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**JOINT CIMO EXPERT TEAM ON
SURFACE-BASED INSTRUMENT INTERCOMPARISONS
AND CALIBRATION METHODS**

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**INTERNATIONAL ORGANIZING COMMITTEE (IOC) ON
SURFACE-BASED INSTRUMENTS INTERCOMPARISONS**

First Session

Trappes, France, 24-28 November 2003

Procedures of WMO Global and Regional Intercomparisons of Instruments

(Submitted by the Secretariat)

Summary and purpose of document

This document provides information on agreed practices as relates to WMO Intercomparisons.

Action proposed

The meeting is invited to take into account information presented in this document when discussing Intercomparisons of Rainfall Intensity Gauges, Thermometer Screens/Shields and Humidity instruments.

Procedures of WMO Global and Regional Intercomparisons of Instruments

1. Eleventh session of the Commission for Instruments and Methods of Observation (CIMO-XI) agreed on the Guidance to standardize the procedures and organization for instrument intercomparisons. This Guidance had been reproduced in the *CIMO Guide*, Part III, Chapter 5 and it should facilitate the work of the International Organizing Committee (IOC) in preparing and carrying out WMO intercomparisons. It could further be considered as very useful information for Members planning to host or participate in WMO intercomparisons.

2. It is expected that ET on SBII&CM and IOC for Surface-based Instrument Intercomparison will refer particularly to Annex 5.A "Procedures of WMO global and regional intercomparisons of instruments" and Annex 5.B "Guidelines for Organizing WMO Intercomparisons of Instruments" of the *CIMO Guide* (see Annex). It should also be taken into account that all intercomparisons differ from each other to some extent, therefore Annexes 5.A and 5.B contain general guidance and should, when necessary, be supplemented by a specific working rules for each comparison.

Guide to Instruments and Methods of Observation

Part III, Chapter 5

ANNEX 5.A

PROCEDURES OF WMO GLOBAL AND REGIONAL INTERCOMPARISONS OF INSTRUMENTS

1. A WMO intercomparison of instruments and methods of observation shall be agreed upon by the WMO constituent body concerned so that it is recognized as a WMO intercomparison.
2. The Executive Council will consider the approval of the intercomparison and its inclusion in the programme and budget of WMO.
3. In case that there is an urgent need to carry out a specific intercomparison that was not considered at the session of a constituent body, the president of the relevant body may submit a corresponding proposal to the President of WMO for approval.
4. In good time before each intercomparison, the Secretary-General, in cooperation with the president of CIMO and possibly with presidents of other technical commissions, regional associations, or heads of programmes concerned, should make inquiries as to the willingness of one or more Members to act as host country and as to the interest of Members to participate in this intercomparison.
5. In the case that at least one Member has agreed to act as host country and that a reasonable number of Members have expressed their interest in participating, an international Organizing Committee (OC) should be established by the president of CIMO in consultation with the heads of the constituent bodies concerned, if appropriate.
6. Before the intercomparison begins, the OC should agree on its organization, e.g. at least on the main objectives, place, date and duration of the intercomparison, conditions for participation, data acquisition, processing and analysis methodology, plans for the publication of results, intercomparison rules, and responsibilities of the host(s) and the participants.
7. The host should nominate a project leader (PL) who will be responsible for the proper conduct of the intercomparison, the data analysis, and the preparation of a final report of the intercomparison as agreed upon by the OC. The PL will be a member ex officio of the OC.
8. In case the OC has decided to carry out the intercomparison at sites in different host countries, each of these countries should designate a site manager (SM). The responsibilities of the SMs and the overall project management will be specified by the OC.
9. The Secretary-General is invited to announce the planned intercomparison to Members as soon as possible after the establishment of the OC. The invitation should include information on the organization and rules of the intercomparison as agreed upon by the OC. Participating Members should observe these rules.
10. All further communication between the host(s) and the participants concerning organizational matters will be handled by the PL and eventually by the SMs unless other arrangements are specified by the OC.
11. Meetings of the OC during the period of the intercomparison could be arranged, if necessary.
12. After completion of the intercomparison, the OC shall discuss and approve the main results of the data analysis of the intercomparison and shall make proposals for the utilization of the results within the meteorological community.
13. The final report of the intercomparison, prepared by the PL and approved by the OC, should be published in the WMO Instrument and Observing Methods Report series.

ANNEX 5.B

GUIDELINES FOR ORGANIZING WMO INTERCOMPARISONS OF INSTRUMENTS

1. Introduction

1.1 These guidelines are complementary to the procedures of WMO global and regional intercomparisons of meteorological instruments. They assume that an international Organizing Committee (OC) has been set up for the intercomparison and provide guidance to the OC for its conduct.

1.2 However, since all intercomparisons differ to some extent from each other, these guidelines should be considered as a generalized checklist of tasks. They should be modified as situations warrant, keeping in mind that fairness and scientific validity should be criteria that govern the conduct of WMO intercomparisons and evaluations.

1.3 Final reports of other WMO intercomparisons and the reports of meetings of OCs may serve as examples of the conduct of intercomparisons. These are available from the World Weather Watch Department of the WMO Secretariat.

2. Objectives of the intercomparison

The OC should examine the achievements to be expected from the intercomparison and identify the particular problems that may be expected. It should prepare a clear and detailed statement of the main objectives of the intercomparison and agree on any criteria to be used in the evaluation of results. The OC should also investigate how best to guarantee the success of the intercomparison, making use of the accumulated experience of former intercomparisons, as appropriate.

3. Place, date, and duration

3.1 The host country should be requested by the Secretariat to provide for the OC a description of the proposed intercomparison site and facilities (location(s), environmental and climatological conditions, major topographic features, etc.). It should also nominate a project leader (PL)¹.

3.2 The OC should examine the suitability of the proposed site and facilities, propose any necessary changes, and agree on the site and facilities to be used. A full site and environmental description should then be prepared by the PL. The OC, in consultation with the PL, should decide on the date for the start and the duration of the intercomparison.

3.3 The PL should propose a date by which the site and its facilities will be available for the installation of equipment and its connection to the data acquisition system. The schedule should include a period of time to check and test equipment and to familiarize operators with operational and routine procedures.

4. Participation in the intercomparison

4.1 The OC should consider technical and operational aspects, desirable features and preferences, restrictions, priorities, and descriptions of different instrument types for the intercomparison.

4.2 Normally, only instruments in operational use or instruments that are considered for operational use in the near future by Members should be admitted. It is the responsibility of the participating Members to calibrate their instruments against recognized standards before shipment and to provide appropriate calibration certificates. Participants may be requested to provide two identical instruments of each type in order to achieve more confidence in the data. However, this should not be a condition for participation.

¹ When more than one site is involved, Site Managers (SM) shall be appointed, as required. Some tasks of the PL, as outlined in this annex, shall be delegated to the SMs.

4.3 The OC should draft a detailed questionnaire in order to obtain the required information on each instrument proposed for the intercomparison. The PL shall provide further detail and complete this questionnaire as soon as possible. Participants will be requested to specify very clearly the hardware connections and software characteristics in their reply and to supply adequate documentation (a checklist for a questionnaire is available from the WMO Secretariat).

4.4 The chairman of the OC should then request:

(a) The Secretary-General to invite officially Members (who have expressed an interest) to participate in the intercomparison. The invitation shall include all necessary information on the rules of the intercomparison as prepared by the OC and the PL;

(b) The PL to handle all further contacts with participants.

5. Data acquisition

5.1 Equipment set-up

5.1.1 The OC should evaluate a proposed layout of the instrument installation prepared by the PL and agree on a layout of instruments for the intercomparison. Special attention should be paid to fair and proper siting and exposure of instruments, taking into account criteria and standards of WMO and other international organizations. The adopted siting and exposure criteria shall be documented.

5.1.2 Specific requests of participants for equipment installation should be considered and approved, if acceptable, by the PL on behalf of the OC.

5.2 Standards and references

The host country should make every effort to include at least one reference instrument in the intercomparison. The calibration of this instrument should be traceable to national or international standards. A description and specification of the standard should be provided to the OC. If no recognized standard or reference exists for the variable(s) to be measured, then the OC should agree on a method to determine a reference for the intercomparison.

5.3 Related observations and measurements

The OC should agree on a list of meteorological and environmental variables that should be measured or observed at the intercomparison site during the whole intercomparison period. It should prepare a measuring programme for these and request the host country to execute this programme. The results of this programme should be recorded in a format suitable for the intercomparison analysis.

5.4 Data acquisition system

5.4.1 Normally the host country should provide the necessary data acquisition system capable of recording the required analogue, pulse and digital (serial and parallel) signals from all participating instruments. A description and a block diagram of the full measuring chain should be provided by the host country to the OC. The OC, in consultation with the PL, should decide whether analogue chart records and visual readings from displays will be accepted in the intercomparison for analysis purposes or only for checking of the operation.

5.4.2 The data acquisition system hardware and software should be well tested before the comparison is started and measures should be taken to prevent gaps in the data record during the intercomparison period.

5.5 Data acquisition methodology

The OC should agree on appropriate data acquisition procedures, such as frequency of measurement, data sampling, averaging, data reduction, data formats, real-time quality control, etc. When data reports have to be made by participants during the time of the intercomparison or when data are available as chart records or visual observations, the OC should agree on the responsibility for checking these data, on the period within which the data should be submitted to the PL, and on the formats and media that would allow storage of these data in the database of the host. When possible, direct comparisons should be made against the reference instrument.

5.6 Schedule of the intercomparison

The OC should agree on an outline of a time schedule for the intercomparison, including normal and specific tasks, and prepare a time chart. Details should be further worked out by the PL and his staff.

6. Data-processing and analysis

6.1 Database and data availability

6.1.1 All essential data of the intercomparison, including related meteorological and environmental data, should be stored in a database for further analysis under the supervision of the PL. The OC, in collaboration with the PL, should propose a common format for all data, including those reported by participants during the intercomparison. The OC should agree on near-real-time monitoring and quality control checks to ensure a valid database.

6.1.2 After completion of the intercomparison, the host country should, on request, provide to each participating Member a dataset from its submitted instrument(s). This set should also contain related meteorological, environmental, and reference data.

6.2 Data analysis

6.2.1 The OC should propose a framework for data analysis and processing and for the presentation of results. It should agree on data conversion, calibration and correction algorithms, and prepare a list of terms, definitions, abbreviations and relationships (where these differ on commonly accepted and documented practice). It should elaborate and prepare a comprehensive description of statistical methods to be used that correspond with the intercomparison objectives.

6.2.2 Whenever a direct, time-synchronized, one-on-one comparison would be inappropriate (e.g. in the case of spatial separation of the instruments under test), methods of analysis based on statistical distributions should be considered. Where no reference instrument exists (as for cloud base, MOR, etc), instruments should be compared against a relative reference selected from the instruments under test, based on median or modal values, care being taken to exclude unrepresentative values from the selected subset of data.

6.2.3 Whenever a second intercomparison is established some time after the first, or in a subsequent phase of an ongoing intercomparison, the methods of analysis and the presentation should include those used in the original study. This should not preclude the addition of new methods.

6.2.4 Normally the PL should be responsible for the data processing and analysis. The PL should, as early as possible, verify the appropriateness of the selected analysis procedures and, as necessary, prepare interim reports for comment by the members of the OC. Changes should be considered, as necessary, on the basis of these reviews.

6.2.5 After completion of the intercomparison, the OC should review the results and analysis prepared by the PL. It should pay special attention to recommendations for the utilization of the results of the intercomparison and to the contents of the final report.

7. Final report of the intercomparison

7.1 The OC should draft an outline of the final report and request the PL to prepare a provisional report based on it.

7.2 The final report of the intercomparison should contain, for each instrument, a summary of key performance characteristics and operational factors. Results of statistical analysis should be presented in tables and graphs, as appropriate. Time-series plots should be considered for selected periods containing events of particular significance. The host country should be invited to prepare a chapter describing the database and facilities used for data processing, analysis and storage.

7.3 The OC should agree on procedures to be followed for approval of the final report, such as for example:

(a) The draft final report will be prepared by the PL and submitted to all OC members and, if appropriate, also to participating Members;

(b) Comments and amendments should be sent back to the PL within a specified time limit, with a copy to the chairman of the OC;

(c) In case there are only minor amendments proposed, the report can be completed by the PL and sent to the WMO Secretariat for publication;

(d) In case of major amendments or if serious problems arise that cannot be resolved by correspondence, an additional meeting of the OC should be considered (the president of CIMO should be informed of this situation immediately).

7.4 The OC may agree that intermediate and final results may be presented only by the PL and his staff at technical conferences.

8. Responsibilities

8.1 Responsibilities of participants

8.1.1 Participants shall be fully responsible for the transportation of all submitted equipment, all import and export arrangements, and any costs arising from these. Correct import/export procedures shall be followed to ensure that no delays are attributable to this process.

8.1.2 Participants shall generally install and remove any equipment under the supervision of the PL, unless the host country has agreed to do this.

8.1.3 Each participant shall provide all necessary accessories, mounting hardware, signal and power cables and connectors (compatible with the standards of the host country), spare parts, and consumables for its equipment. A participant requiring a special or non-standard power supply shall provide his own converter or adapter. Participants shall provide all detailed instructions and manuals needed for installation, operation, calibration, and routine maintenance.

8.2 Host country support

8.2.1 The host country should provide, if asked, necessary information to participating Members on temporary and permanent (in the case of consumables) import and export procedures. It should assist with the unpacking and installation of the participants' equipment and provide rooms or cabinets to house equipment that requires protection from the weather and for storage of spare parts, manuals, consumables, etc.

8.2.2 A reasonable amount of auxiliary equipment or structures, such as towers, shelters, bases or foundations, should be provided by the host country.

8.2.3 Necessary electrical power for all instruments shall be provided. The participants should be informed of the network voltage and frequency and their stability. The connection of instruments to the data acquisition system and the power supply will be done in collaboration with the participants. The PL should agree with each participant on the provision, by the participant or the host country, of power and signal cables of adequate length (and with appropriate connectors).

8.2.4 The host country should be responsible for obtaining legal authorization related to measurements in the atmosphere, such as the use of frequencies, transmission of laser radiation, compliance with civil and aeronautical laws, etc. Each participant shall submit the necessary documents on request of the PL.

8.2.5 The host country may provide information on accommodation, travel, local transport, daily logistic support, etc.

8.3 Host country servicing

8.3.1 Routine operator servicing by the host country will be done only for long-term intercomparisons for which the absence of the participants or their representatives can be justified.

8.3.2 When responsible for operator servicing, the host country should:

(a) Provide normal operator servicing for each instrument, such as cleaning, chart changing, and routine adjustments as specified in the participant's operating instructions;

(b) Check each instrument every day of the intercomparison and inform the nominated contact person representing the participant immediately of any fault that cannot be corrected by routine maintenance;

(c) Use its best efforts to do routine calibration checks according to the participant's specific instructions.

8.3.3 The PL should maintain in a log regular records of performance of all equipment participating in the intercomparison. This log should contain notes on everything at the site that may have an effect on the intercomparison, all events concerning participating equipment, and all events concerning equipment and facilities provided by the host country.

9. Rules during the intercomparison

9.1 The PL shall exercise general control of the intercomparison on behalf of the OC.

9.2 No changes to the equipment hardware or software shall be permitted without the concurrence of the PL.

9.3 Minor repairs, such as the replacement of fuses, will be allowed with the concurrence of the PL.

9.4 Calibration checks and equipment servicing by the participants, which requires specialist knowledge or specific equipment, will be permitted according to predefined procedures.

9.5 Any problems that arise and concern the participants' equipment shall be addressed to the PL.

9.6 The PL may select a period during the intercomparison in which equipment will be operated with extended intervals between normal routine maintenance in order to assess its susceptibility to environmental conditions. The same extended intervals will be applied to all equipment.