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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. 4.1** |
| Submitted by: Drago Groselj  12.11.2017 |

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**CONCEPT OF TRAINING UNITS**

(Submitted by Drago Groselj)

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| **Summary and purpose of document**  This document provides information concept of training unit and general training units developed. |

**Action proposed**

The Meeting is invited to review the concept and training unit developed.

**Appendices:** I Concept of training units

1. 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 addresses:
2. Vocabulary used in metrology: basic terms used in metrology.
3. 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.
4. Metrology in Meteorology: metrology system, traceability, typical infrastructure of a standard meteorological laboratory, ways to use calibration certificates in the NMHS.
5. Inter-laboratory comparisons: terms and definitions, purpose of ILC, protocol, evaluation of the results, two examples.
6. Field inspections.
7. Required competences for laboratory personnel.
8. 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.
9. All available training units were harmonised and using same outlook. Practical examples were developed for temperature, pressure and humidity units describing uncertainty components for basic meteorological parameter for different measurement systems in detail, including generic determination of uncertainty sources and its quantification.
10. Training units must be transformed to suitable environment for E-learning training courses. Also e-learning platform needs to be chosen.
11. Turkish State Meteorological Service – TSMS provided document “Training material for basics of calibration” addressing metrology in meteorology, calibration infrastructure and procedures for temperature, humidity, pressure, wind speed, precipitation and solar radiation. Individual components of a document can be usefully implemented in training

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**APPENDIX I**

**W O R L D M E T E O R O L O G I C A L O R G A N I Z A T I O N**

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**Expert team on operational metrology**

**CONCEPT FOR WORKSHOP UNITS ON UNCERTAINTY CALCULATIONS**

**General:** Web based workshop (e.g. moodle)

**Duration:** several webinars of 1,5 - 2 h within a week for each topic

**Audience:** staff from the calibration laboratories of NMHS

**Number of participants:** 15 - 20 participants doing homework, listening is unlimited

**A: Webinar for the workshop units 1 - 5**

* presentation
* online quiz (multiple choice, automated result)

**B: Webinar and Homework for each practical workshop unit 6-11 (considering each meteorological parameter):**

Webinar I: introduction and theoretical background considering the parameter (including theory, standards, methods of calibration, uncertainty components, evaluation of uncertainty budget)

Homework I: homework for each participant and online quiz

Webinar II: examples of uncertainty calculations for the particular parameter

Homework II:

* practical calculation of an uncertainty budget on the basis of a hypothetical laboratory instrumentation (e.g. on the basis of an Excel sheet template)
* opportunity for the participant to check their calculation (online)
* reply of the participant to the trainer of specific difficulties during the calculation

Webinar III:

* comparison of uncertainties of field inspection versus laboratory calibration
* Solutions for the experiences of the participants
* template of a calibration certificate
* ways to use the calibration certificate in the NMHS

End: test and certificate for the participant (option)

**CONTENT OF THE DIFFERENT WORKSHOP UNITS**

1. **Vocabulary used in metrology**: basic terms used in metrology.
2. **Theoretical guidelines on uncertainty of measurements:** uncertainty, A and B type of uncertainty, uncertainty analysis, types of distributions, components of uncertainty, degrees of freedom, calibration model, combining uncertainty, expanded uncertainty.

1. **Metrology in Meteorology**: metrology system (NMI/DI, RIC, accredited labs, field inspection), traceability, typical infrastructure of a standard meteorological laboratory, ways to use calibration certificates in the NMHS.
2. **Interlaboratory-comparisons**: terms and definitions, purpose of ILC, protocol, evaluation of the results, examples)
3. **Field inspections:**
4. Required **competences** for laboratory personnel
5. **Pressure measurements & calibration**: theory, pressure standards, methods of calibration, uncertainty components, evaluation of uncertainty budget, practical examples of calibration systems.
6. **Temperature measurements & calibration**: definitions, International temperature scale ITS90, temperature standards, fixed points, medium metrological evaluation, methods of calibration, uncertainty components, evaluation of uncertainty budget, practical examples of calibration systems: resistance thermometers, Liquid-in-glass, thermographs.
7. **Humidity measurements & calibration**: concept and definitions, traceability, measuring methods, humidity generators, vapour pressure, enhancement factors, humidity calculators, calibration systems, uncertainty components, evaluation of uncertainty.
8. **Wind measurements & calibration**: calibration systems, uncertainty components, uncertainty budget, examples.
9. **Solar radiation measurements & calibration**: introduction, metrology in Solar radiation, instruments, calibration methods, in-house calibrations, uncertainty components, uncertainty budget, examples.
10. **Precipitation measurements & calibration**: calibration systems, uncertainty components, uncertainty budget, examples.