P717 EUROMET Comparison in Humidity (dew-point temperature high range)

Dew Point Temperature +30 °C to +95 °C

Technical protocol (Draft 20080422)

Contents

1. INTRODUCTION

1.1 At the EUROMET TC-THERM meeting in April 2003 in Wabern, Switzerland, it was agreed to organise an EUROMET Comparison in dew point temperature (high range) (minutes of the meeting, section 7.1.3.) as follow-up of the existing project P621 for high dew point temperatures up to +95 °C.

1.2 This technical protocol has been drawn up by the Coordinator in consultation with the nominated participants listed in Section 2.

1.3 The procedures outlined in this document cover the technical procedure to be followed during measurement of the travelling standards. The procedure, which follows the guidelines established by the BIPM[1] and EUROMET[2], is based on current best practice in the use of dew/frost-point hygrometers and takes account of the experience gained from the regional comparisons over the years.

1.4 This comparison is aimed at establishing the degree of equivalence between realisations of local scales of dew point temperature of humid gas, in the range from +30 °C to +95 °C, among the participating national metrology institutes.

2. ORGANIZATION

2.1 Participants

2.1.1 A list of participants representing is given in table 1. Details of mailing and electronic addresses are given in Appendix B.

2.1.2 The participants are divided into two groups. Each group will form a comparison loop. To link the loops to each other, the loops have besides the two Pilots one common participant who measures also both travelling standards.

2.1.3 PTB is the Coordinator of the comparison and the Pilot for loop 1, taking main responsibility for running the comparison. BEV/E+E is Co-Pilot being responsible for running loop 2.

2.1.4 By their declared intention to participate in this key comparison, the laboratories accept the general instructions and the technical protocol written down in this document and commit themselves to follow strictly the procedures of this protocol as well as the version of the "Guidelines for Key Comparisons" in effect at the time of the initiation of the Key Comparison.

[1] T.J. Quinn, "Guidelines for key comparisons carried out by Consultative Committees", Appendix F to the MRA, BIPM, Paris.

[2] EUROMET Guide 3, EUROMET Guidelines on Conducting Comparisons

2.1.5 Once the protocol and list of participants have been approved, no change to the protocol or list of participants may be made without prior agreement of all participants.

2.1.6 All participants must be able to submit an uncertainty budget of their humidity standards.

Table 1 List of participants (*C*=Coordinator, *P*=Pilot, *L*=Linking laboratory)

Central Office of Measures (GUM)	Poland	
Centre for Metrology and Accreditation (MIKES)	Finland	
Centre Technique des Industries Aérauliques et Thermiques (CETIAT)	France	
DELTA Danish Electronics (DELTA)	Denmark	
E+E Elektronik Ges.m.b.H. (BEV/E+E)	Austria	***P***
Federal Office of Metrology (METAS)	Switzerland	
Hellenic Institute of Metrology (EIM)	Greece	
Instituto Nacional de Technica Aeroespacial (CEM/INTA)	Spain	***L***
Istituto Nazionale di Ricerca Metrologica (INRIM)	Italy	
National Metrology Laboratory (NML)	Ireland	
National Physical Laboratory (NPL)	UK	
Nederlands Meetinstituut (NMi-VSL)	Netherlands	
Physikalisch-Technische Bundesanstalt (PTB)	Germany	***C,P***
TUBITAK - Ulusal Metroloji Enstitüsü (UME)	Turkey	
University of Ljubljana (FE-LMK)	Slovenia	

2.2 Method of comparison

2.2.1 The comparison is of the type of the realisations of local scales of dew point temperature at the participating national institutes.

2.2.2 The comparison will be made by calibration of a travelling standard lent by the MBW Calibration Ltd (Switzerland). The travelling standard will measure dew point temperature of a sample of moist gas produced by a participant's standard generator.

2.2.3 The comparison is carried out in two parallel loops with separate travelling standards. Measurements will start in the Pilot/co-Pilot laboratory. The other participants in the loop will then perform comparison measurements at the dew point temperatures required. The last participant will then return the travelling standard to the Pilot of the loop to carry out final measurements to monitor drift. The draft of a time schedule for this comparison can be found in Appendix A. Allowing between 5 and 6 weeks per set of measurements (including shipping), this set of measurements will take a time of about 20 months.

2.2.4 All results are to be communicated directly to the Pilot of the corresponding loop within six weeks after the completion of the measurements by a

laboratory. If this time is seriously exceeded without coordination with the Pilot, the results of this laboratory may be excluded from the comparison.

2.2.5 If for some reason, the measurement facility is not ready or customs clearance takes too much time in a country, the participating laboratory must contact the Pilot laboratory immediately. Exclusion of a participant's results from the report may occur if the results are not available in time to prepare the draft report.

2.2.6 In case of serious difficulty with customs, or other delays which might over-run the time period of the ATA Carnet, the Pilot may request the instruments be returned to the holder of the ATA Carnet (MBW Calibration Ltd) or to the Pilot laboratory, or the sequence of participation may be changed to the most practical arrangement.

2.2.7 Within ten weeks after the completion of the last measurements in the loop, the Pilot sends all the results obtained in the loop to the Coordinator.

2.2.8 The Pilot informs the Coordinator about the progress in the loop. Especially, the Coordinator must be informed about delays in the schedule and the completion of the last measurements in the loop.

2.3 Handling of artefacts

2.3.1 The artefacts should be examined immediately upon receipt at the laboratory. All participants are expected to follow all instructions in the operator's manual provided by the instrument manufacturer for proper unpacking, subsequent packing and shipping to the next participant. During packing and unpacking, all participants should check the contents with the packing list including the operator's manual.

2.3.2 The travelling standards should only be handled by authorized persons and stored in such a way as to prevent damage.

2.3.3 During operation of the travelling standards, if there is any unusual occurrence, e.g., loss of heating control, the Pilot laboratory should be notified immediately before proceeding.

2.4 Transport of artefacts

2.4.1 The transportation process begins when the artefact leaves the sending laboratory and does not end until it reaches the destination laboratory. All participants should follow the following general guidelines:

(1) Plan the shipment well in advance. The recipient should be aware of any customs issues in their country that would delay the testing schedule. The

shipping laboratory must be aware of any national regulations covering the travelling standard to be exported;

(2) Mark the shipping container "**FRAGILE SCIENTIFIC INSTRUMENTS**" "**TO BE OPENED ONLY BY LABORATORY STAFF**" and with arrows showing "**THIS WAY UP**"; attach tip and shock indicators if such devices are available and seal the container (i.e. with old calibration marks etc.)

(3) Determine the best way to ship the travelling standard to the next participant. In general ground transportation by truck with an approved courier must be preferred.

(4) Obtain the recipient's exact shipping address. If possible, have it shipped directly to the laboratory. Note that the addresses in Appendix B may be outdated.

(5) Coordinate the shipping schedule with the recipient. The sending laboratory should provide the recipient with the carrier, the exact travel mode, and the estimated time of arrival;

(6) Instruct the recipient to confirm receipt and condition upon arrival to the sender and the Pilot. A form for reporting on the receipt of the travelling standards is shown in Appendix C.

2.4.2 Each travelling standard is supplied with its shipping container, which is sufficiently robust to ensure safe transportation.

2.4.3 The artefacts will be accompanied by a suitable customs ATA Carnet. Care should be taken with the timing of the ATA Carnet, which only lasts for one year.

2.5. Costs

2.5.1 Each laboratory is responsible for the cost of shipping to the next participant including any customs charges. The insurance of the instruments is arranged by MBW Calibration Ltd.

2.5.2 Each laboratory pays its share of the services provided by MBW Calibration Ltd (which lends the travelling standards). The participants will be invoiced by MBW Calibration Ltd after completion of the comparison.

3. DESCRIPTION OF THE TRAVELLING STANDARDS

3.1. Artefacts

3.1.1 MBW Calibration Ltd lends one travelling standards per loop for the key comparison. The instruments are state-of-the-art, commercially available chilled-mirror type of dew point hygrometers.

3.1.2 Details of travelling standards:
The two travelling standards are new and of the same type:

Model:	MBW 373 HX
Size (in packing case):	75 x 69 x 41 cm
Weight (in packing case):	36 kg
Manufacturer:	MBW Calibration Ltd
Owner:	MBW Calibration Ltd
Electrical supply:	230 V / 50 Hz
Electrical connection:	Instrument socket IEC/EN 60320-2-2 (socket C14/plug C13) The instrument will be supplied with a Schuko (Continenetal Europe) plug Standard CEE 7/VII
Power consumption:	300 W
Tube connectors:	Swagelok® 6 mm
Accessories:	Endoscope, 4-wire cable for resistance measurements (3 m), heated flexible hose with 6 mm Swagelok® connectors, operating manual
Approximate value for insurance and customs declaration:	40 000 EUR

Serial numbers of the instruments are:

Loop 1	Loop2
08-	08-

4. MEASUREMENT INSTRUCTIONS

4.1. Measurement process

4.1.1 All participants should refer to the operating manuals for instructions and precautions for using the travelling standards. Participants may perform any initial checks of the operation of the hygrometers that would be performed for a normal calibration. In the case of an unexpected instrument failure at a participant institute, the Pilot institute should be informed in order to revise the time schedule, if necessary, as early as possible.

4.1.2 Sample gas generated by a participant's standard generator, is introduced into the inlet of a travelling standard hygrometer through the supplied heated flexible hose terminated with Swagelok® 6 mm connectors. The electrical connector of the hose is plugged into the appropriate socket near the gas inlet terminal. For all dew points normal precautions (heating) should be used to protect against condensation in sample lines. Special care has to be taken with the connection between the end of the heated hose and the input terminal of the instrument. This point has to be heated externally to prevent condensation at high dew points.

4.1.3 Measurements are carried out at nominal dew point temperatures of 30 °C, 50 °C, 65 °C, 80 °C, 85 °C, 90 °C and 95 °C (refer to 4.1.4 for limited range at high dew points). These values are chosen in accordance with the maximal dew point, participants can generate.

4.1.4 If the scope of a laboratory does not cover the whole range of this comparison, the laboratory is allowed to limit measurements to the highest nominal dew point temperature that is within the scope.

4.1.5 Measurements should be done in rising order of dew point temperature.

4.1.6 The values of dew point temperature applied to the travelling standards should be within ±0.5 °C of the agreed nominal values for the comparison, and ideally closer than this. Deviations greater than this may increase the uncertainty in the comparison, for a particular result.

4.1.7 If the type of generator used (e.g. two pressure generator) requires a precise pressure measurement at the point of condensation (mirror), pressure should be measured as close as possible to the outlet terminal of the hygrometer. The hygrometers are **NOT** equipped with a gas pump, so the outlet of the measuring cell is directly connected to the rear outlet terminal. The remaining pressure drop between the point of condensation and the point of pressure measurement – if any – should be estimated as good as possible. A possible value for this pressure drop is given after initial tests in the Pilot laboratories have been performed.

4.1.8 A float-type flow meter enclosed with the instrument should be connected between the hygrometer outlet and a flow meter of the laboratory. Due to dew points above ambient temperature the condensing water from the outlet of the hygrometer should be separated before entering the float-type flow meter e.g. by a water trap. Doing this, the water content exceeding saturation conditions at room temperature is removed. This requires a correction of the flow rate indicated by the float-type flow meter and the laboratory's flow measurement. The following table shows this correction assuming saturation condition at 20 °C (room temperature) and a wet gas flow of 0.5 l/min.

Dew point °C	Volume of water %	Volume of water condensed in the water trap %	Indicated flow rate after the water trap l/min
30	4,21	1,89	0,49
50	12,25	9,93	0,45
65	24,86	22,54	0,39
80	47,06	44,74	0,28
85	57,40	55,08	0,22
90	69,55	67,23	0,16
95	83,70	81,38	0,09

Table 2: Indicated flow rate after the water trap for the selected dew points

4.1.9 Four repeated full set of measurements are carried out, i.e. each nominal dew point temperature should be separately repeated (reproduced) four times to reduce the effect of any irreproducibility of the travelling standards.

4.1.10 The condensate on the mirror should be cleared and re-formed for each value or repetition of dew point temperature performing a “Manual Mirror Check” (fixed function key at the bottom bar). The “Automatic Mirror Check” must be disabled (Menu Keys: “Control Setup” → “Mirror Check”)

4.1.11 Operation with the travelling standards

Before any humidity measurements, initial actions should be taken:

1) Read the manual “Operating Instructions” delivered by the manufacturer (a copy of the manual is in the transport case).

2) At a flow rate of 0.5 l/min, the flow rate indications of the hygrometer, the float-type flow meter and the laboratory flow meter are compared to each other (at a pressure corresponding the sample gas pressure during dew point measurements). It is highly recommended to carry out the test in the generator system used in the comparison. In a case of strongly fluctuating sample gas flow, the flow indicator of the hygrometer may show incorrect value. For this test, the dew point should not exceed room temperature to avoid condensation.

3) When the hygrometer is in a standby mode (i.e. mirror temperature control is switched off), the dew point temperature indication, resistance of a PRT embedded in the mirror and mirror temperature reading from the RS-232 port are recorded during ten minutes (at least ten measurements).

4) Set the hygrometer ready for cleaning with “Mirror Cleaning”.

5) Remove the endoscope following carefully with separate instructions (a copy of the instruction is in the transport case).

6) Open the measuring head carefully according to the instructions given in the operating manual.

7) Clean the mirror surface using a suitable lint-free tissue or cloth or cotton tips with distilled or de-ionised water preceded by initial cleaning with pure ethanol of p.a. grade if necessary. As the last act of the cleaning procedure it is advantageous to rinse pure distilled water over the mirror which is collected with a cloth below the mirror.

8) Close the measuring head carefully according to the instructions given in the operating manual.

9) Replace the endoscope following carefully with separate instructions (a copy of the instruction is in the transport case).

Dew point temperature measurements:

1) Clean the mirror if needed according to the instructions above (no sample gas flow).

2) Set the heater control for the measuring head and the inlet tube to 'Fixed Mode' with the target value 30 K **above** the nominal dew point temperature (Menu Keys: "Control Setup" → "Heater"→"Fixed Mode Target") and switch on the Heater with the fixed function key at the bottom bar. **Note:** The maximal selectable head temperature is 105 °C. This fits also for dew points of 80 °C and above.

3) Wait until the head temperature has stabilized to the preset value. If a head temperature of 95 °C or above is not reached after a certain time (switch one display-line to "Head Temperature" to observe it), the smaller fan opening at the rear of the instrument (when looking onto the rear it is the left one) should be covered with a suitable piece of paper using adhesive tape. **Don't forget** to remove it with lower head temperatures.

4) Set the flow rate of wet sample gas at 0.5 l/min according to an indication by the supplied float-type flow meter taken from the table 2 in section 4.1.8.

5) Start measurements with "Dew/Frost Control" key at the bottom bar (Fixed Function Keys)

6) A homogenous condensate should appear on the mirror; if not, the condensate should be cleared and re-formed with "Mirror Check" (Fixed Function Keys). If necessary, the mirror is cleaned again according to the instructions above.

7) After appropriate time of stabilisation, measurements are carried out. The process of collecting data is described below (chapter 4.2). At this time the head temperature and the tube temperature must not increase or decrease.

8) Before changing the sample gas dew point temperature, make sure that the head temperature and the tube temperature are high enough for the new desired dew point (see instructions 2 above).

9) Before measuring at the next measurement point, the condensate should be cleared and re-formed with "Mirror Check" (Fixed Function Keys)

4.1.12 Participants should avoid lengthy additional measurements, except those necessary to give confidence in the results of this comparison.

4.1.13 The travelling standards used in this comparison must not be modified, adjusted, or used for any purpose other than described in this document, nor

given to any party other than the participants in the comparison. All changes of instrument parameters made in the Extended-Access-Menu of the instruments or via command line of the serial interface must be discussed with the Pilot in advance.

4.1.14 The Pilot will make an assessment of any drift in the travelling standards during the comparison, based on measurements at the Pilot laboratory at the beginning and end of the comparison period. If drift is found, this will be taken into account in the final analysis of the comparison results.

4.1.15 If poor performance or failure of a travelling standard is detected, the Pilot of the loop will propose a course of action, subject to agreement of the participants.

4.2. Data collection

4.2.1 In the travelling standards, there are two 100-ohm platinum resistance thermometers (PRT) embedded beneath the surface of the chilled-mirror to measure the dew/frost-point temperature. One is used for system measurement and control. The resistance of the other one is measured via a Lemo connector in the rear panel. Dew point temperature readings used primarily in this comparison are obtained from the resistance of the second PRT. The current input to the PRT should be nominally 1 mA. The resistance of the PRT should be measured using a calibrated multi-meter or a resistance bridge, and then converted to a corresponding dew point temperature. The calculation of the temperature is done according to IEC 60751 and is described in Appendix D.

4.2.2 Each measured value (incl. its experimental standard uncertainty) is obtained calculating the mean and standard deviation of at least 10 readings of the resistance of the PRT recorded during 10 to 20 minutes.

4.2.3 Participants may apply their own criteria of stability for acceptance of measurements.

4.2.4 As a supporting measurement, the digital display readings (and/or digital signal through a serial port in the rear panel) for dew point temperature, head temperature, flow rate and head pressure in the travelling standard should be monitored. The mean and standard deviation of a set of at least 10 readings, taken over the same period as the dew point measurements should be reported.

4.2.4 Values reported for dew point temperatures produced by a participant's standard generator should be the value applied to the instruments, after any allowances for pressure and temperature differences between the point of realisation (laboratory standard generator or reference hygrometer) and the point of use (travelling standards).

5. REPORTING OF MEASUREMENT RESULTS

5.1 Participants must report their measurement results of four repeated experiments, within six weeks of completing their measurements to the Pilot (refer to section 2.2.4).

5.2 The Pilot of the loop should accumulate data continually and should analyse the results for possible anomalies in the travelling standard. If problems arise, the Pilot should consult with the participant that submitted the data as soon as possible, and certainly before the distribution of Draft A of the Report of the comparison. If the participant is a link between the loops, the Pilot must consult also with the Coordinator. The Pilots must inform the Coordinator of all problems.

5.3 The parameter to be compared between the laboratories in this comparison is the difference found between the travelling standards and the laboratory dew point temperature standard. Note that the values of dew point temperature reported are “arbitrary” values calculated from the measured resistance output. The travelling standards are used simply as comparators.

5.4 Participants should report results to the Pilot in terms of dew point temperature. The main measurement results comprise:

- values of dew point applied to the travelling standard, and associated standard uncertainty
- values measured using the travelling standard (and the associated uncertainties derived from standard deviation of the set of readings)
- values of difference between applied dew point and measured dew point.

A template for reporting results will be made available to participants in electronic form as an Excel spreadsheet later. Use of this format, including calculations of means and differences, allows participants to see clearly the values and uncertainties of the parameters they are submitting for comparison.

5.5 From the data measured by each participant, results will be analysed in terms of differences between applied and measured dew point temperatures. In each case, the difference will be taken between the applied (realised) value and the mean (mid-point) between the hygrometer value.

5.6 In addition, the difference between the hygrometer reading on all occasions will be analysed and will serve as a check of consistency.

5.7 The participants should report the conditions of realisation and measurement, as background information to support the main results. These conditions may include, pressure and temperature in saturator or reference hygrometer, pressure difference between saturator or reference hygrometer and travelling standards, measurement traceability, frequency of AC (or DC) resistance

measurement, and other items. A template for reporting conditions of measurement will be made available to participants in electronic form as an Excel spreadsheet later.

5.8 Participants should provide a description of the operation of their dew point facilities used in the comparison.

5.9 Participants should also provide an example plot of equilibrium condition (resistance versus time) at a nominal dew point temperature of 30 °C over at least one hour.

5.10 Any information obtained relating to the use of any results obtained by a participant during the course of the comparison shall be sent only to the Pilot laboratory and as quickly as possible. The Pilot laboratory will be responsible for coordinating how the information should be disseminated to other participants. The Pilot laboratory informs the Coordinator about the progress and results obtained in the Pilot's loop. No communication whatsoever regarding any details of the comparison other than the general conditions described in this protocol shall occur between any of the participants or any party external to the comparison without the written consent of the Coordinator. The Coordinator will in turn seek permission of all the participants. This is to ensure that no bias from whatever accidental means can occur. These constraints on communication apply until the circulation of Draft A of the report of the comparisons.

5.11 If a participant significantly delays reporting of results to the Pilot, then a deadline will be agreed among the participants. If that deadline is not met, then inclusion of those results in the comparison report will not be guaranteed.

5.12 The Pilots must send the measurement results obtained in their loop to the Coordinator within ten weeks of completing the last measurements of the loop. The Pilots will also send an estimation on the uncertainty due to any drift of the travelling standard over the period of the comparison.

6. UNCERTAINTY OF MEASUREMENT

6.1 The uncertainty of the key comparison results will be derived from:

- the quoted uncertainty of the dew point realisation (applied dew point temperature)
- the estimated uncertainty relating to the short-term stability of the travelling standard at the time of measurement
- the estimated uncertainty due to any drift of the travelling standard over the period of the comparison (estimated by the Pilots)
- the estimated uncertainty in mean values due to dispersion of repeated results (reflecting the combined reproducibility of laboratory standard and travelling standards)

- the estimated uncertainty due to non-linearity of the travelling standards in any case where measurements are significantly away from the agreed nominal value
- the estimated covariance between applied (laboratory standard) and measured (travelling standard) values of dew point temperature (if found significant)
- any other components of uncertainty that are thought to be significant

6.2 Participants are required to submit detailed analyses of uncertainty for their dew point standards. Uncertainty analysis should be according to the approach given in the ISO Guide to the Expression of Uncertainty of Measurement. A list of the all significant components of the uncertainty budget should be evaluated, and should support the quoted uncertainties. Type B estimates of uncertainty may be regarded as having infinite degrees of freedom, or an alternative estimate of the number of degrees of freedom may be made following the methods in the ISO Guide. A provisional template for documentation of uncertainties will be made available to participants in electronic form as an Excel spreadsheet later. Individual institutes may add to the template any additional uncertainties they consider relevant.

6.3 The Pilot laboratories will collect draft uncertainty budgets as background information to the uncertainties quoted by participants for the comparison measurements. The Pilots and the Coordinator will review the uncertainty budgets for consistency among participants.

6.4 The uncertainty budget stated by the participating laboratory should be referenced to an internal report and/or a published article.

7. DETERMINATION OF THE KEY COMPARISON REFERENCE VALUE

7.1 The outputs of the key comparison are expected to be:

- Results of individual participants for comparison of the hygrometers against their dew point reference in terms of mean values for each hygrometer at each measured value, estimated standard uncertainty of each mean result and estimated standard uncertainty of comparison process (e.g. effect of long-term stability and non-linearity of the travelling standards) if necessary.
- Estimates of bilateral equivalence between every pair of participants at each measured dew point temperature.
- A key comparison reference value (KCRV) for each nominal value of dew point temperature in the comparison. The KCRV might be calculated as the mean of all valid results, or a weighted mean.
- Estimates of equivalence of each participant to the KCRV. This might be expressed in terms of the Degree of Equivalence (DOE) given as a difference and its uncertainty ($\Delta \pm U$), in °C.

7.2 In the field of dew point standards, the KCRV does not have any absolute significance. It is calculated only for purposes such as the presentation and inter-relation of key comparison data for the MRA.

7.3 The Pilots will make an assessment of any drift in the travelling standards during the comparison. The assessment will be based on initial and final measurements done by the Pilots. If drift is found, this will be taken into account in the final analysis of the comparison results. If the drift is small compared with uncertainty values reported by the participants, an estimate for the drift may be set to zero with a standard uncertainty calculated according to the ISO Guide. In a case of a significant drift, the effect is taken into account by assigning a time-dependent value to KCRV, or by other suitable method so that the estimates of equivalence can be meaningfully calculated between results taken at different times.

7.4 If a travelling standard fails or performs poorly during the comparison, the Coordinator and Pilots will propose a course of action, subject to agreement of the participants.

APPENDIX A. PROVISIONAL TIME SCHEDULE FOR THE COMPARISON

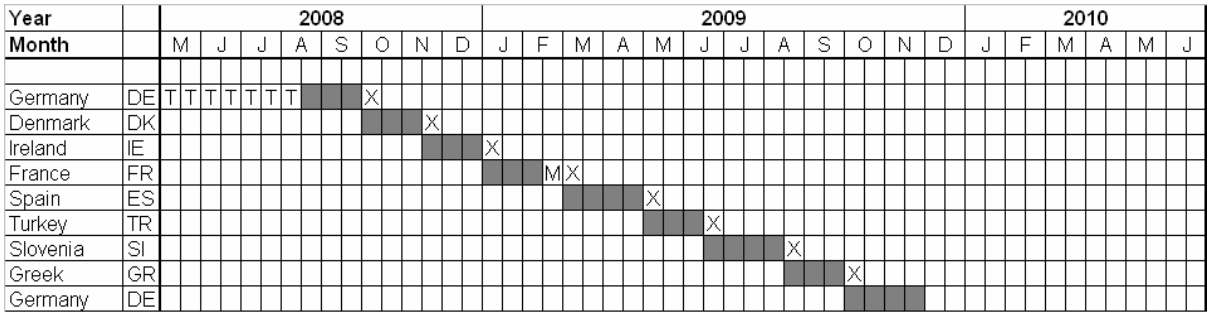

Figure 1 Comparison scheme of loop 1 (One column corresponds to two weeks; M = transportation to MBW Calibration Ltd / Swiss customs for a new ATA Carnet, ■ = measurement, X = measurement / transportation, T = testing the instrument)

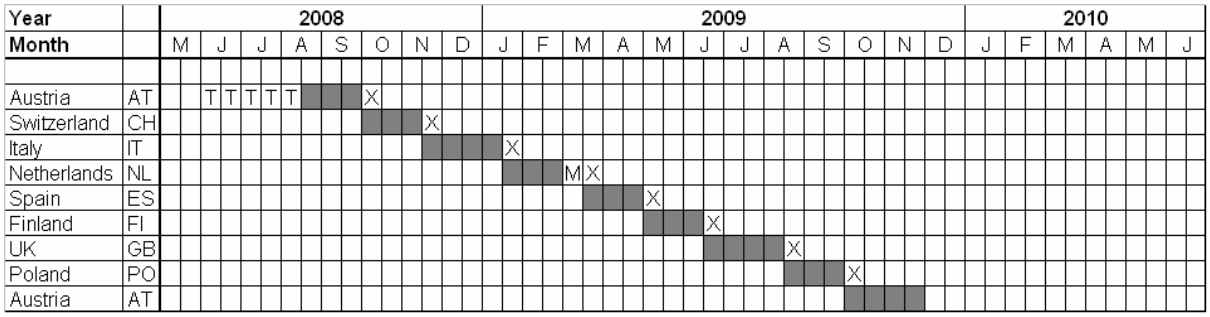

Figure 2 Comparison scheme of loop 2 (One column corresponds to two weeks; M = transportation to MBW Calibration Ltd / Swiss customs for a new ATA Carnet, ■ = measurement, X = measurement / transportation, T = testing the instrument)

Activity	Start Month	Provisional date
Draft of technical protocol completed by the Coordinator and sent to participants		Apr. 2008
All comments received from participants		Jun. 2008
Submission of a revised protocol to participants for unanimous approval		Aug. 2008
Submission of revised protocol to CCT/WG6 and TC THERM Chairman		Aug. 2008
Travelling standards characterized by the Pilots		Mai. 2008 - Sep. 2008
The fist set of key comparison measurements according to the protocol at the Pilot laboratories	Month 1	Sep. 2008
Travelling standards sent to participant by Pilots	Month 2	Oct. 2008
Completion of measurements	Month 15 approx.	Nov. 2009
Draft A ready	Month 19 approx.	1Q. 2010
Deadline for comments on draft A	Month 22	2Q. 2010
Draft B ready and submitted to THERM TC	Month 25	3Q. 2010

APPENDIX B. DETAILS OF PARTICIPATING INSTITUTES

Central Office of Measures (GUM) Poland
Address: ul. Elektoralna 2, 00-139 Warszawa
Contact: Krzysztof Flakiewicz
Phone: +48 22 581 93 99
Fax: +48 22 620 83 78
E-mail: physchem@gum.gov.pl

Centre for Metrology and Accreditation (MIKES) Finland
Address: Tekniikantie 9, FIN-02151 Espoo
Contact; Dr Martti Heinonen
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Fax: +358 10 6054 498
E-mail: martti.heinonen@mikes.fi

Centre Technique des Industries Aérauliques et Thermiques (CETIAT) France
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Instituto Nacional de Téchnica Aeroespacial (INTA) Spain

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Istituto Nazionale di Ricerca Metrologica (I.N.RI.M) Italy

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National Metrology Laboratory (NML) Ireland

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National Physical Laboratory (NPL) UK

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APPENDIX C. FORM FOR REPORTING ON RECEIPT OF TRAVELLING STANDARDS

TO: *(Pilot Laboratory)*

Fax:

FROM: *(Participating Laboratory)*

Fax:

We confirm having received the travelling standards of the EUROMET Comparison of Dew Point Temperature (EUROMET P717)

on: _____ (date)

After visual inspection

☐ No damage has been noticed;

☐ The following damage must be reported:

Have the hygrometer transportation packages been opened during transit ?
e.g., Customs …

☐ No

☐ Don't know (no seals applied)

☐ Yes: Please give details:

Is there any damage to the transportation packages?

☐ No

☐ Yes: Please give details:

Are there any visible signs of damage to the instruments?

☐ No

☐ Yes: Please give details:

Do you believe the travelling standards are functioning correctly?

☐ Yes

☐ No: Please indicate your concerns:

PACKING LIST

Received	Items	Dispatched
	Dew point hygrometer MBW 373 HX S/N 08-_____	
	Endoscope with mounting instructions	
	Flexible hose (heatable) with Swagelok® 6 mm fittings	
	Float-type flow meter	
	4-wire cable with Lemo-connector for 2nd PRT	
	Power cord with Standard CEE 7/VII plug	
	Operators manual	
	Transport case	
	(additional items may be added later)	

Laboratory: .....

Date: ..... Signature: .....

APPENDIX D. IEC 60751 RELATIONSHIP

Based on the IEC 60751 (1995-07), a nominal resistance-temperature characteristic of the PRT in the travelling standard can be defined as follows:

$$R_t = R_0(1 + At + Bt^2)$$

where:

t = Temperature (ITS-90) in °C,
R_t = Resistance of the PRT at temperature t in Ω
R_0 = Nominal resistance of 100 Ω at 0 °C,
A = 3.9083×10^{-3} °C^{-1} and
B = -5.775×10^{-7} °C^{-2}

Solving the quadratic equation, the temperature can be calculated with

$$t = -\frac{A}{2B} - \sqrt{\frac{A^2}{4B^2} - \frac{R_0 - R_t}{BR_0}}$$