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**Progress Report on Mass and Related Quantities**  
**at**  
**National Institute of Standards (NIS) - Egypt**  
**(From May, 2021 to May, 2023)**  
**19<sup>th</sup> meeting of the CCM**  
**25 and 26 May 2023**

**Prepared by:**

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## 1-Calibration and Measuring Capabilities (CMCs)

The following **Published (20) CMCs** had been approved and published in the BIPM-KCDB:

### 1.1 Mass

The following CMCs had been approved and published in the BIPM-KCDB website on 25<sup>th</sup> Oct., 2022:

- **100 kg Mass Standard**

Absolute expanded uncertainty: **0.5 g**, Comparison in air, Temperature: 18 °C to 27 °C

- **200 kg Mass standard**

Absolute expanded uncertainty: **1 g**, Comparison in air, Temperature: 18 °C to 27°C

- **500 kg Mass standard**

Absolute expanded uncertainty: **1.2 g**, Comparison in air, Temperature: 18 °C to 27 °C

- **1000 kg Mass Standard**

Absolute expanded uncertainty: **1.5 g**, Comparison in air, Temperature: 18 °C to 27 °C

### 1.2 Density

The following CMCs had been approved and published in the BIPM-KCDB website on 2022:

- Density of liquid: **950 kg/m<sup>3</sup> to 1850 kg/m<sup>3</sup>**, Hydrometers, Absolute expanded uncertainty: **5.4E-2 kg/m<sup>3</sup> to 7.4E-2 kg/m<sup>3</sup>**, Cuckow method (Hydrostatic weighing), Liquid temperature: 20 °C  
Pressure: 101 kPa ( **11<sup>th</sup> May, 2022**)
- Density of liquid: **650 kg/m<sup>3</sup> to 950 kg/m<sup>3</sup>**, Hydrometers, Absolute expanded uncertainty: **5.4E-2 kg/m<sup>3</sup>**, Cuckow method (Hydrostatic weighing) Liquid temperature: 20 °C, Pressure: 101 kPa( **1<sup>st</sup> Feb., 2022**)
- Density of solid: 7700 kg/m<sup>3</sup> to 8400 kg/m<sup>3</sup> Mass standard 5 kg to 20 kg, Absolute expanded uncertainty: **0.82 kg/m<sup>3</sup> to 0.8 kg/m<sup>3</sup>**, Hydrostatic weighing by weight comparison, Reference temperature: 20 °C,(**25<sup>th</sup> October 2022**)
- Density of solid: **7700 kg/m<sup>3</sup> to 8400 kg/m<sup>3</sup>**, Mass standard 1 kg, Absolute expanded uncertainty: **0.85 kg/m<sup>3</sup>**, Hydrostatic weighing by weight comparison, Reference temperature: 20 °C ,( **11<sup>th</sup> May, 2022**)
- Density of solid: **7700 kg/m<sup>3</sup> to 8400 kg/m<sup>3</sup>**, Mass standard 2 kg, Absolute expanded uncertainty: **0.83 kg/m<sup>3</sup>**, Hydrostatic weighing by weight comparison, Reference temperature: 20 °C , (**11<sup>th</sup> May, 2022**)

### 1.3 Hardness

The following CMCs had been approved and published in the BIPM-KCDB website on 4<sup>th</sup> Nov., 2022:

- **Hardness: 184 HV30 to 712 HV30**, Hardness reference blocks, Absolute expanded uncertainty: **3 HV to 1.1E1 HV**, Vickers HV 30, ISO 6507-3
- **Hardness: 455 HV to 854 HV**, Hardness reference blocks, Absolute expanded uncertainty: **7.3 HV to 1.4E1 HV**, Vickers HV 120, ISO 6507-3
- **Hardness: 292 HV10 to 854 HV10**, Hardness reference blocks, Absolute expanded uncertainty: **4.7 HV10 to 1.4E1 HV10**, Vickers HV10, ISO 6507-3
- **Hardness: 270 HV to 832 HV**, Hardness reference blocks, Absolute expanded uncertainty: **4.3 HV to 1.3E1 HV**, Vickers HV 20, ISO 6507-3
- **Hardness: 380 HV to 770 HV**, Hardness reference blocks, Absolute expanded uncertainty: **6 HV to 1.2E1 HV**, Vickers HV50, ISO 6507-3
- **Hardness: 452 HV to 772 HV**, Hardness reference blocks, Absolute expanded uncertainty: **7.2 HV to 1.2E1 HV**, Vickers HV 100, ISO 6507-3

#### 1.4 Torque

The following CMCs had been approved and published in the BIPM-KCDB website on 5<sup>th</sup> Nov., 2022:

- **Torque:** clockwise and anticlockwise: **0.1 N m to 1 N m** Reference torque transducer, Relative expanded uncertainty: **0.14 %**, Direct comparison, DIN 51309, BS 7882.
- **Torque:** clockwise and anticlockwise: **1.0 N m to 20.0 N m** Reference torque transducer, Relative expanded uncertainty: **0.06 %**, Direct comparison, DIN 51309, BS 7882

#### 1.5 Fluid Flow

The following CMCs had been approved and published in the BIPM-KCDB website on 13<sup>th</sup> Sep., 2021:

- **Fluid flow, Volume of liquid: 1 µL to 10 µL**, Micropipettes or piston pipettes, Absolute expanded uncertainty: **9.0E-2 µL**, Gravimetric Liquid: Water, Reference temperature: 20 °C
- **Fluid flow, Volume of liquid: 10 µL to 100 µL**, Micropipettes or piston pipettes, absolute expanded uncertainty: **0.35 µL**, Gravimetric, Liquid: Water, Reference temperature: 20 °C
- **Fluid flow, Volume of liquid: 100 µL to 1000 µL**, Micropipettes or piston pipettes, absolute expanded uncertainty: **0.58 µL**, Gravimetric, Liquid: Water, Reference temperature: 20 °C

## 2- Submitted CMCs

Activity	Number of CMCs	Status
Pressure	1	draft
Torque	1	under review
Viscosity	6	under review

## 3- Comparisons:

The ongoing comparisons are summarized in the following table:

Year	Identifier	Description	Participants	Pilot	Status
2022-2023	CCM.D-K1.2023	Density measurement of a silicon sphere (1 kg sphere made of natural silicon)	PTB, CENAM, INRIM, METAS, NIM, NIS, NMIA, NMIJ AIST, NRC, SASO-NMCC, UME	PTB	Measurements in progress
2020-2022	CCM.P-K16	Pressure 25 kPa to 350 kPa (Absolute mode)	CENAM, KRIS, LNE, METAS, NIS, NIST, NMIJ AIST, PTB, VNIIM	CENAM	Measurements in progress
2020-2022	CCM.P-K17	Pressure 25 kPa to 350 kPa (Gauge mode)	CENAM, KRIS, LNE, METAS, NIS, NIST, NMIJ AIST, PTB, VNIIM	CENAM	Measurements in progress
2020-2022	CCM.P-K18	Pressure 0.7 MPa to 7 MPa (gauge mode)	CENAM, KRIS, LNE, METAS, NIS, NIST, NMIJ AIST, PTB, VNIIM	CENAM	Measurements in progress
2022-2023	GULFMET.M. D-S1	Solid density (Stainless steel weights 1 kg, 200 g, 20 g and 2 g)	EMI, NIS, SASO-NMCC, UME,	EMI	Protocol complete
2017-2022	AFRIMETS.M.P-S2	Pressure measurements (Absolute mode) Absolute Pressure 10 kPa, 30 kPa, 50 kPa, 70 kPa, 90 kPa, 100 kPa and 110 kPa	NMISA, KEBS, LPEE-LNM, NIS, PTB	NMISA	Measurements in progress

2022	AFRIMETS.M.T-S1	Torque measurements (500 N m and 1000 N m)	NIS,PTB	NIS	Approved
2022-2023	APMP.M.FF-K4.2022	Liquid volume (Water volume: 100 ml and 20 L 100mL, 20 L)	NIM, IPQ, MUSSD, NIMT, NIS, NMIA, NMIM, NMLPHIL, NPLI, SASO-NMCC, SCL, SNSU-BSN, UzNIM, VMI-STAMEQ, VNIIM	NIM	Planned

#### **4-Patents under Evaluation**

- **Patent Title:** Multi-capacity Force Transducer, **Request No.:** 566/2020
- **Patent Title:** Serial Build-up Force Measurement System, **Request No.:** 1385/2020
- **Patent Title:** Design of a torque lever arm for primary torque calibration machine, **Request No.:** EG/P/2022/515
- **Patent Title:** Design of a 100 KN.m multi-function torque calibration machine, **Request No.:** EG/P/2022/516

#### **5-Research Activities**

There are **four** Completed **Ph.D. thesis** in density, pressure, fluid flow and force activities

- Using Single Crystal Silicon Sphere for Primary Density Measuring Systems
- Investigation of non-rotating piston gauges as primary and secondary standards for the intermediate vacuum-pressure range from 0 to 15 kPa
- Study of two-phase flow in a horizontal pipe and obstruction flow measurement devices
- Novel Design of a Multi-Capacity Force Measurement Instrument.

There are still **five** running **Ph.D. thesis** which cover the mass, density, fluid flow, and force activities.

- Establishment of NIS Watt Balance Prototype
- Establishment a versatile system for measuring the density of various kinds of materials
- Metrological Investigation of Flow Rate and Characteristics of Flowing Heavy Oil Mixed with Immiscible Fluids
- A metrological Study of Air Flow Inside Buildings and its Applications
- Determining and studying the parameters of force transducers under applying static and dynamic forces for Dynamic force calibrations

There is **One** master thesis is completed in the field of force activity

- Mechanical Characterization of Glass Fiber/Metal Laminates Composites

NIS has published around **25 publications** in scientific journals indexed in SCOPUS. These publications are listed as following:

1. ESTABLISHING AND CHARACTERIZING A PERMANENT MAGNET SYSTEM FOR THE PROTOTYPE OF NIS'S KIBBLE BALANCE", Metrol. Meas. Syst., Vol. 30, (2023), No.1.
2. NIS-EGYPT MASS SCALE UP TO ONE TON AFTER THE REDIFINITION OF THE MASS UNIT", ARPN Journal of Engineering and Applied Sciences, VOL. 16, NO. 14, JULY 2021
3. Validation of a PTB force-balanced piston gauge primary pressure standard (2021) Acta IMEKO, 10 (1), pp. 271-276 .DOI: 10.21014/ACTA\_IMEKO.V10I1.821
4. Results of a project to calibrate mercury sphygmomanometer blood pressure-measuring devices in Egypt (2021) Journal of Human Hypertension, 35 (10), pp. 921-926. DOI: 10.1038/s41371-020-00424-0

5. Design and Performance Evaluation of a Portable Chamber for Prevention of Aerosol Airborne–Infection, Journal of Advanced Research in Fluid Mechanics and Thermal Sciences, vol. 100, no. 2, pp.181-197, 2022.
6. Recent Preventive Methods to Reduce the Infection Diseases by Air Distributions Control. Journal of Measurement Science and Applications (JMSA), (Articles in Press),2023
7. The resolution of analogue measuring devices and its associated uncertainty An investigation with practical recommendations Precision Engineering ,2021
8. An Investigation on using Lagrange, Newton and Least Square Methods for Generating Nonlinear Interpolation Function for the Measuring Instruments, ASM Science Journal, 2021
9. Difference between calibration and practical force proving instruments, Revista Scierterium (Javeriana), 2021
10. An investigation on using the falling mass technique for dynamic force calibrations, Metrology and Measurement Systems,2021
11. Enlargement of a force sensor measurement range based on a build-up principle, Engineering Research Journal (ERJ), 2021
12. An Investigation on using measurement Uncertainty as decision rule for statement of conformity, Revista Scierterium (Javeriana),2021
13. Proposed Approach for force proving instruments classification, International Journal of Metrology and Quality Engineering,2021
14. Novel design of a multi-capacity force measurement instrument, Measurement,2021
15. Developing the NIS Solid Density Hydrostatic Weighing System Up to 20 kg, Metrology & Quality Engineering,2021
16. An accurate method for determining stress intensity factor by caustic, MRS Advance (Material research society),2022
17. Modeling of the Quantization Effects on the Resolution Uncertainty of Digital Indictors, IEEE Instrumentation & Measurement Magazine,2022
18. Flexural behavior of functionally graded polymeric composite beams, Journal of Industrial Textiles,2022
19. Mechanical and Tribological Behavior of Functionally Graded Unidirectional Glass Fiber-Reinforced Epoxy Composites, Polymers,2022
20. A comparison between static and dynamic stiffness of force transducers for dynamic force calibrations, Measurement: Journal of the International Measurement Confederation,2022
21. Calibration of Reference Torque Transducer in one Direction and Use its Cubic Coefficients in Both Directions With Improved Interpolation Error, Metrology and Measurement Systems,2022
22. Effect of Carbon Content on The Impact Energy of Ductile Austenitic Cast Iron, ASM science,2022
23. Extrapolation errors of force transducer curve fitting equations, Revista Scierterium (Javeriana),2023
24. Commissioning NIS 1 kN·m Primary Torque Standard Machine, Mapan- Journal of Metrology Society of India,2023
25. Report on the AFRIMETS.M.T-S1 supplementary torque comparison for 500 N·m and 1000 N·m between NIS (Egypt) and PTB (Germany), Metrologia,2023