

## Discussion Group on Step Gauges – DG5

### DG5 report to CCL-WG MRA 2018

#### DG5 membership

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#### Discussions

No new discussions have taken place after the last CCL/WG MRA meeting in 2017.

#### Comparison activities

- **APMP.L-K5.2006.1**

Registered at the KCDB on 22 August 2012, as a follow-up comparison of the previous APMP.L-K5.2006.

Participants: NPLI (India) and NMIJ (Japan).

Mitutoyo supplied the circulated step gauge and participated in the comparison but their results were not included in the reports.

Comparison ran from August 2012 to May 2013.

Draft A Report submitted to the participants in September 2014.

Draft B1 circulated in October 2014 followed by succeeding revisions.

Final approved version, Draft B3, accepted in January 2017.

Executive Report prepared on 29 March 2018 and sent for peer-reviewing and approval by this CCL 2018 meeting.

- **APMP.L-K5.2014**

Registered at the KCDB on 24 February 2015.

Participants: KRISS (Korea), the Pilot, NIM (China), NIMT (Thailand), NMIA (Australia) and Puslit KIM-LIPI (Indonesia).

Comparison finished and Draft B under preparation.

- **EURAMET.L-K5.2016**

Technical protocol prepared and presented at CCL 2015.

There are 23 participants including the Pilot (NPL, UK). 15 of these are EURAMET members, of whom, all but one have current CMC for step gauges.

There are 3 participants from the SIM region (an additional participant from this region withdrew without making measurements) and 1 from AFRIMET region, all with step gauge CMCs under the MRA. A single participant from GULFMET was added after the comparison began with the agreement of the other participants. This institute does not have a current CMC for step gauges.

There are also 4 participants from APMP acting as linking labs between EURAMET.L-K5.2016 and APMP-K5.2014. Additionally a non-NMI participant was included at the request of the chair of EURAMET TC-L with the agreement of the other participants.

Two artefacts (a 620 mm step gauge and a “new design” 1020 mm step gauge) under circulation following two independent loops.

For the first time, a new type of step gauge with similar metrological dimensions than a KOBA step gauge under circulation, but machined from a single piece of ceramic to avoid the ‘slugs’ moving during shipping and a relatively low CTE (2.3 ppm/K), much lower than common step gauges.

Circulation under way. Measurements estimated to conclude in October 2018.

## Potential topics for DG discussions

No potential topics for discussion have been communicated to this Moderator.

## Updated list of papers related to DG5

1. P.S. Lingard, M.E. Purss, C.M. Sona, E.G. Thwaite, *Length-Bar and Step-Gauge Calibration Using a Laser Measurement System with a Coordinate Measuring Machine*, CIRP Annals, Volume 40, Issue 1, 1991, Pages 515-517
2. Y-F. Zang, G. Zhang, X-Y. Liu, *Laser interferometric device for measuring step gauges with high accuracy*, SPIE Proceedings Vol. 2101: Measurement Technology and Intelligent Instruments, September 1993.
3. O. A. Kruger, *High-accuracy interferometric measurements of flatness and parallelism of a step gauge*, *Metrologia*, 2001, 38, 237-240.
4. O. A. Kruger, *Investigation into the measuring of the length spacing of step gauges*, SPIE Proceedings Vol. 4401: Recent Developments in Traceable Dimensional Measurements, October 2001.
5. S. Osawa T. Takatsuji, T. Kurosawa, *Development of an Interferometric Coordinate Measuring Machine Used for Step-gauge Calibration*, Journal of the Japan Society for Precision Engineering, Volume 68 (2002) Issue 5 Pages 687-691.

6. S. Osawa T. Takatsuji, T. Kurosawa, *Step-gauge calibration using an interferometric coordinate measuring machine and the uncertainty*, XVII IMEKO World Congress "Metrology in the 3rd Millennium", Dubrovnik, Croatia, June 22–27, 2003.
7. E. Prieto, J. Rodriguez, *New capabilities of the CEM-TEK 1200 interferometric comparator for calibrating long gauges, step gauges, and now line scales*, SPIE Vol. 5190: Recent Developments in Traceable Dimensional Measurements II, San Diego (USA), August 2003.
8. O. Jusko, *Comparison CCL-K5 (1999-2002), Final Report, Metrologia*, 2006, 43, Tech. Suppl., 04006
9. H. Yan; W. Wang, *A method for the calibration of step gauges*, Proc. SPIE 6280, Third International Symposium on Precision Mechanical Measurements, 62800S, 13 October 2006.
10. E. Prieto, *Step gauges and CMM Traceability - Historical Study and international Comparisons*, Metromeet 09, 5th International Conference on Industrial Dimensional Metrology, 27 March 2009.
11. J. R. Stoup; B. S. Faust, *Measuring step gauges using the NIST M48 CMM*, *Measure Magazine*, April 01, 2011.
12. E. Prieto et al, *Inter-RMO Key Comparison EUROMET.L-K5.2004: Calibration of a step gauge: Final report, Metrologia*, 2012, 49(1A). Tech. Suppl., 04008.
13. T. Eom et al., *Comparison APMP.L-K5.2006 (2005-2007), Metrologia*, 2012, 49, Tech. Suppl., 04007
14. S. Sun, X. Shen, L. Zou, H. Gao, X. Ye, *A novel measuring device for step gauge*, SPIE Proceedings Vol. 9283: 7th International Symposium on Advanced Optical Manufacturing and Testing Technologies: Design, Manufacturing, and Testing of Micro- and Nano-Optical Devices and Systems, August 2014.
15. M. Abe, A. P. Drijarkara, V. Babu, *Bi-lateral comparison APMP.L-K5.2006.1, Calibration of step gauge*, 2017 *Metrologia* 54 04006.
16. F. Hennebelle, T. Coorevits, R. Vincent, *Optimizing step gauge measurements and uncertainties estimation*, Meas. Sci. Technol. 28 (2017) 025002.
17. V. Byman, T. Jaakkola, I. Palosuo, A. Lassila, *High accuracy step gauge interferometer*, Meas. Sci. Technol. 29 (2018) 054003.

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