

**Report of the Working Group on Force
(2002 - 2004)**

The last CCM Force Working Group meeting was held at CSIR, Pretoria, South Africa from 22nd to 24th March 2004. The main topic of this meeting was:

”Key Comparisons in Force and Torque“.

Report of the 5 kN and 10 kN Force Key Comparison, MIKES, Finland.

The 5 kN and 10 kN Force Key Comparison was organized by MIKES-Raute, Finland. First results were presented during the last CCM WG Force working group meeting which was held in October 2001 at NIST. But during that meeting it was decided that additional information had to be taken into account for the evaluation of the data under consideration of the measurement uncertainty. The pilot laboratory presented in draft A the final measurement results of all participants and the corresponding uncertainties and the relative deviations between the participants and the pilot laboratory was evaluated in draft A. This draft A (Part 1) was accepted by all participants and is the basis for the further evaluation of the data. For the final evaluation and for the calculation of the reference value the pilot laboratory evaluated the data according to different methods (mean, median, weighted mean). But during the meeting no consensus could be reached for an acceptance of this draft A (Part 2). Therefore, the pilot laboratory was asked to prepare a new primarily draft B. But the following recommendations should be taken into account for the further evaluation. For the calculation of the reference value, it would be better to analyse all transducers separately because of the different transducer stabilities. Furthermore it was suggested that the weighted mean should be used for the evaluation of the data. However, the way of evaluating the data should not be fixed in detail during the WG meeting because the other comparisons can come to other results. The pilot laboratory has now prepared a new primarily draft B which will be further discussed with the participants.

Report of 4 MN Key Comparison carried out by NIST, USA.

The 2 MN and 4 MN Key Comparison is carried out by NIST, USA, and a report from the pilot laboratory was distributed during the WG meeting. From September 2002 until March 2004, the following institutes participated in the 4 MN comparison: NIST, BNM-LNE, NMIJ/AIST, KRISS, PTB. NIM, NPL and CSIR-NML have been complementing machine refurbishment, but the measurements of NIM and NPL will follow in the next months. CSIR-NML will not complete refurbishment in time to participate and has therefore been withdrawn from the comparison. The 4 MN comparison was finished in 2004 and the 2 MN comparison is going on. Three institutes (NIST, PTB and GUM) participate, and it is planned that the measurements will be finished in spring 2005.

Report of 50 kN and the 100 kN Key Comparison, NPL, UK.

The 50 kN and 100 kN Key Comparison is organized by the pilot laboratory NPL, UK, and a report was given by Andy Knott. This comparison, which was originally planned for 2001-2002, was shifted

because NPL moved to a new laboratory and the installation of the new 120 kN has to be completed first, which was finished in 2004. The comparison has started in the end of 2004 and will be completed in 2006. The participants of CCM.F-K2.a the 50kN,100 kN comparison are: NPL (pilot), SMD, MIKES, PTB, CNR-IMGC, SP, UME, INMETRO, CENAM, NIST, NIM, NPLI, KRISS. The participants of CCM.F-K2.b, the 50 kN comparison, are: NPL (pilot), BNM-LNE, NMIJ, KRISS, NML-SIRIM, NIS, CSIR-NML.

Report of 500 kN and 1 MN Key Comparison, PTB, Germany.

PTB decided to use the new 2 MN dead-weight force standard machine (2-MN-fsm) for this comparison, which was moved from Berlin to Braunschweig and completely modernized. The first loop is group A with the 1 MN transducers which has started in January 2005. The participants are PTB (pilot), NPL, NIST, IMGC, NIM and VNIM. After this comparison is completed, group B will follow with the 500 kN transducers in autumn 2005. The participants are: PTB (pilot), IMGC, LNE, CEM, GUM, KRISS, CSIRO-NML, AIST, NIM.

Future Recommendations

Future recommendations and topics in the field of force will be related to smaller forces, to multicomponent force measurement, comparison in tension ranges and influences related to compression and tension.

Key Comparisons in Torque

Due to the good results of the Force Key Comparison, the measurement sequences and loading/waiting times should be the same for the Torque Key Comparison.

It was proposed to start a first key comparison of dead-weight torque standard machines in the very important range from 500 N·m up to 1 kN·m. At 1 kN·m, MX, JP, KR, GE, ES, UK and CH each have one dead-weight machine in the National Metrological Institute (NMI). At least the four countries: MX, ES, JP and GE should participate in this comparison.

A second range (20 kN·m) was identified for a key comparison with the difference that there are only two dead-weight torque standard machines (JP, DE) in the world, but a greater number of reference-type machines. It was suggested to include these machines and to have a key comparison in this second range for the dead-weight and the reference-type machines. At 20 kN·m, MX, FI, FR, CH, JP and GE have a reference (JP and GE a dead-weight) machine in their NMI (except China).

The PTB (Germany) was identified to be the pilot laboratory for the comparison in both ranges. The pilot should prove the difference between clockwise and anti-clockwise torque (comparable with tension and compression for the force).

The key comparisons should start at the beginning of the year 2005 and will take about one year.

The next CCM Force WG meeting

It was decided that the next CCM Force WG meeting should be held in the autumn of 2006 in Mexico.

Table of Key Comparisons:

Key comparison	Torque range	Dead-weight machines	Reference machines
CCM.T-K1	1 kN·m	0 – 500 N·m – 1000 N·m	
CCM.T-K2	20 kN·m	0 – 10 kN·m – 20 kN·m	0 – 10 kN·m – 20 kN·m

Allocation of countries to torque ranges:

	CCM.T-K1 1 kN·m, dead-weight	CCM.T-K2 20 kN·m, dead-weight 20 kN·m, reference
SIM	CENAM	CENAM
EUROMET	CEM NPL METAS PTB	PTB BLM-LNE RAUTE
APMP	NMIJ KRISS	NMIJ SMERI