 51:2006	R 58:1998	R 59:2016	R 60:2000	R 60:2017	R 61:2004	R 61:2017	R 75:2002	R 76:1992	R 76:2006	R 81:1998	R 85:2008	R 88:1998	R 93:1999	R 99:2008	R 102:1992	R 104:1993	R 106:2011
AU	National Measurement Institute, Australia (NMIA)				1	1					1					1	1								
BE	Federal Public Service Economy	3		3		3	3	3			1		3		3		1		3			3			3
CA	Measurement Canada										2	1			1		2								
CH	Federal Institute of Metrology (METAS)			1	2	2	1	1			2		1		1		2								1
CN	State Administration for Market Regulation (SAMR)							1			2	1	1	1		2	2								
CO	Superintendencia de Industria y Comercio (SIC)	3		3	4	4	3	3			2		3		3	2	2		3			3			3
CU	Oficina Nacional de Normalizacion (NC)	3	3	1		1	3	1	3	3	1	1	3	3	3		1	3	3	3	3	3	3	3	3
CZ	Czech Metrology Institute (CMI)					1		1						1			1								
DE	Physikalisch-Technische Bundesanstalt (PTB)	5		3	3	4	3	3			2		3		3		2					5			1
DK	FORCE Certification A/S				2	2	1	1			2	1	1	1			2								1
FR	Laboratoire National de Métrologie et d'Essais (LNE)	1		1	1	1	1	1			1		1		1	1	1		1			1			1
GB	NMO Certification	3			4	4	3	3			2		3			2	2		3						3
IN	Legal Metrology Division, Department of Consumer Affairs	3		3		4	3	3			2		3		3		2		3						1
IR	Iran National Standards Organization (INSO)				4	4					2	1				2	2								
JP	NMIJ/AIST										2	1				2	2								
KE	Weights and Measures Department		3	3	4	4		3			4	4	3	3		4	4		3						3
KH	National Metrology Centre (NMC)	3		3	3	3	3	3			1		3		3	1	1		3			3			3
KI	Ministry of Commerce, Industry and Cooperatives	5	5	5	1	1	5	1		5	1	1	5	5	5	1	1	5	5						5
KR	Korea Testing Certification (KTC)															2	2								
LV	LNMC Ltd. Metrology Bureau																								
NA	Namibian Standards Institution			3	4	4	3	3			2		3			2	2		3						3
NL	NMi Certin B.V.	3		3	3	4	3	3			2	1	3	3	3	1	2		3			3			3
NZ	Trading Standards (Ministry of Business, Innovation and Employment) (MBIE)				4	4	3	3			2					2	2		3						3
RU	VNIIMS																								
RW	Rwanda Standards Board	3	3	3	3	3		3	3	3	1	1	3	3		1	1					3	3	3	3
SA	SASO (Saudi Standards, Metrology and Quality Organization)			3		1						1					1								
SE	RISE Research Institutes of Sweden AB							3			2	1	3				2		3						
SK	Slovak Legal Metrology (SLM)				2	2											2								
TN	National Agency of Metrology (ANM)	3		3	2	2	3	3			2		3				2		3			3			3
UG	Uganda National Bureau of Standards (UNBS)			3	1	3					1	1				1	1								
US	National Conference on Weights and Measures (NCWM)										2														
ZA	NRCS: Legal Metrology				3	3		3			1					1	1		3						3
ZM	Zambia Metrology Agency	3		3	3	3	3	3			1		3		3	1	1		3			3			3

OIML Certification System (OIML-CS)

List of Utilizers, Associates and their scopes (Cont'd)

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Updated: 2022-03-31

1 = Scheme A only **5 = Scheme B only**
2 = Scheme A and MAA
3 = Scheme A and B
4 = Scheme A, B and MAA

		R 107:2007	R 110:1994	R 117:1995	R 117:2007	R 117:2019	R 122:1996	R 126:1998	R 128:2000	R 129:2000	R 129:2020	R 133:2002	R 134:2006	R 136:2004	R 137:2012	R 139:2014	R 139:2018	R 143:2009	R 144:2013	R 145:2015	R 146:2016	R 148:2020	R 149:2020	R 150:2020
AU	National Measurement Institute, Australia (NMIA)																							
BE	Federal Public Service Economy	3			3					3					3	3								
CA	Measurement Canada																							
CH	Federal Institute of Metrology (METAS)	1						1		1			1		1									
CN	State Administration for Market Regulation (SAMR)																							
CO	Superintendencia de Industria y Comercio (SIC)	3		3	3			3		3			3		3	3								
CU	Oficina Nacional de Normalizacion (NC)	3	3		3		3	3	3	3		3	3	3	3	3	3	3	3	3	3			
CZ	Czech Metrology Institute (CMI)				1	1									1									
DE	Physikalisch-Technische Bundesanstalt (PTB)	3			3	1				3			1	5	3									
DK	FORCE Certification A/S	1			1	1				1	1		3		1	1	1							
FR	Laboratoire National de Métrologie et d'Essais (LNE)	1			1			1		1			1		1	1								
GB	NMO Certification	3		3	3					3			3											
IN	Legal Metrology Division, Department of Consumer Affairs	3			3					3			1		3	3								
IR	Iran National Standards Organization (INSO)																							
JP	NMIJ/AIST			1	1	1																		
KE	Weights and Measures Department			3	3			3					3	3	3	3	3							
KH	National Metrology Centre (NMC)	3		3	3			3		3			3		3	3								
KI	Ministry of Commerce, Industry and Cooperatives		5	1	1							5	5		5	5	5							
KR	Korea Testing Certification (KTC)																							
LV	LNMC Ltd. Metrology Bureau							3					3											
NA	Namibian Standards Institution	3		3	3			3		3			3											
NL	NMi Certin B.V.	3		3	3	1		3		3			3		3	3	3							
NZ	Trading Standards (Ministry of Business, Innovation and Employment) (MBIE)	3		3	3					3			3											
RU	VNIIMS			3	3																			
RW	Rwanda Standards Board		3	3	3		3	3		3		3	3		3			3	3		3			
SA	SASO (Saudi Standards, Metrology and Quality Organization)				3																			
SE	RISE Research Institutes of Sweden AB			3	3																			
SK	Slovak Legal Metrology (SLM)																							
TN	National Agency of Metrology (ANM)	3		3	3			3		3			3		3	3								
UG	Uganda National Bureau of Standards			1	1	1							3		3									
US	National Conference on Weights and Measures (NCWM)																							
ZA	NRCS: Legal Metrology	3		3	3			3		3			3		3	3								
ZM	Zambia Metrology Agency	3		3	3			3		3			3		3	3								

OIML-CS

Report on the Seventh OIML-CS Management Committee meeting

Paul Dixon, BIML

Introduction

Due to the ongoing situation with the COVID-19 pandemic, the Seventh OIML-CS Management Committee meeting was held as an online meeting on 22–23 March 2022. This built on the experience gained when holding the successful online meetings in 2020 and 2021.

Review Committee and Maintenance Group meetings

As in 2021, the Management Committee meeting was preceded by online meetings of the Review Committee and Maintenance Group on 23 February and 2 March respectively. This replicated the approach normally taken when in-person meetings were previously held in 2018 and 2019, and enabled the Review Committee and Maintenance Group to discuss key issues and to develop proposals for consideration and decision at the Management Committee meeting.

Management Committee meeting

The Management Committee meeting was chaired by the Management Committee Chairperson, Mr Mannie Panesar, with 18 of the 22 Management Committee Members from OIML Member States either present or represented. In addition, there were representatives from the following liaison organisations: CECIP, CECOD, ILAC/IAF, and ISO CASCO, and representatives from a potential new participant in the OIML-CS participated as observers.

Meeting over two consecutive days allowed for a full agenda, and some of the key items that were discussed and considered were as follows:

- feedback and experiences of participants in the OIML-CS;
- report on the Review Committee meeting;
- report on the Maintenance Group meeting, including the revision of the OIML-CS documentation to implement CIML Resolution CIML/2021/31 (see below);
- update on the re-approval of Legal Metrology Experts and Management System Experts;
- review of OIML Issuing Authority Annual Reports for 2021 and the re-approval of the OIML Issuing Authorities and Test Laboratories;
- high priority publications and periodic reviews;
- modular approvals;
- remote assessments; and
- update on the OIML Digitalisation Task Group.

Implementation of CIML Resolution CIML/2021/31

Following the CIML approval of the Management Committee proposal to allow OIML Issuing Authorities to use ISO/IEC 17020 (with additional requirements) as an alternative to ISO/IEC 17065 to demonstrate competence, a significant amount of work has been undertaken to implement this decision into the OIML-CS documentation.

Under the responsibility of the Management Committee, a new OIML Document *Guide to the application of ISO/IEC 17020 to the assessment of OIML Issuing Authorities under the OIML-CS* is being developed and it is anticipated that it will be completed in time for it to be submitted to the CIML for approval at the 57th CIML Meeting. The relevant Operational and Procedural Documents are being revised and OIML B 18 *Framework for the OIML Certification System* is also in the process of being revised.

Recommendation to the 57th CIML Meeting

The Management Committee will be recommending that the CIML approve the Final Draft revision of B 18 at the 57th CIML Meeting.

Looking forward

The meeting has again demonstrated that an online meeting can be a very useful tool in supporting the work of the Management Committee to ensure that the OIML-CS continues to operate smoothly.

It is hoped that an in-person Management Committee meeting can be held in March 2023, but this will require a further improvement in the global situation regarding COVID-19. The situation will be closely monitored and, if an in-person meeting is not feasible, an online meeting will again be used to ensure continuity in the work of the Management Committee and the smooth running of the OIML CS. This underpins CIML Resolution CIML/2021/04 which states that in-person and online participation in all OIML meetings is considered to be equivalent. ■

OIML-CS

The implementation of the OIML-CS in P.R. China

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0 Introduction

In recent years, with the rapid development of science and technology and the acceleration of the globalization process, the regulation system for measuring instruments in China has been continuously improving and increasingly conforms to international standards. In the meantime, in the context of global integration, the mutual recognition of international metrology is becoming an important vehicle for advancing global trade cooperation, infrastructure interconnection, and economic growth. Since 2017, in order to adapt to the development of the OIML Certification System (OIML-CS), China has also undergone considerable changes in the structure of its legal metrology system.

This article presents China's participation in the activities of the OIML over the years, and the work that has been done for China's participation in the OIML-CS, such as the adjustment and reconstruction of the OIML Issuing Authority and Utilizer in China. It also briefly introduces China's current regulatory requirements for new measuring instruments and the various work that China has done to promote the effective implementation of the OIML-CS.

1 China's participation in the OIML-CS and its recent development

1.1 Historical overview of China's participation in the OIML

China joined the OIML in 1985. Thereafter, China joined the OIML Basic Certificate System in 1992 and signed the Declaration of Mutual Confidence to join the OIML Mutual Acceptance Arrangement (MAA) in 2006. The Office for OIML Affairs in the former General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China (AQSIQ) acted as the Issuing Authority (IA) during this period and was responsible for issuing OIML certificates. At the same time, the National Institute of Metrology (NIM), as the nation's highest research facility for measurement science and a national statutory authority in the field of metrology, was responsible for performing OIML tests and providing core technical support to the Office for OIML Affairs in these issues (see Figure 1). During the same period, in order to help measuring instrument manufacturers enter the global market more smoothly, China also made a great effort to establish mutual confidence with other countries. Since 1999, AQSIQ has signed a series of Mutual Recognition Arrangements (MRAs) with NMi (NL), PTB (DE), NWML (UK) and METAS (CH) respectively.

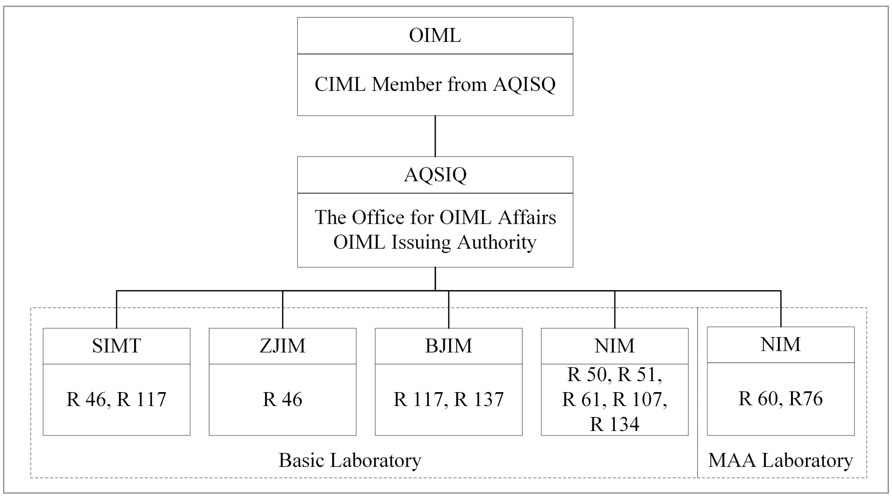


Figure 1: Former structure of OIML affairs in China before 2018

1.2 Establishment of a new OIML Issuing Authority in China

At the initial stage of the development of the OIML-CS, China sent experts to participate in the work of the MAA Ad-hoc Working Group, the provisional Management Committee, and other relevant working groups. Through these working groups, Chinese experts participated in and followed up on the development of the OIML-CS. On behalf of China, the experts put forward opinions and constructive suggestions for adopting and developing the regulation of the OIML-CS.

As for the establishment of an OIML Issuing Authority in China, AQSIQ could no longer meet the requirements of being an OIML IA under the OIML-CS due to its administrative nature. NIM became the natural alternative, given the institute's consistent participation in OIML work and its strict quality system, advanced metrological technology, and high quality human resources. Accordingly, on May 20, 2017, with the joint efforts of AQSIQ and NIM, the former CIML Member for China and former Vice Minister of AQSIQ, Mr. Wu Qinghai wrote to the BIML to designate NIM as the OIML Issuing Authority of China.

Subsequently, NIM actively invested in the establishment of the new OIML Issuing Authority. In 2017, NIM established an OIML certification office on its Changping campus. In the same year, NIM drafted a Quality Manual and relevant quality documents and completed the construction of the quality system of its OIML Issuing Authority according to the requirements of ISO/IEC 17065 and OIML D 29. In addition to the OIML IA quality system, the OIML-CS is also highly dependent on the testing capabilities of test laboratories. Regarding the construction of OIML test laboratories, in 1999 NIM obtained the qualification to perform OIML tests as a designated test laboratory.

As the former OIML MAA test laboratory, NIM possesses complete and advanced test equipment and professional personnel. Its quality system continuously meets the requirements of ISO/IEC 17025. The third-party laboratories of NIM, the Shanghai Institute of Measurement and Testing Technology (SIMT), the Zhejiang Province Institute of Metrology (ZJIM) and the Beijing Institute of Metrology (BJIM), were also the designated test laboratories under the OIML Basic System. These three test laboratories are all provincial metrology institutes in China and have participated in the drafting or revision work of the international and national metrological standards of the relevant instrument categories. The personnel of these third-party laboratories has participated in the relevant technical committees and has rich experience in the field of type evaluation of relevant measuring instruments. Their quality system and technical capability meet the requirement of the relevant OIML documents. At that point, the scope of the OIML Issuing Authority of China covered multiple legal measuring instruments such as non-automatic weighing instruments (R 76), automatic weighing instruments (R 51, R 61) load cells (R 60), and active electrical energy meters (R 46).

In November 2018, NIM went through international peer assessment for its OIML Issuing Authority and internal test laboratory, during which the assessors spoke highly of NIM's quality management system and technical capability. Based on this assessment, NIM applied to modify the scope of the relevant measuring instruments from Scheme B to Scheme A respectively according to the OIML-CS transition period arrangement (NAWI and AWI). From this moment on, NIM can conduct OIML type evaluations and issue OIML certificates under Scheme A for relevant types of measuring instruments based on the requirements of OIML Recommendations.

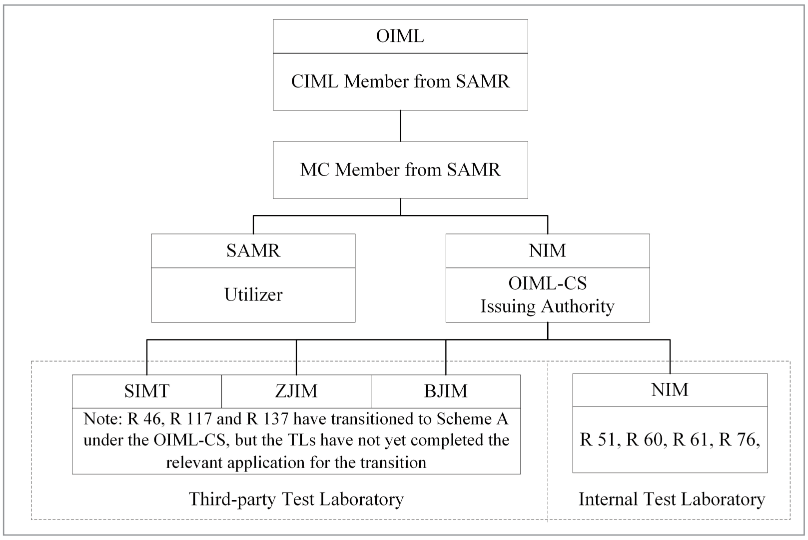


Figure 2: Current OIML structure in China

2 Promoting the use of OIML certificates

2.1 Utilizers in China

During the development process of the OIML-CS, in addition to OIML Issuing Authorities, the OIML also proposed the concepts of "Utilizer" and "Associate", which refer to the national issuing authority or national responsible body from an OIML Member State or Corresponding Member that has signed the Declaration, specifying the terms of acceptance of OIML certificates and/or OIML type evaluation reports issued under Scheme A or Scheme B. This means that only when the Utilizers and Associates sign the Declarations and commit to accepting OIML certificates are the objectives of the OIML-CS (including but not limited to avoiding unnecessary re-testing, fostering mutual confidence among participating members and facilitating the global trade of individual instruments) truly realized. Therefore, the continuous expansion of the number of Utilizers and the scope of the certificates that Utilizers commit to use is an important part of promoting mutual recognition.

Generally, the Utilizer is the national authority that is responsible for issuing certificates of national type approval. Therefore, the Utilizer in China is the State Administration for Market Regulation (SAMR, formerly AQSIQ). Among the existing OIML Issuing Authorities in 12 countries, only China's OIML IA and Utilizer belong to two different organizations. In order to explain the reasons for this, we provide below a brief description of China's metrology management system.

China's metrology management is mainly undertaken by the metrology administrative department and technical institutes. The metrology administrative department is mainly based on the metrology administrative departments of governments at all levels, which are mainly responsible for the management of metrology. They are established to ensure the smooth progress of metrology. The departments are divided into administrative levels such as provinces (autonomous regions and municipalities), cities, and counties, forming a stepped hierarchical structure. However, the metrology technical institutes form a hierarchical and regional network based on the characteristics of the administrative management system and the dissemination of quantity values.

The main technical institutes include NIM and the metrology technology institutes of various provinces, cities and counties, and the metrology testing centers of enterprises and institutes. Their main responsibility is to realize the dissemination of quantity values, carry out metrology verification, conduct research on measurement standards, and provide technical support for legal metrology.

In China, measuring instrument manufacturers must ensure that the measurement performance of their samples of new products obtain the type approval of the metrology administrative department at or above the provincial level before they are put into production. Taking into account the regulatory needs, China compiled the *Measures for the Administration of New Products of Measuring Instruments* for measuring instruments that require type evaluation and type approval. China also issued a supporting document entitled *Catalogue of Measuring Instruments control by Law (Part of Type Approval)* and all measuring instruments within the scope of this catalogue need to apply for type approval. Regarding the type approval of imported measuring instruments, China issued the *Measures for the Supervision and Administration of Imported Measuring Instruments of the People's Republic of China*. In 2020, SAMR unified the Catalogues of imported and domestic measuring instruments. As a consequence, SAMR issued the *Catalogue of Measuring Instruments under Compulsory Management*. Thereafter, the number of measuring instruments requiring type approval has been reduced from the original 75 categories to the current 32 categories.

Currently, the Provincial Administration Bureaus for Market Regulation are responsible for the type approval of new products in their own regions, and SAMR is responsible for the supervision and management of the type approval of new measuring instruments nationwide. Meanwhile, SAMR is responsible for the relevant applications and type approval of imported measuring instruments. Therefore, domestic manufacturers need to apply for type approval to the Provincial Administration Bureaus for Market Regulation where the product is produced, while imported measuring instrument manufacturers and their agents need to apply to SAMR for type approval. Once the administrative department accepts the application, it will entrust the corresponding technical institute to carry out the type examination and testing on the sample of the product in accordance with the relevant national standards. If the measuring instrument passes the type examination and testing, it will obtain a type approval certificate and can then be put into production.

Per the description above, the technical institutes are only responsible for performing type evaluation testing on measuring instruments. It is the metrology administrative department that undertakes the responsibility of issuing national type approval certificates. Despite these differences, SAMR, as the Utilizer, has also done a lot of work to promote the implementation of the use of OIML certificates.

2.2 The Utilizer promotes the use of OIML certificates

In order to actively participate in international mutual recognition and promote the use of OIML certificates in China, in 1991 the former State Bureau of Technical Supervision (SBTS) issued the *Notice on the implementation of the OIML Certificate System* nationwide. This marked the official implementation of the OIML Basic Certificate System in China. In 2005, China revised the *Measures for the Administration of New Products of Measuring Instruments* implemented in 1987. The document referred to OIML D 19 *Pattern evaluation and pattern approval* and adopted a unified management mode type approval, including type evaluation and the decision of type approval. The concepts of pattern evaluation and prototype testing were unified into type evaluation. This revision made China's regulation more consistent with international conventions and common practices. The unified type approval management is conducive to strengthening the supervision and management of government and improving the quality of measuring instruments. This also provided the possibility to use OIML certificates widely.

In March 2018, due to the institutional reform of the State Council, AQSIQ merged with the State Administration for Industry and Commerce (SAIC) and the China Food and Drug Administration (CFDA) to form the SAMR. After the reform, as an active response to the development of the OIML-CS and its implementation in China, SAMR issued the *Notice of the General Office of SAMR of using OIML Certificates to issue Type Approval Certificates*. According to this document, the applicant only needs to have its OIML certificate and relevant test reports reviewed by the designated technical institutes, before applying to SAMR for a national type approval certificate. This will help manufacturers to avoid unnecessary re-testing when obtaining national type approvals.

Through years of hard work and the series of reforms mentioned above, China's type approval system of measuring instruments is now even more in line with international standards and compatible with the OIML-CS. This extends the scope and enhances the level of China's metrology mutual recognition, further realizing the interconnection of international metrology.

3 Raising the awareness of the OIML-CS

China is not only deeply involved in the development of the OIML-CS, but also carries out a lot of work to promote the awareness of the OIML-CS in China and around the world.

In order to successfully implement the requirements of the OIML-CS in China, after OIML B 18 *Framework for the OIML Certification System* was approved by the CIML the former AQSIQ and NIM cooperated many times to hold promotion meetings, trainings and other activities in Hangzhou, Shanghai, Beijing and elsewhere. These activities publicized the direction and specific content of the development of the OIML-CS to various market supervision and management departments, provincial metrology institutes, and manufacturers. The changes and challenges were also pointed out. To ensure that the process of issuing OIML certificates meets the requirements of ISO/IEC 17065 and OIML D 32, NIM held several seminars in 2018 to develop relevant quality documents to coordinate the interface between the Issuing Authority and its internal and third-party laboratories.

At the end of 2019, with the support and help of the BIML, the Chinese translations of B 18 and related Procedural and Operational Documents were published by NIM and provided to the public for free. The translations are also available for download on the OIML website.

In 2021, the National Legal Metrology Technical Committee established a working group under the leadership of SAMR to work on OIML-CS matters. Representatives from various stakeholders such as Issuing Authorities, Utilizers, Test Laboratories and manufacturers are all part of this working group, which will be responsible for tracking and studying the relevant regulations and procedures of the OIML-CS, and organizing relevant technical institutions to participate in the revision and feedback of OIML Recommendations. This working group will also be responsible for drafting and revising the *National Technical Specifications for Metrology*, aiming at further promoting the implementation of the OIML-CS in China.

Internationally, in order to promote the OIML and the OIML-CS on a global scale, the OIML established an OIML Pilot Training Center (OPTC) in China in 2016 and successfully held the first training course on OIML R 76. In 2017, NIM organized training on Weighing in Motion and the program was well received by 40 trainees from various countries.

In 2018 and 2019, seminars organized by the PTB and NIM were held in Jingdezhen, China and Munich, Germany respectively, to discuss the problems encountered at the beginning of the implementation of the OIML-CS and share experience to ensure its smooth operation.

In 2018 at the 25th Asia-Pacific Legal Metrology Forum (APLMF) meeting, the APLMF established an

Figure 3 (a): OPTC

Figure 3 (b): Seminars between the PTB and NIM in Jingdezhen

OIML-CS working group and SAMR sent staff to participate and took on the role of WG chair. This working group is committed to raising awareness of the OIML-CS and to promoting the acceptance and use of OIML certificates in emerging economies. As the chair of the OIML-CS working group, China drafted a questionnaire to obtain feedback and information on experiences concerning the OIML-CS from the group members. In 2021, a promotional animation about the OIML-CS was also completed by China. The animation starts with the introduction of legal metrology and international mutual recognition, and then leads on to the OIML and the OIML-CS. It also provides an example of the process for obtaining an OIML certificate and how to use it. The animation introduces and promotes the OIML-CS to interested parties in a more vivid way.

4 Concluding remarks

Through the work described above, China is striving to establish a complete legal metrology system that can be accepted domestically and internationally. In the meantime, China is also committed to creating a cooperation and exchange platform for the dissemination and implementation of the OIML-CS. China will continue to pay close attention to the implementation of the OIML-CS and promote the use of OIML-CS certificates in China and abroad.

With the goal of improving the product quality of measuring instruments, facilitating the trade of measuring instruments and enhancing the level of international mutual recognition, China will reach and build more milestones in the reform and development of international legal metrology. ■

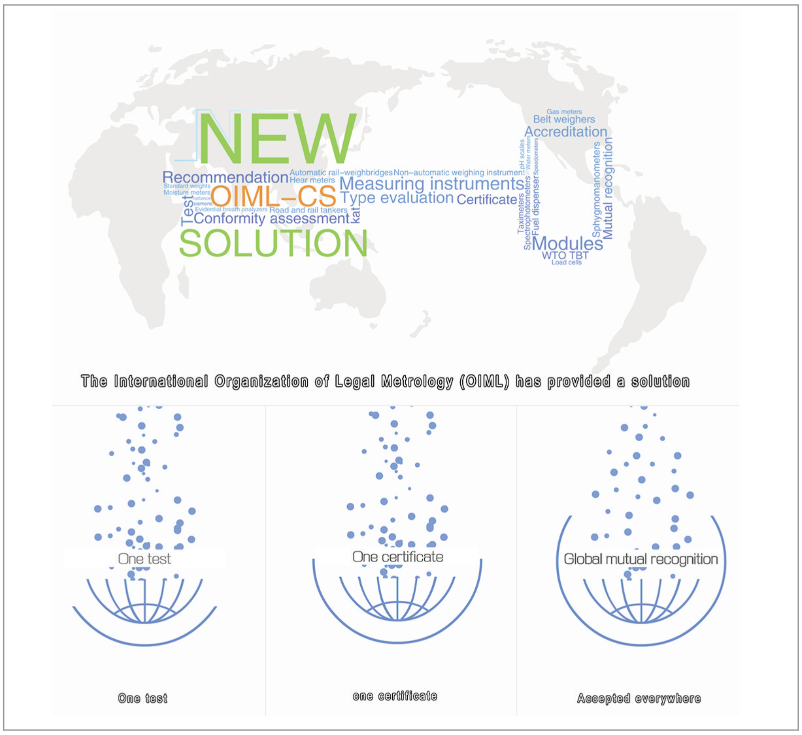


Figure 3 (c): Animation schematic

OIML DTG

Inaugural meeting of the OIML Digitalisation Task Group (OIML DTG)

Chris Pulham, BIML

1 Welcome and introduction of the participants

Dr Roman Schwartz, President of the International Committee of Legal Metrology (CIML), welcomed participants to the first meeting of the OIML Digitalisation Task Group (OIML DTG) which was held online on 24 February 2022. 11 OIML Member States, four OIML Corresponding Members, three Organisations in Liaison, and two invited guests were present (26 participants in total).

Dr Schwartz said he hoped participants could agree to him chairing this (and the next) DTG meetings as the Interim Chair until the official Chair could be elected, nominated by the DTG, and approved by the CIML at its 57th meeting in October 2022.

He first welcomed two special guests: Mr Peter Rauh, Project Coordinator at the DIN (the German national standardisation organisation) in Berlin, who would be giving a keynote presentation under agenda item 4, and Mr Peter Mason, CIML Immediate Past President and Chair of the Advisory Group for Countries and Economies with Emerging Metrology Systems (CEEMS AG), who had initiated the *Use of Online Technology* project, to be considered under item 8.1. Dr Schwartz invited participants to introduce themselves; during the various introductions a number of key points were raised:

1 Questions of interest:

- How does digital transformation affect the OIML-CS?
- How can interoperability be achieved between developments?
- How can synergies be leveraged?
- How can expertise from within the DTG be effectively provided to the OIML?

2 Comment from Mr Mason regarding the CEEMS AG *Use of Online Technology* project:

- If the DTG had already been in existence, this project would have been approached very differently (and probably much more efficiently).

2 Background and purpose of the meeting

Dr Schwartz gave a short introduction to the background and purpose of the meeting. He said that the digitalisation of functions, products and services are critical to all national, regional and international organisations, including the OIML, whose mission is to enable economies to put in place effective legal metrology infrastructures that are mutually compatible and internationally recognised, for all areas for which governments take responsibility.

Therefore, he continued, the DTG will play a key role within the OIML to consider, advance and deliver on both strategic and practical issues impacting our Organisation, our Members, and our various stakeholders with the aim of digitally transforming our Organisation, all this in cooperation with other international organisations.

Dr Schwartz explained that the DTG dates back to the CIPM workshop on the “Digital SI” in February 2021, when it became obvious that the OIML needs a competent group of experts to analyse the challenges of digital transformation especially for the various legal metrology processes and activities, and to come up with respective proposals and actions, all based on a respective Joint Statement of Intent (JSI) that will be signed soon by various stakeholders in the scientific and quality infrastructure, including the OIML and the BIPM.

That means, he continued, that the DTG is a strategic, horizontal Task Group looking at the various OIML activities, and it is intended to serve as a contact point for the other IOs working in the field of metrology, standardisation, accreditation and conformity assessment, especially those organisations which will be signing the JSI.

Dr Schwartz said he was glad that the CIML approved the proposal to set up an OIML DTG; the CIML had defined a broad framework for its work, which had been taken into consideration in the Draft Terms of Reference.

Dr Schwartz handed the floor to Dr Sascha Eichstädt, who gave a short technical introduction and overview of the challenges and opportunities entitled *Digital Transformation in the Quality Infrastructure – Challenges and opportunities.*

3 Current status and planned signature of the Joint Statement of Intent (JSI)

Mr Anthony Donnellan, BIML Director, briefly introduced the JSI and explained the current status and the planned signing procedure.

4 Keynote presentation on *The development of "smart standards"* (Peter Rauh)

Dr Schwartz handed the floor to Mr Rauh, who gave a presentation on *The development of "Smart standards"*.

Following his presentation two questions were raised:

- How can this be related to the Digital Calibration Certificate (DCC)? Can smart standards help in the standardisation of DCCs?
- How will the process of creating standards change to achieve the aims of the roadmap?
  - Mr Rauh replied that the development of a new editing tool to support modular standards has started.

Dr Schwartz asked what the implications would be for OIML technical work, for example OIML R 49 on water meters, which was revised as a joint OIML/ISO/CEN/CENELEC WG publication. One of the OIML's tasks will be to understand how smart standards should be taken into consideration.

5 Discussion of Draft Terms of Reference (ToR) for the DTG

Dr Schwartz explained that version 0.3 of the Draft Terms of Reference (ToR) dated 11 February 2022 had been drawn up by the provisional Steering Committee on the basis of CIML Resolution 2021/07 and Addendum 4.4, and circulated to participants prior to the DTG meeting.

He said that the intention was to provide a good basis for discussion at this first DTG meeting; however, he pointed out that comments and proposals for further improvements were still welcome.

The Draft ToR were discussed in detail, with the following comments:

1) Purpose

Mr Mason felt that we need to decide whether we are looking at measuring instruments being digitised, or functions and operations being digitised, or at metrological processes and activities.

Dr Schwartz reiterated that the DTG should analyse all the possible implications for the OIML as an organisation, but also for the broad range of legal metrology activities and services it provided. He also said consideration should be given to how detailed the ToR should be, and identified the need to find the right balance between the basic needs of digitalisation and advanced technologies (e.g. AI). One main task would be to identify which Recommendations should be examined (and eventually revised) in the light of the development of digitalisation (e.g. remote monitoring).

2) Principal responsibilities and tasks

Mr Bill Loizides suggested that the DTG should allow for sub-committees to be established, and also allow for further nominees to be appointed as specialists in certain sub-committees. Observers should also be invited to DTG meetings.

3) Membership

Dr Martin Koval (CMI) asked why no "deputies" were catered for in the last but one section. Dr Schwartz replied that up to now only representatives had been nominated; deputies could be considered by the DTG, but they should be nominated by the respective Member State.

4) Chairperson and Deputy Chairperson

There were no comments on this section.

5) Meeting frequency

Dr Eichstädt suggested holding a meeting four times per year; there were no objections.

6) Duration of the DTG

There were no comments on this section.

Annex 1 - Appointment of the DTG Chairperson and DTG Deputy Chairperson

1) Appointment of the DTG Chairperson

Mr Paul Dixon reported that experience in the context of the OIML-CS had been positive; however, the procedure might be too detailed for the DTG. Dr Schwartz suggested adapting it later in the light of experience gained.

2) Appointment of the DTG Deputy Chairperson

There were no comments on this section.

3) Procedure for nominating the DTG Chairperson and Deputy Chairperson

There were no comments on this section.

Next steps:

1 Further comments on the Draft ToR with a deadline of two weeks.

2 Consideration and implementation of comments: two weeks.

3 Agreement on the Draft ToR via the OIML website or on the PG workspace? – Deadline 15 April?

4 Nomination of candidates for Chair/ Deputy Chair – 31 March?

5 Presentation of nominated candidates at the next DTG meeting (28 April … 25 May).

6 Online voting on nominated candidates – 17 June?

7 Submission of the Draft ToR and selected Chair / Deputy Chair to the CIML – 15 July.

8 Approval of the DTG ToR and confirmation of selected candidates by the CIML at its 57th Meeting in October 2022.

Dr Schwartz commented that steps 5 and 6 above could be merged. Concerning the voting rules, he thought that no specific rules were required at the moment; all the participants should be given the possibility to express their opinion, regardless of whether they represent a Member State or not; the final decision will be taken by the CIML anyway.

6 Discussion of proposals for future projects and next steps

Mr Loizides said that NMI Australia considers digitalisation of metrology as being critical to improve efficiency, enhance the reliability and security of information, to support distributed measurement systems, and to reduce regulatory burden. He said that NMI Australia are exploring opportunities nationally, but consider international coordination and harmonisation to be a key component. He proposed the following ideas for the DTG's technical work programme:

- Create OIML solution(s) for digitally identifying measuring instruments (e.g. code, digitally connected).
- Create OIML solution(s) for prepackages (e.g. code).
- Digitalise OIML publications.
- Digitalise Reports and Certificates under the OIML-CS. Provide pathways for knowledge and data sharing.
- Explore the role of the OIML in coordinating a digital metrology system, or how national or regional systems can be united or connected.
- Explore opportunities for blockchain, including for the security and integrity of data.
- Articulate and promote the benefits and opportunities – to support investment.
- Collaborate with other stakeholders e.g. BIPM, RLMOs, RMOs, standards bodies.
- Provide support for CEEMS members.

7 Events of other international and regional organisations related to "Digital-QI"

7.1 Presentation / teaser for the IMEKO TC6 Conference on 19-21 September 2022

The OIML was asked whether it wished to contribute with a special two-hour session on "Legal Metrology in the digital era". If so, respective topics and presenters would have to be identified soon, for example smart utility meters, sensor networks, weighing systems in networks, testing and certification in the digital era, etc. The deadline is 15 March 2022. It was proposed to identify a first sub-committee of the DTG, including the provisional Steering Committee.

7.2 Weighing in the digital era

Dr Schwartz said that an International Conference on Weighing ("Weighing in the digital era") will take place in April 2023, organised by CECIP and other national Weighing Federations such as the CWIA and the JMIF. The OIML is also contributing and is represented on the Steering Committee.

8 Any other items

8.1 Cross reference (link) to the Online Technology Project of the CEEMS Advisory Group

Mr Mason announced that a draft publication will be circulated to the DTG for comments as soon as it is considered mature enough.

8.2 World Metrology Day (20 May 2022)

Mr Donnellan mentioned the theme of this year's World Metrology Day, "Metrology in the Digital Era".

8.3 Date of the second DTG meeting

Dr Schwartz noted three possible dates: 28 April, 18 May, 25 May 2022. The BIML will finalise the date.

8.4 Any other items

There were no further discussion items and so Dr Schwartz expressed his thanks to all the participants for contributing to this important Task Group. He especially thanked Mr Rauh and Mr Mason, and said he was looking forward to future cooperation, to lively discussions, and to good proposals in the best interest of the legal metrology community worldwide. ■

Signing of a Joint Statement of Intent

On the digital transformation in the international scientific and quality infrastructure

The International Organization of Legal Metrology (OIML), the International Bureau of Weights and Measures (BIPM), the International Measurement Confederation (IMEKO), the International Science Council (ISC) and its Committee on Data (CODATA) signed a Joint Statement of Intent *On the digital transformation in the international scientific and quality infrastructure* (Joint Statement) on 30 March 2022.

The Joint Statement provides a platform for the signatory organisations to come together to indicate their support, in ways that are appropriate to each particular organisation, for the development, implementation, and promotion of the SI Digital Framework as part of a wider digital transformation of the international scientific and quality infrastructure. Other international organisations are expected to sign the Joint Statement in the future.

The OIML is openly and actively engaging in the digital transformation of legal metrology. This has been recently demonstrated by the creation of the OIML Digitalisation Task Group. This Task Group, which consists of 15 OIML Members and international and regional organisations, is a new horizontal group of the OIML which will support the digital transformation of legal metrology processes and services and support, promote and coordinate the international harmonisation and implementation of digital transformation in legal metrology. By signing the Joint Statement, the OIML signals its support of the principles contained in it and provides a frame of reference for the OIML Digitalisation Task Group.

The Joint Statement also supports the 2022 World Metrology Day theme, *Metrology in the Digital Era*. This theme was selected because digitalisation and digital transformation are part of our community and are of interest to all the Members of the OIML and our various stakeholders.

In signing the Joint Statement, the OIML aims to continue to support the objectives of its 125 Members.

Signing of the Joint Statement of Intent

Clockwise from top left:

Wynand Louw, CIPM President (on behalf of the BIPM)
Mathieu Denis, ISC Science Director and Acting CEO
Barend Mons, CODATA President
Roman Schwartz, CIML President (on behalf of the OIML)
Frank Härtig, IMEKO President

WMD 2022

World Metrology Day 2022

Metrology in the Digital Era

The theme for World Metrology Day 2022 is *Metrology in the Digital Era*

This theme was chosen because digital technology is revolutionising our community, and is one of the most exciting trends in society today.

Indeed more widely metrology, the science of measurement, plays a central role in scientific discovery and innovation, industrial manufacturing and international trade, in improving the quality of life and in protecting the global environment.

World Metrology Day is an annual celebration of the signature of the Metre Convention on 20 May 1875 by representatives of seventeen nations. The Convention set the framework for global collaboration in the science of measurement and in its industrial, commercial and societal applications. The original aim of the Metre Convention - the world-wide uniformity of measurement - remains as important today as it was in 1875.

The World Metrology Day project is realised jointly by the BIPM and the OIML. We hope that you enjoy this site and that your Country or Metrology Organisation will join us and participate in this year's event.

www.worldmetrologyday.org

Promotion of the OIML Bulletin: Become a Mentor

The OIML Bulletin is one, if not the only, international publication dedicated to legal metrology topics.

In accordance with CIML Resolutions 2019/30 and 2020/21, there is a clear desire for the Bulletin to be an attractive publication for legal metrology worldwide, and for it to be an excellent advertisement for our Organisation.

This can be achieved through long-term planning of the future editions and identification of key topics of high interest, for instance, legal control of measuring instruments in the fields of energy, health and the environment, where important aspects such as new technology, legal requirements, or test/verification procedures will be addressed.

In addition, support is sought from CIML Members and Corresponding Member Representatives who are ready to take on the responsibility of acting as "**Mentors**" for certain key topics / editions and technical articles. These are not necessarily expected to be written by the "**Mentors**" themselves, but by experts that a "**Mentor**" has identified and contacted.

In order to identify key topics of significant interest and "**Mentors**" to lead them, it was proposed by the CIML President that the BIML prepares, and makes publicly available on the OIML website, a plan for the upcoming eight to ten editions of the Bulletin.

The table on the following page is intended to be "dynamic", i.e. proposed key topics may be moved to other editions depending on available "**Mentors**" and authors for technical articles. The table can also be found at www.oiml.org/en/publications/bulletin/future-editions.

All CIML Members and Corresponding Member Representatives are encouraged to support the OIML Bulletin, to share their legal metrology experiences with the legal metrology community worldwide, and to take responsibility either as a "**Mentor**" for one of the next editions of the Bulletin, or by promoting it at TC/SC/Project Group meetings, RLMO meetings, CEEMS AG meetings, and other opportunities.

CIML Members and Corresponding Member Representatives who would like to be a "**Mentor**" for a specific edition / key topic, or who would like to suggest that a new key topic be added to the list, are asked to contact the BIML (chris.pulham@oiml.org).

Edition	General key topic	Mentor	Proposed article submissions
July 2022	Metrology for a sustainable environment / climate change	METAS	▪ Soot particle measurement (PTB/METAS joint article) ▪ Particulate matter (P.R. China) ▪ Circular economy (METAS) ▪ Smart metering ▪ Digital Transformation in the Quality Infrastructure - Challenges and opportunities
October 2022	Training of inspectors / verification officers	CEEMS AG Chair?	▪ E-Learning material already available ▪ Revision of OIML D 14 *Training and qualification of legal metrology personnel* ▪ DAM (Deutsche Akademie für Metrologie) ▪ Summary of CEEMS AG achievements and outlook
Future editions	National / Regional Metrology Systems		
	Pre-packages / Statistical control	RLMOs?	▪ Theoretical principles / basics ▪ Various systems in different regions ▪ Report on OTE (July 2023) in Bad Reichenhall (DE)
	Intellectual property		▪ Role of patents in legal metrology

2022-04-06

info

The OIML is pleased to welcome the following new

CIML Members

Indonesia:
Mr. Matheus Hendro Purnomo

Iran:
Mr. Hassan Khanehzar

Vietnam:
Dr. Ha Minh Hiep

OIML meetings

20–21 April 2022
TC 9/SC 2/p 10
Revision of R 51:2006
Automatic catchweighing instruments

27–28 April 2022
TC 9/SC 2/p 11
Revision of R 134:2006
Automatic instruments for weighing road vehicles in motion and measuring axle loads

18–20 October 2022
57th CIML Meeting

Committee Draft

Received by the BIML, 2022.02 – 2022.03

New Document: Guide for the application of ISO/IEC 17020 to the assessment of OIML Issuing Authorities under the OIML-CS	1 CD	TC OIML-CS/SC 7/p 6	BIML	2022-02-04

www.worldmetrologyday.org
World Metrology Day Website

2022 Theme: Metrology in the Digital Era

Bulletin online

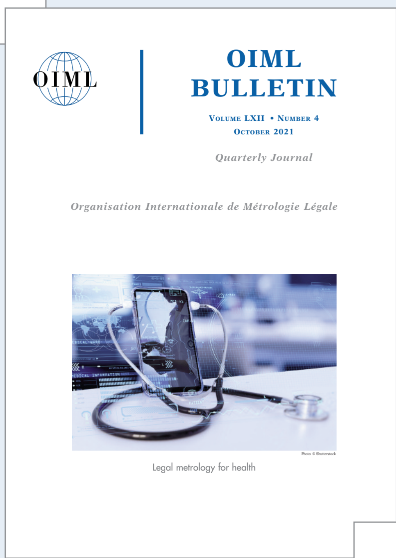
Download the OIML Bulletin
free of charge

www.oiml.org/en/publications/bulletin

Call for papers

OIML Members
RLMOs
Liaison Institutions
Manufacturers' Associations
Consumers' & Users' Groups, etc.

- Technical articles on legal metrology related subjects
- Features on metrology in your country
- Accounts of Seminars, Meetings, Conferences
- Announcements of forthcoming events, etc.



The **OIML Bulletin** is a forum for the publication of technical papers and diverse articles addressing metrological advances in trade, health, the environment and safety - fields in which the credibility of measurement remains a challenging priority. The Editors of the Bulletin encourage the submission of articles covering topics such as national, regional and international activities in legal metrology and related fields, evaluation procedures, accreditation and certification, and measuring techniques and instrumentation. Authors are requested to submit:

- a titled, typed manuscript in Word or WordPerfect either on disk or (preferably) by e-mail;
- the paper originals of any relevant photos, illustrations, diagrams, etc.;
- a photograph of the author(s) suitable for publication together with full contact details: name, position, institution, address, telephone, fax and e-mail.

Note: Electronic images should be minimum 150 dpi, preferably 300 dpi.

Technical articles selected for publication will be remunerated at the rate of 23 € per printed page, provided that they have not already been published in other journals. The Editors reserve the right to edit contributions for style, space and linguistic reasons and author approval is always obtained prior to publication. The Editors decline responsibility for any claims made in articles, which are the sole responsibility of the authors concerned. Please send submissions to:

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BIML, 11 Rue Turgot, F-75009 Paris, France
(chris.pulham@oiml.org)