Technical Protocol of the APMP Supplementary Comparison APMP.AUV.V-S2

1 Task and Purpose of the Comparison

According to the rules set up by the CIPM MRA the consultative committees of the CIPM have the responsibility to establish 'degrees of equivalence' (DoE) between the different measurement standards operated by the national NMIs. This is done by conducting key comparisons (KC) at different levels of the international metrological infrastructure.

However, in the sub-field of rotational speed, there is no formal comparison completed so far either at Consultative Committee (CC) level or Regional Metrology Organization Technical Committee (RMO TC) level. Therefore, during the meeting of APMP TCAUV in 2021, the decision was taken to make preparations for a Supplementary Comparison targeted at rotational speed (constant acceleration).

This regional Supplementary Comparison is organized in order to compare primary measurements of rotational speed in the range from 30 r/min to 99 996 r/min. It is the task of the comparison to calibrate two laser digital tachometers at different rotational speed values as specified in section 3. The results of this APMP Supplementary Comparison may serve as supporting evidence for the registration of 'calibration and measurement capabilities' (CMCs) in the framework of the CIPM MRA.

The measured value of rotational speed is calculated as the average of ten successive measurement results at its reflective mark or upon the optical flash. The measured value shall be given in revolutions per minute (r/min) for different measurement conditions specified in section 3.

For the calibration of the laser tachometer, rotational speed standard device of mechanical generator type or optical simulator type has to be applied.

The reported measured values and associated uncertainties will be used for the calculation of mean values of the Supplementary Comparison results and their associated uncertainties, as well as the deviations to the mean values with associated uncertainties.

2 Pilot Laboratory

Pilot laboratory for this regional Supplementary Comparison is

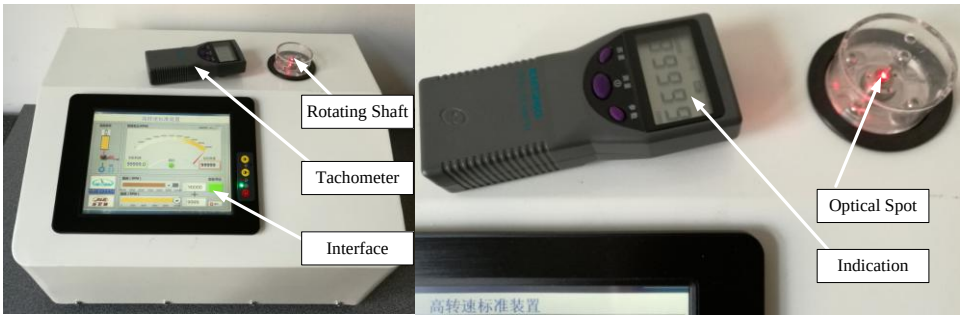
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3 Device under Test and Measurement Conditions

For the calibration task of this comparison two laser tachometers will be circulated between the participating laboratories. The laser tachometers are two EMT260C (SN: NLYZ-02 and NLYZ-03).



The measurement value of the laser tachometers is to be calibrated according to those procedures and conditions implemented by the laboratory. The measurement values reported shall be the average of ten successive measurement results at its reflective mark of a rotational speed standard device or upon the optical flash of an optical simulator type.

The rotational speed range of the measurements was agreed to be from 30 r/min to 99 996 r/min. Specifically, the laboratories are supposed to measure at the following rotational speeds (all values in r/min).

30, 300, 3 000, 30 000, 99 996.

The measurement conditions should be kept according to the laboratory's standard conditions for calibration of customers' laser tachometers for claiming their best measurement capability.

Specific conditions for the measurements of this comparison are:

- Measurement distance is within 0.1 to 1 m.
- Ambient temperature during the calibration: (23 ± 3) ℃.
- Relative humidity: max. 75 % RH.
- No flash of background light affects the measurement.

4 Circulation Type, Schedule and Transportation

The artefacts are circulated in a star type fashion with a measurement period of two weeks provided for the participating laboratory. At the beginning and the end of the circulation, the laser tachometers are measured at the pilot laboratory in order to monitor the stability.

The schedule is planned as follows:

Participant	Measurement (calendar week)	Transportation to next Participant (calendar week)
NIM	41-42/2022	43-44/2022
NMC	45-46/2022	47-48/2022
NIML	49-50/2022	51-52/2022
NMT	01-02/2023	03-04/2023
KEBS	05-06/2023	07-08/2023
NIS	09-10/2023	11-12/2023
NIM	13-14/2023	

The cost of transportation to the next laboratory shall be covered by the participating laboratory. The laser tachometers should be delivered by an international logistic service with on-line tracking system. The transportation has to include an insurance covering a value of USD 500 in case the artefacts get damaged or lost during transportation. Hand-carry can be used as an option.

5 Measurement and Analysis Instructions

The participating laboratories have to observe the following instructions:

- The motion of the rotational output disc of mechanical generator should be measured at the reflective mark surface in perpendicular direction.
- The optical flash of the optical simulator should be measured in line with the tachometer.
- A tripod is recommended for installation of the laser tachometer.
- It is advised that the measurement results should be compiled from complete measurement series carried out at different days under nominally the same conditions, except that the laser tachometer is remounted. The standard deviation of the subsequent measurements should be included in the report.

6 Communication of the Results to Pilot Laboratory

The participating laboratory will submit one printed and signed calibration report (a scanned copy sent by email to the pilot laboratory) for each laser tachometer including the following:

- a description of the calibration system used for the comparison with a photo of the system, preferably when the laser tachometer is installed,
- a description of the calibration method used and the mounting techniques for the laser tachometer,
- documented records of the ambient conditions during measurements,
- calibration results, including the relative expanded measurement uncertainty, and the applied coverage factor for each value,
- a detailed uncertainty budget for the system covering all components of measurement uncertainty (calculated according to GUM [1,2]). Including, among others, information on the type of uncertainty (A or B), assumed distribution function and repeatability component.

In addition, the use of the electronic spreadsheets for reporting is mandatory. The consistency between the results in electronic form and the printed and signed calibration report is the responsibility of the participating laboratories. The data submitted in the electronic spreadsheet shall be deemed as official results submitted for the comparison.

The results have to be submitted to the pilot laboratory within four weeks after the measurements have been completed.

References

[1] ISO/IEC Guide 98-3:2008 ‘Uncertainty of measurement -- Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)

[2] ISO/IEC Guide 98-3:2008/Suppl 1:2008 ‘Propagation of distributions using a Monte Carlo method’

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