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PREPARATION FOR A COMPARISON OF PLATINUM-IRIDIUM KILOGRAM MASS STANDARD AMONG NMIS IN APMP

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Abstract − The kilogram is unique among the base SI units in being the only one defined by an artefact. A major problem with maintaining the traceability of the mass scale is the inherent instability of the kilogram artefacts. To resolve the problem, there had been done a comparison of the values of the national standard kilogram of 18 European National Metrology Institutes (NMIs) by National Physical Laboratory (NPL) in England. The similar comparison in APMP is needed to plan as a pilot study. The ten institutes of APMP are participated in this pilot study. KRISS in Korea and NMC/ASTAR in Singapore act as a pilot and a co-pilot laboratory respectively. The travelling standard (No. 651) used for comparison among European NMIs is provided by NPL.

In this paper, the preparation of comparison and the interim result for stability of the travelling standard at KRISS will be presented.

Keywords: kilogram, prototype kilogram, adsorption

1. INTRODUCTION

As time approaches to 2011 to define a new method in mass unit, CGPM resolution recommended each National Metrology Institute (NMI) to monitor the mass change of national prototype kilogram in mass metrology [1]. Unfortunately, there has been no exact way or formula to calculate the mass change of national prototype kilogram after BIPM calibration [2, 3].

Therefore, Korea Research Institute of Standards and Science (KRISS) would like to design and organize the comparison of national prototype kilogram as a kind of pilot study in Asia Pacific Metrology Programme (APMP).

The main purpose of new pilot study is to compare the mass change of national prototype kilogram after 3rd periodic verification at BIPM [4] and to connect between APMP and European Collaboration in Measurement Standards (EURAMET).

Being used in EURAMET comparison [5], the transfer prototype kilogram (Pt-Ir) is provided by NPL in England. All transportations of the transfer prototype kilogram should be hand-carried for safety of the standard. This means each NMI will have a responsibility for the costs of transportation and customs clearance of the transfer prototype kilogram to the next participating laboratory. This protocol was written with reference to the "Guidelines for CIPM key Comparisons", and the formula was adopted from the "CCM Key Comparison (CCM.M.K-2)" document.

2. SCHEDULE OF THE COMPARISON

This comparison will be carried out for about one year as shown in Table 1.

Table 1. Schedule of comparison.

Date	Actions
Mar. 2008	First proposed the study
Jun. 2008	Survey for participants in APMP
Sept. 2008	Obtaining the transfer standard from NPL (Thanks to Dr. S. Davidson, NPL)
Oct. 2008	First notification Registration to APMP TCM by KRISS
Jan. ~ Dec. 2009	Measurement in each NMI
Jan. 2010	Stability check in KRISS
Feb. 2010	Return the travelling standard to NPL
Apr. 2010	First Draft
Jun. 2010	Final Draft & Reporting to a scientific paper

3. PARTICIPANTS AND CIRCULATION

The participating institutes and the order of circulation are summarized in Table 2. KRISS will act as the pilot lab for

this comparison. Additionally, the NMC/ASTAR in Singapore will act as the co-pilot lab for this comparison.

4. MASS STANDARD

As it mentioned, one platinum-iridium kilogram is used as the travelling mass standard for this comparison; this had the designation 651. Kilogram 651 is an underweight copy produced in 1979 and calibrated and supplied to the NPL in 1982. KRISS platinum-iridium kilogram No. 72 is used as a reference standard against which to monitor the stability of the travelling standard [6]. The stability of the transfer and reference standard has been monitored over periods of 3 months before the start of the comparison.

Table 2. List of participating institutes and circulation order of the travelling standard.

Order	Nation	Institute	Received date
1	Korea	KRISS	-
2	Australia	NMIA	14-Jan-09
3	India	NPLi	24-Feb-09
4	Taiwan	ITRI/CMS	01-Apr-09
5	Japan	AIST / NMIJ	01-May-09
6	Korea	KRISS	15-Jun-09
7	Hong Kong	SLC	15-Jul-09
8	Thailand	NIMT	15-Aug-09
9	China	NIM	15-Sep-09
10	Indonesia	KIM-LIPI	01-Nov-09
11	Singapore	NMC / ASTAR	01-Dec-09
12	Korea	KRISS	01-Jan-10

5. GENERAL INFORMATION [7]

5.1. Weight transportation

As described in the protocol and the announcements, the Pt-Ir travelling standard must be hand carried between participants and arrived no later than the transportation period stated in Table 2. It is the responsibility of each participant to arrange the transportation of the standard to the next participating laboratory.

The container housing the Pt-Ir kilogram as shown Fig. 1 is predominantly made of glass, allowing easy viewing of the weight for inspection by the customs. An explanatory letter, describing the standard and stating the purpose of the transportation will be provided by the pilot laboratory.

Fig. 4. The Photograph of travelling standard (No. 651).

A written record of any disturbance to the Pt-Ir kilogram standard during transportation or transit must be kept and the pilot laboratory (KRISS) must be notified immediately.

5.2. Handling the transfer standard

The transfer standard should be handled carefully and only with the appropriate tools. When it is not in use, the standard should be kept in its travelling container or in a suitable clean environment protected from dust, drafts and vapour. The standard may be dusted with a soft clean brush but it must not be cleaned in any other way.

Details of the procedure for removing the platinum-iridium kilogram from its travelling enclosure are given in a document that will be accompanying the weight. The weight should only be handled with the tongs (covered with chamois leather) provided in a prototype of kilogram in each NMI.

5.3. Visual inspection

On arrival at the participating laboratory, a visual inspection of all the surfaces of the Pt-Ir shall be made. The results of initial inspection shall be recorded in the arrival recording sheet. The results of the visual inspection should be reported to the pilot laboratory as soon as possible. In addition, an final inspection of the weight shall also be carried out immediately before the weight leaves the participating laboratory. A record of this final inspection shall be made using the departure recording. The records of the initial and final inspection shall be reported to the pilot laboratory immediately before transportation to the next laboratory.

5.4. Measurement of the standard

Each participating laboratory should determine the (true) mass value of the standard according to their normal calibration procedure. An appropriate time should be allowed for the stabilisation of the weight following transportation. For the application of buoyancy corrections air density should be determined using the CIPM-2007

formula [8]. Volume for the transfer standard together with uncertainty is given on the result sheet.

5.5. Reporting of result and uncertainty

Forms for the recording of measurement result, uncertainty, traceability, data for ambient conditions and instruments used have been provided by the pilot laboratory and circulated via e-mail. Hard copies of these forms will accompany the transfer standard. Completed forms should be returned to the pilot laboratory not later than 1 month after completion of the measurement. Uncertainty should be calculated according the ISO Guide to the Expression of Uncertainty in Measurement [9].

6. INTERIM MEASUREMENT RESULT

The stability of travelling standard was checked for about 4 months. The photograph of No. 651 shows in Fig. 1. It is compared with prototype kilogram (No. 72) at KRISS and the interim result shows in Fig. 2. During the measurement, mass comparator has some problem which it happened unexpectedly. But No. 651 shows good stability with in uncertainty. The mass comparator (*M*_one) used for measuring the apparent mass differences between kilogram prototypes has a capacity of 1001.5 g, a readability of 0.1 μg and a standard deviation of less than 0.3 μg.

Fig. 2. Mass comparator (*M*_One, center) and the environmental condition measurement system.

The mass comparator was installed inside an air-tight chamber. The sensors for measurement of humidity and temperature are installed inside the mass comparator window, and two pressure gauges and one CO_2 analyzer are connected to the air-tight chamber through Teflon tube (see Fig. 2). The uncertainty(k=1) sources are the 0.6 %RH (Vaisala HMI38, div. 0.1 %RH) for the humidity, the 2 mK (ASL F700, div. 1 mK) for temperature, the 2.0 Pa (Paroscientific 745-16B, div. 0.1 Pa) for pressure, and 5×10^{-5} (Horiba 2000, div. 10^{-6}) for CO_2 concentration in mole fraction.

Fig. 3 shows travelling standard and KRISS prototype kilogram on automatic weight exchanger of mass comparator.

In the Fig. 4, the dark square and error bar represent the mass difference between No. 72 and No. 651 and the standard deviation in each measurement group.

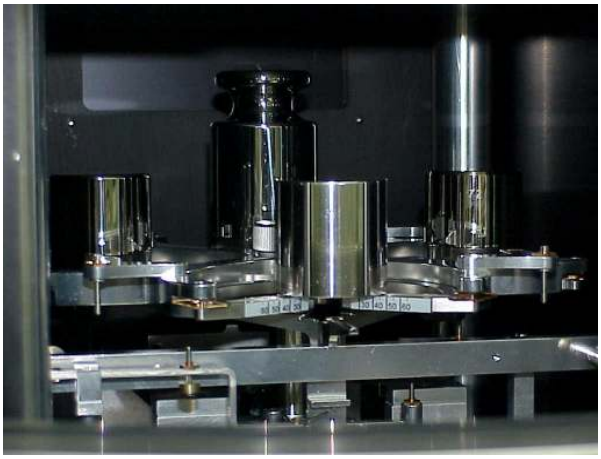

Fig. 3. Kilogram prototypes installed on the weight handler of mass comparator.

Each measurement group consists of 6 A-B-B-A measurements.

At present, the first half circulation is going successfully as scheduled in Table 2. But trial problem was happened during transportation from NPLi India to ITRI/CMS Taiwan because some pages of ATA carnet documents were missed. So KRISS got new documents from authority and sent them to ITRI/CMS. Now travelling standard is in AIST/NMIJ, Japan.

The schedule for second half circulation is changed little bit because KIM-LIPI, Indonesia wants to take part in this pilot study during circulation. Table 2 shows the revised schedule.

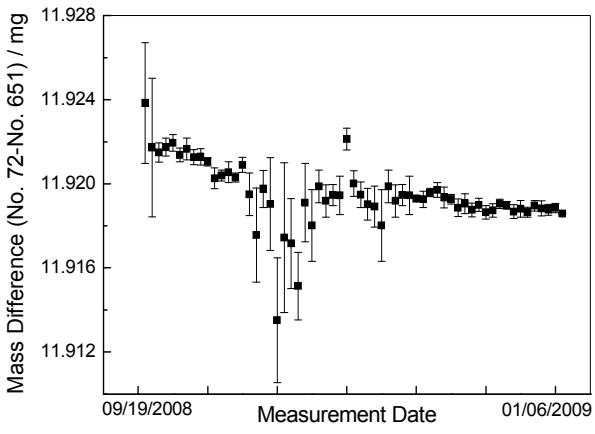

Fig. 4. Interim result for stability check of travelling standard.

7. CONCLUSION

KRISS is preparing for comparison of national prototype kilogram among 10 NMIs in APMP. Protocol and schedule of comparison was completed. The interim result of stability

of travelling standard is obtained. The circulation is going well as scheduled.

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