16th Meeting of the CCM
18 May 2017, BIPM

Update: Working Group on Hardness

Sam Low, Chair

National Institute of Standards and Technology (NIST), Gaithersburg, MD, USA

« Chairmanship »

From 1998 until March 2014 [Ad-hoc WGH 1998 to 1999]:

Chair: Alessandro Germak (IMGC/INRIM)

Secretary: Sam Low (NIST)

From March 2014:

Chair: Sam Low (NIST)

Vice-Chair: Febo Menelao (PTB)

« Terms of Reference »

1) To advise the CCM on matters relating to hardness;
2) To improve harmonization of primary standards by developing new primary definitions and/or organizing pilot studies;
3) To organize key comparisons for supporting the CIPM MRA;
4) To support activities of RMOs;
5) To produce working documents for the evaluation of uncertainty;
6) To maintain good links and interface with the hardness community
   - *IMEKO TC5* – Hardness Measurement
7) To provide formal liaison among organizations involved in the standardization
   - *ISO TC164/SC 3* - Mechanical testing of metals / Hardness testing
   - *ASTM-International Committee E28.06* - Mechanical Testing / Indentation Hardness Testing

« Program of work of the WGH for the next 5 years »

- Development of international primary hardness definitions
  Proposals currently under development for:
  Rockwell (B, 15N, 30N, 45N), Brinell, Vickers, Knoop and Leeb scales

- KCs & Pilot Studies in different hardness scales:
  [CCM.H-K3] Rockwell C hardness (HRC): Key Comparison - Initiate measurements all 4 regions (2017)
  [CCM.H-P1] Rockwell diamond indenters: Pilot Study - Approve completed Draft A Report (2017)
  [CCM.H-P2] Leeb (HL): Pilot Study – Measurements completed. Prepare Draft A Report (2017)
  [CCM.H-P3] Brinell hardness: Pilot Study [formally CCM.H-K2] – Approve completed Draft A (2017)

  [Planned] Rockwell B (HRBW): Key Comparison or Pilot Study - Develop test protocol (2017)
  [Planned] Rockwell N (HR15N, HR30N and HR45N): Key Comparison - Develop test protocol (2017)
  [Planned] Brinell (HBW scales to be determined): Key Comparison - Develop test protocol (2018)

- Future activities to improve the measurement traceability through development of primary definitions and organization of KCs and pilot Studies:
  - instrumented indentation test
  - nano-indentations
  - dynamic hardness
  - portable hardness testers,
  - hardness of elastomers,
  - Martens hardness

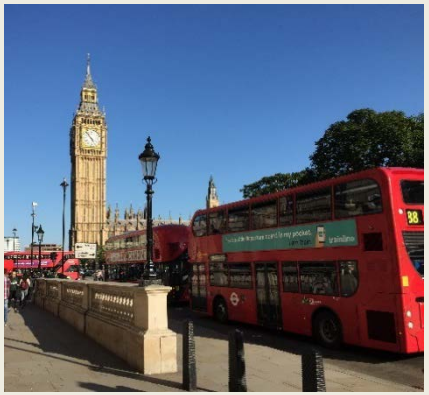
« Present Membership (NMIs and individuals) »

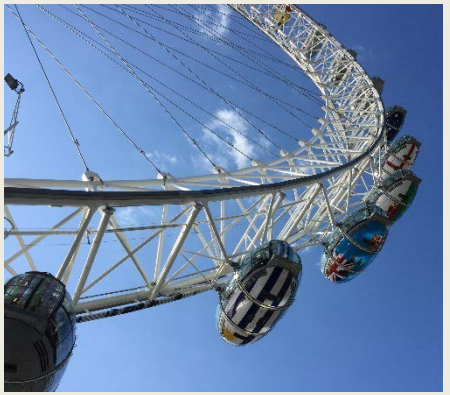
	Institute	*Country*	*Delegate*	*Technical Experts*
1	CENAM	Mexico	Alfredo Esparza Ramírez	
2	GUM	Poland	Anna Osinska-Karczmarek	
3	INMETRO	Brazil	Renato Reis Machado	Sergio Pinheiro de Oliveira
4	**INRIM**	**Italy**	**Alessandro Germak**	
5	**KEBS**	**Kenya**	**Josephat Bang'i**	
6	**KRISS**	**Korea, Republic of**	**N. H. Tak**	Junhee Hahn
7	LNE	France	Stéphane Lefrançois	
8	**NIM**	**China**	**Cui Yuanyuan** [Previous delegate He Li retired from NIM]	
9	NIMT	Thailand	Sanponpute Tassanai	Rugkanawan Wongpithayadisai
10	**NIST**	**United States of America**	**Samuel Low**	**John Song**
11	**NMIJ**	**Japan**	**Koichiro Hattori**	Satoshi Takagi
12	NMISA	South Africa	Corné Gouws	
13	**NPL**	**United Kingdom**	Andy Knott	Currently not filled **Xiaodong Hou** [Resigned from NPL] [Replaced previous Expert Nigel Jennett, resigned from NPL]
14	**PTB**	**Germany**	**Febo Menelao**	
15	SMU	Slovakia	Dana Bolibruchová [Previous delegate Robert Spurný retired from SMU]	
16	SP	Sweden	Leslie R. Pendrill	
17	**UME**	**Turkey**	**Cihan Kuzu**	
18	**VNIIFTRI**	**Russian Federation**	Edward Aslanyan	**Andrey Aslanyan**
19	VNIIM	Russian Federation	Natalia G. Domostroyeva	
20	VSL	Netherlands	Gerard Kotte	

Yellow highlight indicates change to personnel since last CCM meeting.
***Bold** indicates the attendees to the last meeting*

No proposal for new membership

« 2 WGH Meetings held since last CCM»





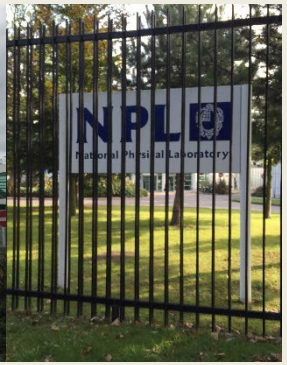
16th meeting of the WGH

Wednesday, 9 September 2015

National Physical Laboratory (NPL)
Teddington, UK

(in coincidence with the meetings of
ISO TC 164 Mechanical testing of metals
held that week in the same location)

ISO Host organization:
British Standards Institute



- 9 NMIs represented
- 13 delegates and technical experts
- 3 visitors

« 2 WGH Meetings held since last CCM»

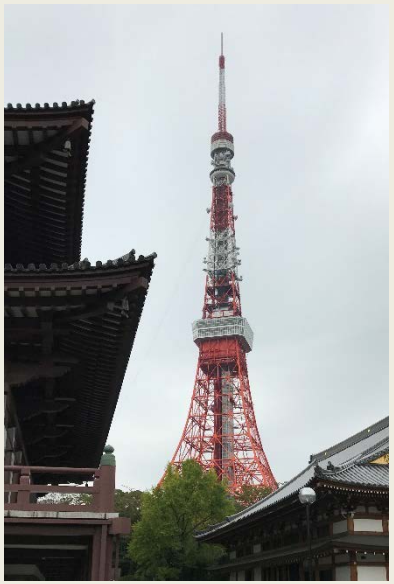
17th meeting of the WGH

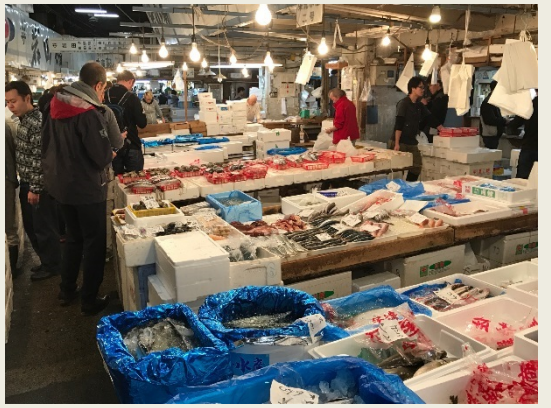
Wednesday, 26 October 2016

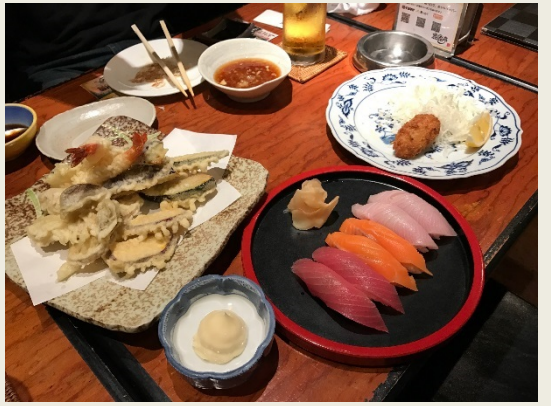
Tekko Kaikan
Tokyo, Japan

(in coincidence with the meetings of
ISO TC 164 Mechanical testing of metals
held that week in the same location)

ISO Host organization:
Japanese Standards Association, JSA



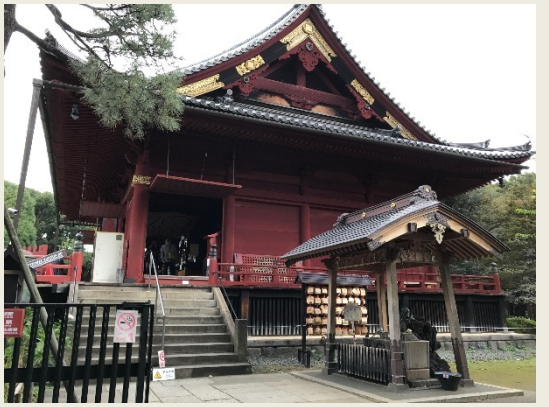




10 NMIs represented

11 delegates and technical experts

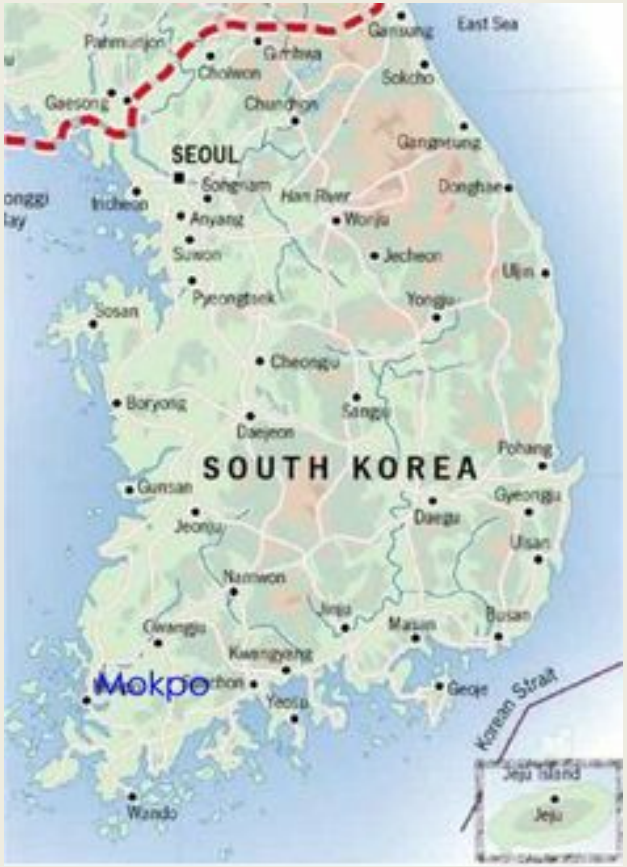
4 visitors



« Next Planned WGH Meeting »

The next meeting will be held on Wednesday, 20 September 2017
in conjunction with the meetings of:

ISO TC 164 Mechanical Testing of Metals
Hotel Hyundai Mokpo, ***Mokpo (originally Seoul), Republic of Korea***
Week of 17 to 22 September 2017



« Liaisons with RMO KCs »

RMO and Name	Scale	Year	Hardness levels	Status
APMP.M.H- K1.b	Vickers 1	2003/2004	200 HV, 600 HV and 900 HV	In progress
APMP.M.H- K1.c	Vickers 30	2003/2004	200 HV, 600 HV and 900 HV	In progress
APMP.M.H- S1	Rockwell C	2004/2005	20 HRC to 60 HRC	Approved and published
APMP.M.H- S2	Rockwell A and B	2009	35 HRA to 85 HRA, and 25 HRB to 100 HRB	Approved and published
APMP.M.H- S3	Rockwell A and B	2009/2010	35 HRA to 85 HRA, and 25 HRB to 100 HRB	Approved and published
APMP	Brinell			Planning Stage
APMP.M.H- S4	Rockwell C	2011	30 HRC, 45 HRC and 60 HRC	Planned
COOMET.M.H-K1	Vickers HV1, HV5, HV30	2007/2010	400 HV, 700 HV	Protocol complete
COOMET.M.H-K1.b	Vickers 1	2004	240 HV, 540 HV and 840 HV	Approved and published
COOMET.M.H-K1.c	Vickers 30	2004	240 HV, 540 HV and 840 HV	Approved and published
COOMET.M.H-K2	Brinell Hardness	2007/2010	100 HBW, 200 HBW, 400 HBW	Protocol complete
COOMET.M.H-S1	Rockwell and Super-Rockwell	2007/2008	60 HRA, 70 HRA, 80 HRA, 60 HRB, 75 HRB, 100 HRB, 30 HRC, 50 HRC, 65 HRC, 70 HR15N, 80 HR15N, 90 HR15N, 50 HR30N, 60 HR30N, 75 HR30N, 30 HR45N, 50 HR45N, 65 HR45N, 80 HR15T, 85 HR15T, 90 HR15T, 55 HR30T, 65 HR30T, 80 HR30T	Approved and published
COOMET.M.H-S2	Martens hardness and Indentation Hardness	2014/2016	HM (0.1 GPa, 3 GPa and 12 GPa), HIT (0.2 GPa, 9 GPa and 23 GPa)	In progress

« KCs underway »

- **CCM.H- K3** Hardness Rockwell C (HRC) scale (2011 – 2012)

  Key comparison in Mass, Hardness

  Status: Underway

  Problems:

  - The KC stalled in about 2012 following the testing by the four original Pilot laboratories.
  - The WGH members proposed that the KC be restarted.
  - INRiM agreed to continue leading the KC. Participation needs to be re-confirmed.

- ~~CCM.H- K2~~ now **CCM.H- P3** Brinell Hardness scale (2003 – 2004)

  Key comparison in Mass, Hardness

  Status: **Re-classified as a Pilot Study in 2016**

  Problems:

  - Significant measurement differences between NMIs, primarily due to the differing measuring instruments being used.
  - Corrections for the differences were applied, but the success of the corrected results was mixed.
  - WGH members view the comparison as ineffective for the purposes of a KC. The results would indicate obsolete information about the current state of measurement at some participating NMIs that have improved their measuring system since the KC measurements were conducted.
  - However, the comparison did point out problematic issues with the measurement of Brinell hardness at several NMIs. Therefore, the CCM-WGH has decided to reclassify this comparison as a Pilot Study, and will initiate a new Brinell hardness KC in the future.

« Pilot Studies underway »

- **CCM.H-P1** Rockwell diamond indenters (2010)
  Pilot Study in Mass **(?)**, Hardness
  Status: Draft A Report completed, not yet approved.
  Problems: None

- **CCM.H-P2** Leeb hardness (2014)
  Pilot Study in Mass, Hardness
  Status: Draft A Report being prepared
  Problems: None

- **CCM.H- P3** Brinell Hardness scale (2003 – 2004) [Formally CCM.H- K2]
  Pilot Study in Mass, Hardness
  Status: Draft A Report completed, not yet approved.

« Future Comparisons »

Planned

- Rockwell B (HRBW): Pilot Study
- Rockwell N (HR15N, HR30N and HR45N): Key Comparison
- Brinell (HBW scales to be determined): Key Comparison

Discussed

- KC or Pilot Study of Instrumented Indentation Testing (IIT).
- KCs of Rockwell scales used to certify Rockwell diamond indenters.
- KC of Shore hardness D scale (HSD)

The current and planned KCs are sufficient for CMCs in hardness field.

« Major successes (since last CCM) »

- *Rockwell Diamond Indenter Pilot Study* [CCM.H-P1].

  All measurements for the Pilot Study to compare the geometrical measurements of Rockwell Diamond Indenters have been completed. The Draft A Report is being prepared.

- *Leeb Pilot Study* [CCM.H-P2].

  All measurements for the Leeb Pilot Study have been completed. The results from the participating NMIs were good. The Draft A Report is being prepared.

- *Brinell Key Comparison* [CCM.H-K2]:

  In 2016, the CCM-WGH decided to reclassify this comparison as a Pilot Study [CCM.H-P3]. The Draft A Pilot Study Report is completed awaiting approval. A new Brinell hardness KC is planned for the future.

- *Hardness test definitions*

  Development of definitions for Rockwell B and N scales is nearly complete. Development of new definitions for the Leeb, Vickers and Knoop hardness tests have been initiated.

« Major problems (since last CCM) »

- The Rockwell C scale hardness KC (CCM.H- K3) has been stalled for a long period, which has led to it being re-initiated.

« Technology trends & challenges in hardness field »

The Working Group on Hardness (WGH) deals with Hardness standards and promotes the international cooperation among NMIs, DIs, RMO members and international organization like ISO, ASTM, VAMAS and others, for improving traceability and standardization in the field.

An increase in the demand of traceability is foreseen in the instrumented indentation test, nano-indentations, dynamic hardness, portable hardness testers, hardness of elastomers and Leeb hardness.

Thank you