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| **World Meteorological Organization**  **Commission for Instruments and Methods of Observation**  **Second Session of the Expert Team on Operational Metrology (ET-OpMet)**  Tokyo, Japan, 27-30 November 2017 | **CIMO/ET-OpMet-2/Doc. 2** |
| Submitted by: Drago Groselj  12.11.2017 |

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**REPORT OF THE CHAIRPERSON**

(Submitted by Drago Groselj)

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| **Summary and purpose of document**  This document provides information on the activities of the Expert Team on Operational Metrology since establishment of the team at CIMO-XVI (2014‑2018) |

**Action proposed**

The Meeting is invited to note the information provided in this report. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Appendices:** I -

1. **BACKGROUND**
   1. The CIMO Expert Team on Operational Metrology (ET-OpMet) was formed during 2014, consisting of members with diverse experience in metrology, and Secretariat participation and support. The ET-OpMet works primarily though individual and small sub-groups efforts, with frequent meetings via WebEx. ET-OpMet Google Drive file storage service was used for file exchange among members, which has proven to be a very effective tool for document management.
   2. The first introductory teleconference was organized March 2015, which was very important to get a better understanding of the tasks assigned to the team and to make the work progress. The first face-to-face meeting was organised from 1st to 4th of December 2015 in Ljubljana to assess progress and to discuss work plan for the inter-sessional period. It was considerable benefit in the Expert Team meeting as it allowed wide discussion on a number of topics.
   3. In this intersessional period seven ET-OpMet WebEx meetings were conducted to discuss and communicate within the expert team. Two small sub-task teams were organised to address and discuss specific activities in workplan. Sub-task team working on developing “Guidance on replacement of mercury-based and obsolete instruments” organised four additional reduced teleconferences focused on guidance document. Sub-task team on “Towards calibration of ceilometer, visibilimeter and present weather sensor” also organised four teleconferences in order to exchange opinions on Upgrades of CIMO Guide Chapter 9, 14 and 15.
   4. ET-OpMet meeting was organised as a side event of TECO 2016 on 28th September 2016 in Madrid attended by majority of ET-OpMet members. Last WebEx of ET-OpMet was organised in October 2017.
   5. Some actions and deliverables of ET-OpMet workplan activities have slightly changed during its implementation. In particular original activity No. 6 “Guidance for transition from mercury-based instruments to alternative technologies (due to Impact of Minamata convention” and No.8 - “Addressing issues with obsolete or unserviceable instruments” were merged since the contents of deliverables addresses and reflects in similar activities (develop guidance on how to select modern instruments replacing outdated instrument/mercury based). Deliverables were also changed accordingly.
   6. The activity No. 4 – “Towards calibration of ceilometer, visibilimeter and present weather sensor” targeted to identify and review existing guidance material on calibration procedure for ceilometer, visibilimeter and present weather sensor, synthesize information obtained into general guidance material and deliver first draft of technical procedures. After identifying existing guidance material, it became evident that development of general guidance material is worthless since calibration and maintenance of optical instruments strongly rely on manufacturer’s recommendations. The efforts were re-routed to upgrade respective CIMO Chapters.
   7. ET-OpMet continues to benefit from valuable efforts and large time commitments from almost all members. The Chair greatly appreciates the dedication shown by all Task Team members.
   8. Progress and status of the tasks will be reported by task or sub-task leaders.
2. **ACHIEVEMENTS WITH RESPECT TO WORKPLAN**

2.1 **Estimation of calibration uncertainty – traceability to SI:**

* + 1. The ET-OpMet reviewed the document on computation of uncertainties, which was latter published as an IOM 119 report (<http://library.wmo.int/opac/index.php?lvl=notice_display&id=17152>). In response to the request of the Congress supporting further strengthening of RICs and NMHSs calibration laboratories in particular with respect to the technical calibration procedure estimating the uncertainties of the calibrations performed, the task was finished. The IOM report includes theoretical background for calculating uncertainties and provides links and reference to the appropriate documents. The document also provides three practical examples of uncertainty calculations for temperature, pressure and humidity calibrations respectively.
    2. Concept for workshop units on uncertainty calculations was developed. Webinars are divided into two groups: general units (introduction and theoretical background considering the parameter including theory, standards, methods of calibration, uncertainty components, evaluation of uncertainty budget) and examples of uncertainty calculations for each particular parameter. General units in the form of PowerPoint presentations consists of:
* Vocabulary used in metrology: basic terms used in metrology.
* Theoretical guidelines on uncertainty of measurements: uncertainty, A and B type of uncertainty, uncertainty analysis, types of distributions, components of uncertainty, degrees of freedom, combining uncertainty, expanded uncertainty.
* Metrology in Meteorology: metrology system, traceability, typical infrastructure of a standard meteorological laboratory, ways to use calibration certificates in the NMHS.
* Inter-laboratory comparisons: terms and definitions, purpose of ILC, protocol, evaluation of the results, examples.
* Field inspections.
* Required competences for laboratory personnel.

The decision was to primarily develop units for basic meteorological parameters, which will be expanded to precipitation, wind speed/direction and solar radiation in later stage. Practical examples were developed describing uncertainty components for basic meteorological parameter for different measurement systems in detail, including generic determination of uncertainty sources and its quantification. Training units must be transformed to suitable environment for E-learning training courses. Also e-learning platform needs to be chosen.

2.2 **RIC interlaboratory comparisons (demonstrating capabilities in achieving declared RIC calibration and measurement capabilities (CMCs)):**

* + 1. The efforts to organize interlaboratory comparisons in all Regional Associations were made with different success. Organizing an ILC is a very challenging activity starting from establishment a set of transfer standards, logistics and results evaluation. As recommended by CIMO, regular ILCs should be organized by RICs and the results published to provide evidence of RICs’ performances to the users.
    2. Interlaboratory comparison of 18 NMHSs in RA VI in the field of temperature, relative humidity and pressure has been finished by the end of 2016. The ILC required 8 months for performing measurements and additionally 3 for data analysis. The ILC was joint venture of RAVI RICs and MeteoMet project partner. The ILC report was submitted to WMO for publishing as IOM report.
    3. The ILC in RAVI also served as a template (ILC protocol and report) for organising ILC in RA II and RA V. Same set of transfer standards will be used in Asian ILC enabling link with RA VI ILC. The Memorandum of Understanding, ILC protocol was prepared by pilot laboratory - RIC Tsukuba. The roadmap needs to be agreed among RICs in China, Japan, Australia, Philippines and potentially Fiji.
    4. An ILC procedure was developed for RA I also. RIC Casablanca also provided transfer standards for ILC. RIC Nairobi has not yet responded to ILC invitation. Although there are interests to perform bilateral comparisons, the organisation of ILC among RICs in RA I is preferred.

2.3 **Strengthening RICs and supporting their communication with Members and with respective RA**

* + 1. Although the RIC contents on the WMO website was developed and opened to the public in July 2013, currently nine RICs (Alger, Beijing, Bratislava, Buenos Aires, Casablanca, Ljubljana, Manila, Toulouse and Tsukuba) of 16 RICs posted their contents on the WMO website. ET-OpMet continues to encourage RICs without contribution to WMO web site to post information and to regularly update information on capabilities of RICs at WMO web site.
    2. Evaluation form (*Evaluation Scheme RIC En\_V\_2.2\_final*) was upgraded and RIC reporting form had been developed. Both documents were sent, together with a request to confirm continuation to provide RIC’s services to PRs of all WMO Members hosting RICs. Only half of them have responded so far. All the available reports are posted on the WMO/CIMO website. WMO Secretariat will remind those that have not responded yet.
    3. A survey on meteorological instruments, calibration and training in RA II was conducted and the result was published as WMO Instruments and Observing Methods Report (IOM report) No. 122: “Survey on Meteorological Instruments, Calibration and Training Regional Association II (Asia)” (http://library.wmo.int/opac/index.php?lvl=notice\_display&id=18527). The general conclusions of the survey can be described as follows:
* In RA II, meteorological instrument calibration was not conducted properly in many cases
* Calibration and maintenance of meteorological instruments were identified as major issues to be tackled by Members and to be supported by RICs and RRCs,
* Conventional instruments such as mercury barometers and liquid-in-glass thermometers were still used rather than electrical instruments for most meteorological parameters.
  + 1. A Web based survey on the Member’s needs in terms of traceability assurance and capacity building was concluded in RA VI in early 2016. Many Members (one third) expressed interest for training on calibration and to establish traceability to RICs.
  1. **Towards calibration of ceilometers, visibilimeters and present weather sensors**
     1. Instead of providing additional guidance, this task was changed into updating relevant CIMO Guide chapters 9, 14 and 15. Several sub-team WebEx meetings were primarily focused on upgrades of calibration procedure in Chapter 9 – measurement of visibility where significant progress was experienced. Some additional work was done related to Chapters 14 and 15, although both chapters are concise and consistent. Additional experts contributed to this tasks (Wauben (Vice-chair ET-DIST), T. Linna (Vaisala) and L. Discazeaux (Meteo-France)).
  2. **Implementation of the strategy for improving traceability of basic measurements (such as p, T, h) to SI**
     1. CIMO-16 requested that the strategy to improve the traceability of instrument calibrations needs to be finalized urgently and that relevant guidance material be prepared to support members in implementing this strategy.
     2. Information Flyer on Traceability has been developed by ET-OpMet and has been published by WMO at the Congress in spring 2015 and is available on the IMOP web page (http://www.wmo.int/pages/prog/www/IMOP/publications/Flyers/Traceability\_flyer.pdf).
     3. As decided on CIMO MG-14 the calibration strategy should be included in the CIMO Guide Part I Chapter 1 which is ready for CIMO Editorial Board.
     4. Methodology for the comparison/checking of AWS sensors at the field stations was developed. This methodology will provide the necessary steps in establishing the corrections of AWSs at the field stations.
  3. &8 **Impact of Minamata convention and guidance for transition from mercury-based instruments to alternative technologies & Addressing issues with obsolete or unserviceable instruments**
     1. The outreach flyer on impact of Minamata convention was developed and published by WMO at the Congress in spring 2015 and is available on the IMOP web page (<http://www.wmo.int/pages/prog/www/IMOP/publications/Flyers/Mercury_flyer.pdf>).
     2. Congress requested CIMO to support Members by developing appropriate guidance material and supporting the identification of appropriate replacement instruments, so as to minimize the impact on data quality and on data compatibility.

The objective of Guidance on the Replacement of Mercury-Based and Obsolete Meteorological Instruments is to provide guidance on possible transition path for meteorological services from the use of mercury‑based and obsolete instruments to modern alternatives. This guidance provides support to network managers in organizing a process for transition to alternative instruments, different transition paths and their specific requirements and aspects, identification of obsolete and unserviceable instruments and provides information on available alternative instruments based on modern technology.

The sub-team developed chapters related to technology descriptions, pro/cons, quantitative specification table, possible transition paths, aspect and conciderations to be taken into account when decision to migrate is made. The initial document was upgraded by a wider team and the draft document presented at Joint meeting of CIMO Expert Team on Operational In-Situ Technologies (A1) and CIMO Expert Team on Developments in In-Situ Technologies (A2) on the 23rd of June 2017.

One day workshop on transitioning away from mercury-based instruments was organised at DWD prior the ICAWS conference in Offenbach am Main. The document was presented and participants were invited to critically review the document and to work towards its finalization in particular topics such as user requirements, manual and automatic alternatives to mercury-based instruments, data acquisition systems, quality assurance and quality control procedures needed for and after transition.

The decision was to restructure the document (technology description is shifted to annex), to develop summarising tables on technology suitable for decision makers and to additionally review the guidance on transition by a small group of CIMO experts to provide their views and comments to ET-OpMet Chait for consolidated version.

* + 1. Cooperation with HMEI was established relating available alternative instruments. A review and a list of available publications is provided that will help developing guidance in selecting modern alternatives to obsolete instruments.
  1. **Assess status and need for regional standard barometer and update CIMO Guide and relevant WMO resolutions accordingly**
     1. Regional associations had selected sets of regional standard mercury barometers in the past. ET-OpMet is aware that a concept of RSBs was needed in the past but also agreed that nowadays the traceability of atmospheric pressure measurements to the SI units, can be efficiently and economically provided through an unbroken traceability chain. Existence of these two parallel systems for traceability of atmospheric pressure measurements can be uneconomical and inappropriate.
     2. Therefore the survey “Assessment of the current status and future role of the Regional Standard Barometers (RSBs)” was prepared and dispatched to the owners of RSBs in order to receive feedback on metrological status of RSBs, on traceability dissemination, intercomparisons made with RSBs on regional scale. The assessment form was sent to all WMO Members hosting RSBs (23) and received feedbacks from twelve Members. Eleven RSB hosts did not respond to the survey. Additional clarification with some Members hosting RSBs (Argentina, Kenya and Egypt) was also provided.
     3. Based on analysis of the survey and calibration strategy recommendation to discontinue concept of RSB was submitted to CIMO-MG 15. Functionalities should be transformed to RIC concept where traceability is assured in accordance with the calibration strategy. RSB should be removed from CIMO Guide Part I.
  2. **Addressing issues with obsolete or unserviceable instruments** – included in chapter 2.6&8
  3. **CIMO Guide update**
     1. The chapters (Part I, Chapter 1 to 4) of the Guide to Meteorological Instruments and Methods of Observation (CIMO Guide, WMO-No.8) were reviewed with focus on Minamata convention. As a result a restructuring of chapters 2 (temperature), 3 (pressure) and 4 (humidity) was proposed. ET-OpMet members also proposed changes and additional upgrades of the respective chapters.
     2. At the meeting in Ljubljana the discussion among ET-OpMet members also included initiative for a major revision of CIMO Guide chapters 2, 3, 4 in focus of technical development made of reference and field instruments, to consider sections with possible outdated information on instrumentation and instrumentation used very rarely could be removed. The structure of these three chapters could be even more unified. Coordination with ET A1 for the update of these CIMO Guide chapters could be taken into account.
     3. The new structure was proposed to harmonise Chapters for temperature, humidity and pressure.
     4. Sub-teams were formed to address certain chapters of CIMO Guide with additional experts outside ET-OpMet with the goal to derive final draft of Chapters by 12th of November.
     5. Update of Part IV/Chapter 4 “Testing, calibration and intercomparison”: The ISO/IEC 17043:2010 and the “Procedure for inter-laboratory comparison” (developed in the scope of MeteoMet project) comparisons served as a base for developing Annex 4d. “Guidelines for organising inter-laboratory comparisons”. The objective is to determine procedures and aspects needed to be taken into account for efficient ILC including defining reference values and evaluation of the results).

1. **FUTURE CHALENNGES**
   1. Updates of CIMO Guide
   2. As many developing countries expect guides in transition away from mercury-based instruments and outdated and unserviceable instruments special attention must be payed in these areas of activities.
   3. Finalize training modules on the subject of calibration processes, uncertainty estimation, field verifications and organise web based workshop to assist implementing calibration strategy to benefit in achieving traceability of measurements to SI (initially RIC-s in accreditation process may be invited).

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