EURAMET TC-MC Subcommittee on Electrochemical Analysis
CCQM WG on Electrochemical Analysis and Classical Chemical Methods

EURAMET 1684/EURAMET.QM-K170
EURAMET.QM-K170: Electrolytic Conductivity at 0.5 S m^{-1} and 20 S m^{-1}

Final Report

Steffen Seitz, Alan Snedden, Joanna Dumańska, Zuzana Hanková, Martina Vičarová, Oleksii Stennik, Tabitha Orwa, Ariel Galli, Hai WANG, Ayu Hindayani, Maulimgazinova Sharbanu

01.12.2025 / Version 1

Summary

This key comparison (EURAMET ID: EURAMET 1684; CCQM/KCDB ID: EURAMET.QM-K170) is a subsequent regional key comparison linked to CCQM-K170. SMU and NIM provided the link to the KCRV of CCQM-K170. The KC aims to demonstrate the capabilities of the participating NMIs and DIs to measure the electrolytic conductivity of aqueous electrolyte solutions in the electrolytic conductivity range around 0.5 S m^{-1} and 20 S m^{-1}. To this end, the electrolytic conductivity of two potassium chloride solutions (nominal electrolytic conductivities 0.5 S m^{-1} and 20 S m^{-1}) have been measured. CCQM-K170 is also a follow-up comparison of CCQM-K36.2016, which included 0.5 S m^{-1}, and of CCQM-K92, which included 20 S m^{-1}. It is intended as an updated support for the corresponding calibration and measurement capabilities (CMCs) entries in the BIPM CMCs database.

The majority of the participants have reported values consistent with the KCRV, even though there are also some participants that must review their measurement process since the deviation of their results is relatively large.

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Technical Protocol

EURAMET 1684
EURAMET.QM-K170

1 Coordinating institute and contact person

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2 List of participants

Table 1 List of participants

Institute	Acronym	Country	Contact person
Physikalisch-Technische Bundesanstalt	PTB	Germany	Steffen Seitz
Dansk Fundamental Metrologi A/S	DFM	Denmark	Alan Snedden
Central Office of Measures	GUM	Poland	Joanna Dumańska
Slovak Institute of Metrology	SMU	Slovakia	Zuzana Hanková
Czech Metrology Institute	CMI	Czech Republic	Martina Vičarová
State Enterprise «All-Ukrainian State Research and Production Center for Standardization, Metrology, Certification, and Consumer Rights Protection»	UkrCSM	Ukraine	Oleksii Stennik
Kenya Bureau of Standards Complex	KEBS	Kenya	Tabitha Orwa
Instituto Nacional de Tecnología Industrial	INTI	Argentina	Ariel Galli
National Institute of Metrology	NIM	P. R. China	Hai WANG
Laboratorium SNSU – BSN	SNSU-BSN	Indonesia	Ayu Hindayani
Kazakhstan Institute of Standardization and Metrology	KazStandard	Kazakhstan	Maulimgazinova Sharbanu

3 Time Schedule

Invitation	June 2024
Registration Deadline	30.08.2024
Sample Preparation	September 2024
Sample Shipment	30.10.2024
Reporting Deadline	21.03.2025
Draft A	July 2025
Approval Draft B report	CCQM-EAWG Meeting Oct 2025

4 Description of Samples

4.1 Preparation

The solutions used for the comparison have been produced by the coordinating laboratory. KCl solutions with nominal conductivity values of approximately 0.5 S m^{-1} and 20 S m^{-1}, respectively, have been prepared from KCl (Suprapur from Merck Millipore) and 10 L pure water in a 25 L PE barrel. The solutions were homogenized and filled in around 50 borosilicate bottles (200 mL) that were closed with rubber stoppers and aluminium crimps. Bottles labels indicated "EURAMET.QM- K170", "0.5 S m^{-1}" or "20 S m^{-1}", respectively, the filling date and the bottle number. The participants had received the number of requested bottles of the solutions. Samples have been shipped to all participants at the same time. The bottles were shock-protected, packed in cardboards and shipped by courier.

4.2 Homogeneity

A number of bottles, evenly distributed across the filling sequence or numbering, were used for the measurement of homogeneity (see Table 2 and Table 3). A salinometer has been used to measure the conductance ratio of the samples of the 0.5 S m^{-1}. A temperature-controlled Jones-type like two electrode cell has been used to measure the solution resistance of the 20 S m^{-1} samples in the measurement cell. The relative standard deviation of the measured conductance ratios of the 0.5 S m^{-1} samples was 0.0012 %. The relative standard deviation of the measured resistance values at 20 S m^{-1} was 0.011 %. Both values are significantly smaller than the typical relative standard uncertainties of the reported conductivity measurement results which were ranging from 0.03 % up to a few percent. Since aqueous electrolyte solutions can be assumed sufficiently homogenous within a bottle, the within bottle homogeneity has not been measured. The demonstrated between-bottle homogeneity is sufficient for this comparison. The results of the individual measurements are shown in Table 2 and Table 3Table 1.

Table 2 Results of homogeneity test at 0.5 S m^{-1}

bottle #	Temperature /°C	conductance ratio / arb. unit
1	23.980	0.18828
5	23.980	0.18829
10	23.980	0.18829
23	23.980	0.18828
34	23.980	0.18829
42	23.980	0.18829

Mean conductance ratio: 0.188286
Standard deviation 0.0000023
Relative standard deviation 0.0012 %

Table 3 Results of homogeneity test at 20 S m^{-1}

bottle #	Temperature /°C	resistance / Ω
10	24.751	33.362
20	24.751	33.361
28	24.751	33.355
36	24.751	33.353
47	24.751	33.358

Mean resistance: 33.3576
Standard deviation 0.0038
Relative standard deviation 0.011 %

4.3 Stability

A number of arbitrarily selected bottles have been measured to verify stability of the samples. Measurements have been conducted with the same instruments as used for the homogeneity measurements. Measurements have been conducted in approximately 4 weeks intervals since sample preparation until the end of the measurement period. The results are given in Table 4 and Table 5 and illustrated in Figure 1. Figure 1 shows that there is no obvious trend and the spread of the results is comparable to that of the homogeneity measurements (indicated by the error bars). Therefore, stability of the samples has been assumed, and a further analytical trend analysis has not been performed.

Table 4 Results of the stability test at 0.5 S m^{-1}

bottle #	date measured	temperature /°C	conductance ratio / arb. unit
homogeneity	07.11.2024	23.980	0.188286
41	17.12.2024	23.980	0.188278
2	15.01.2025	23.980	0.188282
49	13.02.2025	23.980	0.188278
3	31.03.2025	23.980	0.188284

Table 5 Results of the stability test at 20 S m^{-1}

bottle #	date measured	temperature /°C	resistance / Ω
homogeneity	13.11.2024	24.751	33.3576
39	19.12.2024	24.751	33.358
40	15.01.2025	24.751	33.369
42	19.02.2025	24.751	33.359

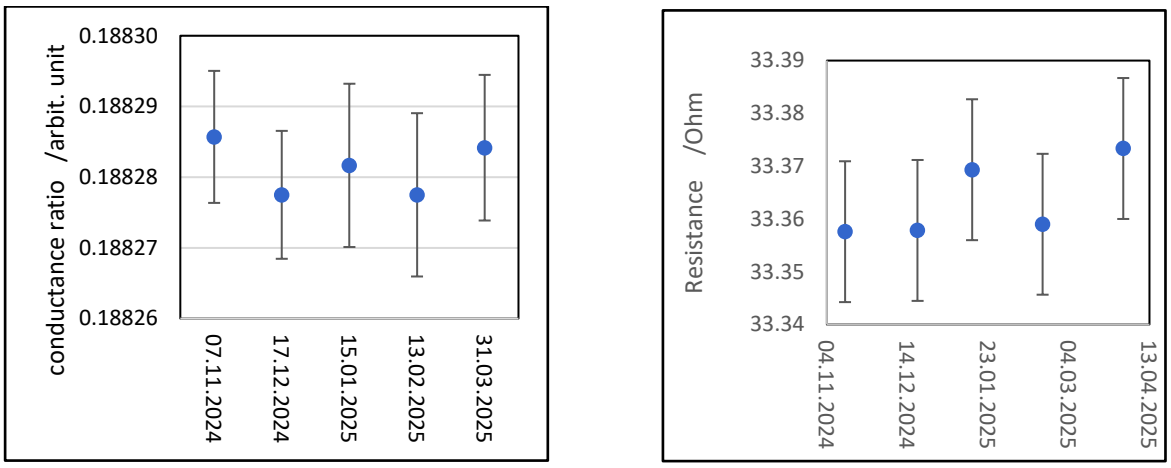

Figure 1 Results of the stability test. Left: 0.5 S m^{-1}; right: 20 S m^{-1} solution. The error bars indicate the double standard deviation of the homogeneity test.

4.4 Bottle integrity

The packaging material had to be removed after arrival of the samples and the bottles were inspected for visible damage or leakage. The bottles were equilibrated in the weighing room overnight. Afterwards, each bottle was weighed with a balance having at least 0.01 g resolution to verify its integrity during shipment. Labels or lids were not to be removed. Weighing results, pressure, temperature and relative humidity at the time of weighing were filled in a Weighing-Excel sheet that had been sent to each participant by email. Bottle masses were automatically corrected for air-buoyancy. The masses were compared with the masses measured at the coordinating institute. Discrepancies larger than 0.2 g had to be reported to the coordinating lab. In this case, a replacement bottle was shipped. Figure 2 shows the differences between masses measured at the institutes from those measured at the coordinating institute. No relevant deviations have been observed.

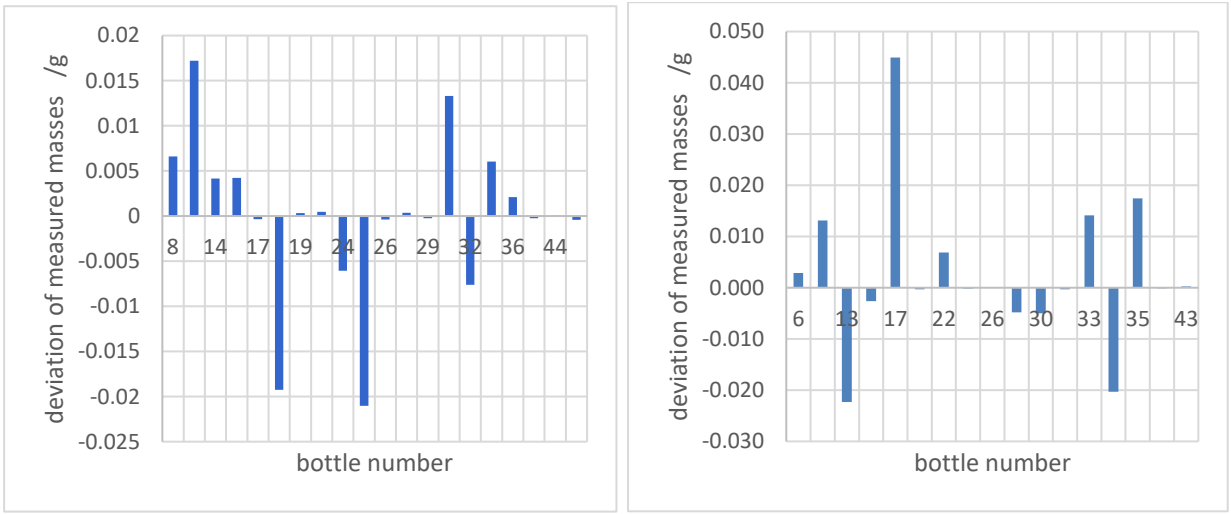

Figure 2 Measured mass differences of bottles with respect to the initial weighing at the coordinating institute. Left: 0.5 S m^{-1}, right: 20 S m^{-1}.

5 Correspondence with institutes

The coordinator informed the participants that the deadline for reporting had been postponed to 21 March 2025. Additional stability measurements were conducted at the end of March.

The coordinating laboratory has sent an encrypted file including its measurement report to the linking laboratory (NIM-China) on 5 March 2025 to ensure data integrity. Afterwards, the linking laboratories have sent their results to the coordinating laboratory.

On 28 March 2025 the following institutes have been informed that their results showed anomalies with respect to the KCRV and its uncertainty. They have been asked to check their results for transcription or calculation errors: INTI (regarding 0.5 S m^{-1} solution), KEBS (regarding both types of solution), UkrCSM (regarding both types of solution), CMI (regarding 20 S m^{-1} solution). No numerical information was given.

DFM has been informed that there were inconsistencies between the values reported in the summary page from those mentioned in the measurement report. No numerical information was given. DFM has clarified a misunderstanding on 28 March 2025. A revised report had not been necessary.

UkrCSM has sent a revised version of the measurement report on 3 April 2025, indicating a calculation error for the 0.5 S m^{-1} solution and a typo in the uncertainty calculation of the 20 S m^{-1} solution. The correction has been accepted.

KEBS has sent a revised version on 4 April 2025 with corrected typos.

CMI confirmed the original result on 3 April 2025

INTI did not respond to the request. Thus, the originally reported results stand.

6 Instructions for measurement

The bottles should be stored at temperatures between 20 °C and 25 °C, however, they were not to be stored above 25°C. The lids and caps of the bottles were only to be opened immediately before the measurements. If possible, the caps should be re-sealed with Parafilm following each opening.
Each participant had to measure electrolytic conductivity of the samples with respect to 25 °C. It was expected that the highest-level method available at the institute was used. However, lower-level methods could additionally be used, and the results could be reported as additional information. To support existing CMCs, the institute were particularly asked to use the same method the CMCs are referring to.

7 Results

7.1 Reported Results

Table 6 and Table 7Table 1 list the reported results for both solutions. The last column lists the stated source of traceability. Figure 3 and Figure 4 show the results graphically together with the reported standard uncertainties.

Table 6 Reported conductivities for the 0.5 S m^{-1} solution at 25 °C and their uncertainties.

Institute *i*	**quantity value κ_i**	**standard uncertainty $u(\kappa_i)$**	**coverage factor k_i**	**expanded uncertainty $U(\kappa_i)$**	**cell type**	**source of traceability**
acronym	S/m	S/m		S/m		
NIM-China	0.49946	0.000125	2	0.00025	Secondary two electrode	NIM IUPAC TR 2001
SMU	0.49941	0.000125	2	0.00025	Secondary Two electrode	SMU OIML solution
INTI	0.4876	0.0051	2	0.0102	Commercial cell	INTI OIML solution
KEBS	0.4957	0.01358	2	0.02716	Commercial cell	KEBS OIML solution
KazStandard	0.498494	0.0006506	2	0.0013012	Secondary cell	KazStandard OIML solution
PTB	0.49889	0.0001	2	0.0002	primary piston type	PTB
SNSU-BSN	0.4991	0.0006	2	0.0013	Secondary Two electrode	CRM from DFM
GUM	0.49934	0.00012	2	0.00024	Primary Piston type	GUM
DFM	0.49959	0.000175	2	0.00033	Tertiary Two electrode	DFM
UkrCSM	0.4986	0.000645	2	0.00129	Primary cell Jones type	UkrCSM

Table 7 Reported conductivities for the 20 S m^{-1} solution at 25 °C and their uncertainties.

Institute *i*	**quantity value κ_i**	**standard uncertainty $u(\kappa_i)$**	**coverage factor k_i**	**expanded uncertainty $U(\kappa_i)$**	**cell type**	**source of traceability**
acronym	S/m	S/m		S/m		
NIM-China	19.892	0.005	2	0.010	Secondary two electrode	NIM IUPAC TR 2001
UkrCSM	19.733	0.0253	2	0.0506	Primary cell Jones type	UkrCSM
DFM	19.881	0.0065	2	0.013	Tertiary Two electrode	DFM
PTB	19.884	0.005	2	0.010	primary piston type	PTB

Institute i	quantity value κ_i	standard uncertainty $u(\kappa_i)$	coverage factor k_i	expanded uncertainty $U(\kappa_i)$	cell type	source of traceability
acronym	S/m	S/m		S/m		
GUM	19.907	0.017	2	0.034	Primary Piston type	GUM
KazStandard	19.92239	0.013391	2	0.026782	Secondary cell	KazStandard OIML solution
CMI	20.077	0.026	2	0.052	Primary Jones cell	CMI
KEBS	20.36	0.01166	2	0.02332	Commercial cell	KEBS OIML solution

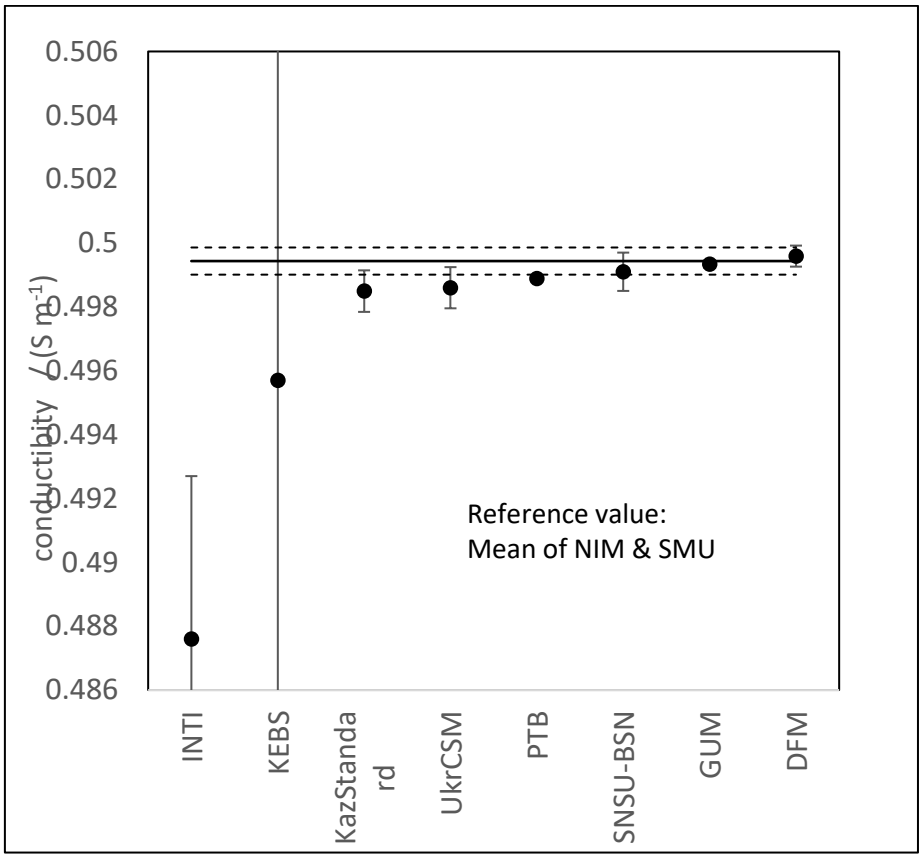

Figure 3 Reported conductivity results of a KCl solution at 0.5 S m^{-1}. The uncertainty bars indicate standard uncertainties. The solid line indicates the mean of the results from SMU and NIM, the dashed line the combined, expanded uncertainty of the linking value.

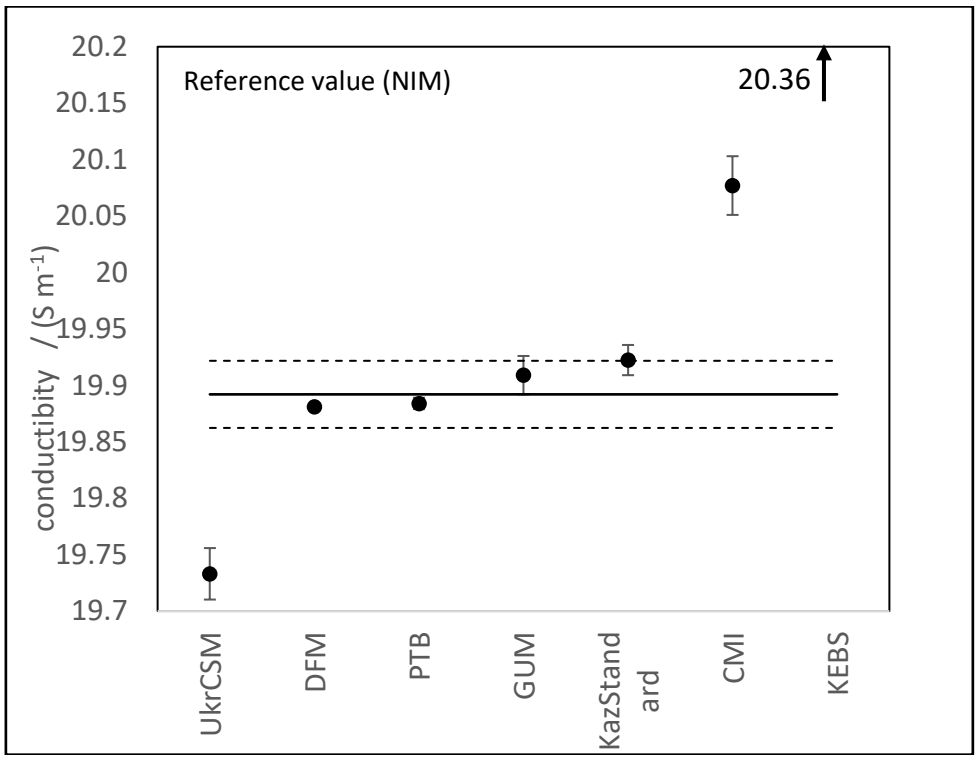

Figure 4 Reported conductivity results of a KCl solution at 20 S m^{-1}. The uncertainty bars indicate standard uncertainties. The solid line indicates the linking result from NIM, the dashed line the combined, expanded uncertainty of the linking result.

The figures illustrate the deviations mentioned in section 5.

7.2 Results of further analysis or investigations

Since this is a subsequent KC the results do not contribute to the KCRV of CCQM-K170. Therefore, the anomalous results have not been further questioned by the coordinating institute. However, the concerned institutes are asked to review their measurement procedures for deficiencies.

8 Key Comparison Reference Value (KCRV)

The KCRVs of the original key comparison CCQM-K170 are the also the KCRVs for this comparison.

For the 0.5 S m^{-1} solution: $KCRV_{0.5}$(CCMQ-K170) = (0.50150 ± 0.00036) S m^{-1}

For the 20 S m^{-1} solution: $KCRV_{20}$(CCMQ-K170) = (20.148 ± 0.028) S m^{-1}

The values are given together with their expanded uncertainties.

9 Degrees of equivalence (DoE)

The results are referred to the KCRV of CCQM-K170 with NIM and SMU being the linking laboratory for the 0.5 S m^{-1} solution and NIM being the linking laboratory for the 20 S m^{-1} solution. The DoE for participant i is calculated according to

$$DoE_{sc}(x_i) = x_i - x_{ll} + DoE_{oc}(x_{ll}) \quad (1)$$

and

$$U^2(DoE_{sc}(x_i)) = U^2(x_i) + U^2(x_{ll}) + U^2(DoE_{oc}(x_{ll})) \quad (2)$$

with

x_i	result of participant i in this subsequent comparison EURAMET 1684
x_{ll}	result of the linking laboratory in this subsequent comparison EURAMET 1684 (if there are two linking labs, x_{ll} is calculated from the mean of both laboratories, and its uncertainty is calculated from the rout-mean-square of both uncertainties;
DoE_{sc}	DoE in this subsequent comparison EURAMET 1684
DoE_{oc}	DoE in the original comparison CCQM-K170 (if there are two linking labs, DoE_{oc} is calculated from mean of the DoEs of both laboratories, and its uncertainty from the route-mean-square of their uncertainties)

For the 0.5 S m^{-1} solution the following values are used (see final report of CCQM-K170):

$DoE(x_{NIM})$= -0.00004 S m^{-1} $\quad$ $U(DoE(x_{NIM}))$ = -0.00042 S m^{-1}

$DoE(x_{SMU})$ = 0.00004 S m^{-1} $\quad$ $U(DoE(x_{SMU}))$ = -0.00043 S m^{-1}

$$U(x_{ll}) = \sqrt{\frac{1}{2}[U^2(x_{NIM}) + U^2(x_{SMU})]} = 0.00025\ \mathrm{Sm^{-1}}$$

$DoE_{oc}(x_{ll})$ = 0 S m^{-1}

$$U\left(DoE_{oc}(x_{NIM,SMU})\right) = \sqrt{\frac{1}{2}\left[U^2\left(DoE_{oc}(x_{NIM})\right) + U^2\left(DoE_{oc}(x_{SMU})\right)\right]} = 0.00042\ \mathrm{Sm^{-1}}$$

For the 20 S m^{-1} solution the following values are used:

$DoE_{oc}(x_{NIM})$ = -0.009 S m^{-1} $\quad$ $U(DoE_{oc}(x_{NIM}))$= 0.028 S m^{-1}

Table 8 and Table 9 list the degrees of equivalence of the results x_i of the participants i and their uncertainties. The third column lists the E_n values

$$E_n(x_i) = \frac{DoE(x_i)}{U(DoE(x_i))} \quad (3)$$

The E_n values are a measure for the consistency of the results with the KCRV. If an E_n value is smaller or equal to 1, the corresponding result is considered consistent with the KCRV. Otherwise, it is considered inconsistent. It is assumed that the participant has underestimated or omitted relevant uncertainty contributions (dark uncertainty). The last column lists the minimal expanded uncertainties consistent with the KCRV. If a result is consistent with the KCRV this value is identical with the reported uncertainty of the participant. If the result is inconsistent, the minimal uncertainty is calculated from

$$1 = \frac{DoE^2(x_i)}{U^2_{minCMC}(x_i) + U^2(x_{ll}) + U^2(DoE_{oc}(x_{ll}))} \quad (4)$$

Table 8 Degrees of equivalence at 0.5 S m^{-1}, their expanded uncertainties, E_n values and minimal expanded uncertainties admissible for CMC submission.

Institute i	DoE_i / S m^{-1}	$U(DoE_i)$ / S m^{-1}	$E_n(x_i)$	$U_{\text{minCMC}}(i)$ / S m^{-1}
INTI	-0.012	0.01021	-1.2	0.012
KEBS	-0.0037	0.02716	-0.14	0.027
KazStandard	-0.00094	0.00139	-0.68	0.0013
PTB	-0.00055	0.00053	-1.0	0.00020
SNSU-BSN	-0.00034	0.00130	-0.26	0.0013
GUM	-0.00010	0.00055	-0.17	0.00024
DFM	0.00015	0.00082	0.19	0.00033
UkrCSM	-0.00084	0.00138	-0.60	0.00129

Table 9 Degrees at of equivalence at 20 S m^{-1}, their expanded uncertainties, E_n values and minimal expanded uncertainties admissible for CMC submission.

Institute i	DoE_i / S m^{-1}	$U(DoE_i)$ / S m^{-1}	$E_n(x_i)$	$U_{\text{minCMC}}(i)$ / S m^{-1}
UkrCSM	-0.17	0.059	-2.9	0.17
DFM	-0.020	0.032	-0.62	0.013
PTB	-0.017	0.031	-0.54	0.010
GUM	0.0060	0.045	0.13	0.034
KazStandard	0.021	0.040	0.53	0.027
CMI	0.18	0.060	2.9	0.17
KEBS	0.46	0.038	12	0.46

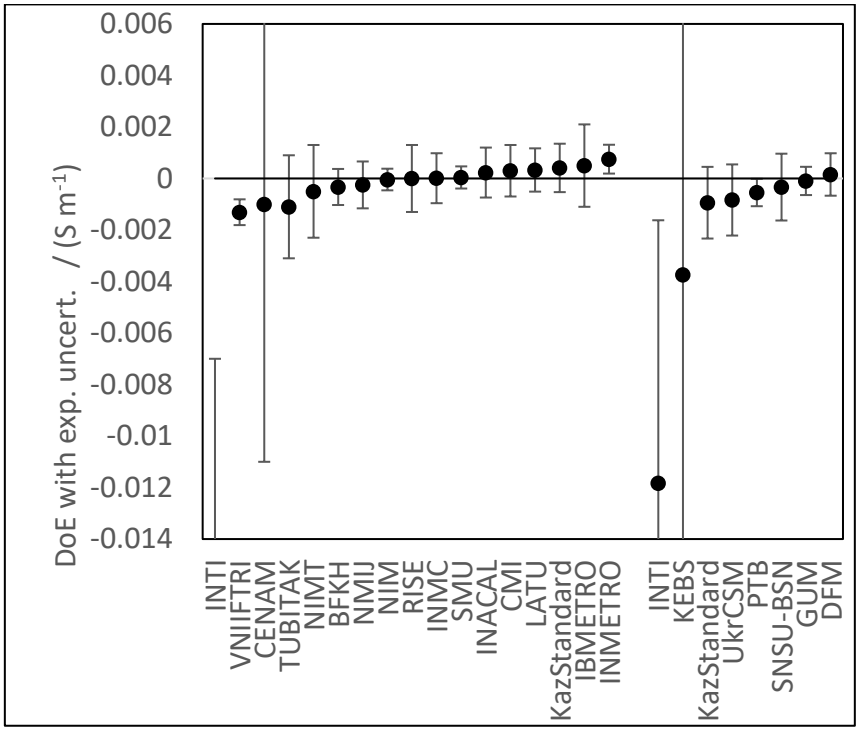

Figure 5 DoEs of the 0.5 S m^{-1} solution of CCQM-K170 and their expanded uncertainties. The values on the left hand-side are those from the original comparison, the values on the right hand-side are from this subsequent comparison.

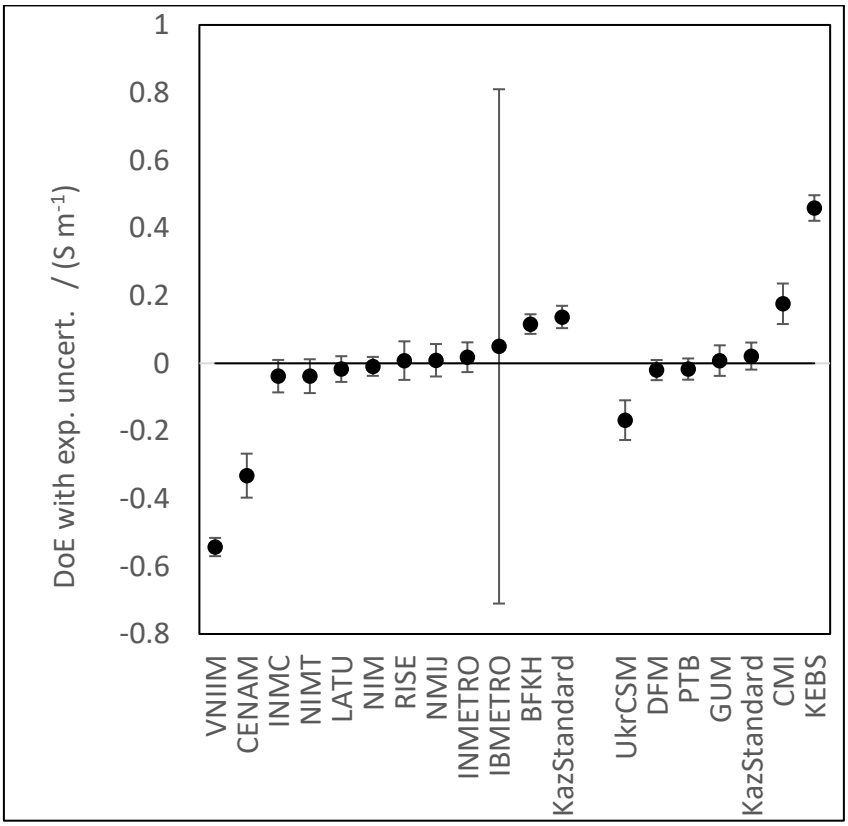

Figure 6 DoEs of the 20 S m^{-1} solution of CCQM-K170 and their expanded uncertainties. The values on the left hand-side are those from the original comparison, the values on the right hand-side are from this subsequent comparison.

10 How Far Does The Light Shines statement

The HFTLS statement of this comparison coincides with that of CCQM-K170. The results are considered representative for electrolytic conductivity measurements of aqueous electrolyte solutions in the electrolytic conductivity range 0.15 S m^{-1} to 1.5 S m^{-1} and 5 S m^{-1} to 25 S m^{-1}, respectively. The uncertainties claimed in CMCs must not be smaller than the U_{minCMC} values stated in Table 8 and Table 9, unless exceptions stated in the EAWG-CMC guidelines can be applied. It must be emphasized that the HFTLS range of CCQM-K105 (1 S m^{-1} to 15 S m^{-1}) overlaps with that of the 20 S m^{-1} solution used in this KC. In case an institute has participated in both KCs, CCQM-K105 prevails in the overlapping range, unless the institute has demonstrated a lower uncertainty in this KC.

11 Acknowledgements

The coordinating laboratory thank NIM-China and SMU for their willingness to act as linking laboratories and it gratefully acknowledges the contributions of all participants.

12 References

CCQM/2013-22 CCQM Guidance note: Estimation of a consensus KCRV and associated Degrees of Equivalence, available at https://www.bipm.org/documents/20126/28430045/working-document-ID-5794/49d366bc-295f-18ca-c4d3-d68aa54077b5

GUM: Guide to the Expression of Uncertainty in Measurement, available at https://www.bipm.org/en/committees/jc/jcgm/publications

CCQM WG on Electrochemical Analysis and Classical Chemical Methods

Key Comparison

EURAMET.QM-K170: Electrolytic Conductivity at 0.5 S m^{-1} and 20 S m^{-1}

Technical Protocol

14.11.2024 / Version 2

1. Introduction

EURAMET.QM-K170 is a subsequent regional key comparison linked to CCQM-K170. SMU and NIM will provide the link to the KCRV of CCQM-K170. The KC aims to demonstrate the capabilities of the participating NMIs and DIs to measure the electrolytic conductivity of aqueous electrolyte solutions in the electrolytic conductivity range around 0.5 S m^{-1} and 20 S m^{-1}. To this end, the electrolytic conductivity of two potassium chloride solutions (nominal electrolytic conductivity 0.5 S m^{-1} and 20 S m^{-1}) must be measured. CCQM-K170 is associated with CCQM-K36.2016, which included 0.5 S m^{-1} and CCQM-K92, which included 20 S m^{-1}. It is intended as an updated support for the corresponding calibration and measurement capabilities (CMCs) entries in the BIPM CMCs database.

2. Coordinating laboratory and contact person

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3. Time Schedule

Invitation	June 2024
Registration Deadline	30.08.2024
Sample Preparation	September 2024
Sample Shipment	30.11.2024
Reporting Deadline	28.02.2025
Draft A	01.05.2025
Draft B report	01.10.2025

4. Description of Samples

The solutions used for the comparison will be produced by the coordinating laboratory. KCl solutions with nominal conductivity values of approximately 0.5 S m^{-1} and 20 S m^{-1}, respectively, will be prepared from KCl and deionised water. The solutions will be homogenized, filled in 200 mL boresilicate bottles and closed with rubber stopper and an aluminium crimp.
Bottles labels will indicate "EURAMET.QM-K170", "0.5 S m^{-1}" or "20 S m^{-1}", respectively, the filling date and the bottle number. The participants will for the most part receive the number of requested bottles of the solutions. Shipment to all participants will be initiated at the same time. The bottles will be shock-protected, packed in cardboards and shipped by courier. The tracking number will be reported by email to the contact person of the laboratory. The contents will be stated as "water for analysis" with a value of 1 € per bottle. Specific customs requirements stated by the laboratories have been considered.
Homogeneity of each solution will be measured with at least 5 bottles before shipment. Stability will be measured after preparation in 4-5 weeks intervals throughout the whole measurement period.

5. Actions after receipt of samples

- The packaging material must be removed after arrival of the samples and the bottles must be inspected for visible damage or leakage.
- The bottles shall be equilibrated in the weighing room overnight. Each bottle shall be weighed with a balance having at least 0.01 g resolution to verify its integrity during shipment. Weighing results, pressure, temperature and relative humidity at the time of weighing must be filled in the Weighing-Excel sheet that is sent together with the final version of this technical protocol to each participant. Bottle masses will be automatically corrected for air-buoyancy. The corrected masses shall be compared with those measured by the coordinating institute which are stated in the Weighing-Excel sheet. If the discrepancy is larger than 0.2 g, please investigate for possible leakage and inform the coordinating lab. A replacement bottle will be shipped as soon as possible.
- Confirm receipt of samples and report bottle masses (corrected for air buoyancy) to the coordinating laboratory within two weeks after arrival.

6. Instruction for measurement

- The bottles should be stored at temperatures between 20°C and 25°C, however, they must not be stored above 25°C. The crimps and rubber stoppers of the bottles may only be opened immediately before the measurements.
- Each participant must measure electrolytic conductivity of the samples with respect to 25 °C. It is expected that the highest-level method available at the institute is used. However, lower-level methods can be additionally used and reported as additional information.
- To support existing CMCs, the institute should use the same method the CMCs are referring to.

7. Reporting

A measurement report must be written, containing the following information:

- Name and address of the laboratory performing the measurements
- Name(s) of the operator(s)
- Date of receipt of samples
- Identification of the samples (bottle numbers) measured.
- Date(s) of measurement.
- Mass of each bottle, pressure, temperature, and relative humidity at time of weighing as stated in the accompanying Weighing-Excel file.
- Description of the method used, including a photo of the experimental setup, if available.
- Provide an uncertainty budget according to the *Guide to the Uncertainty in Measurement*. The uncertainty budget of primary measurements must at least include the following contributions:
  - uncertainty of temperature measurement
  - uncertainty of resistance measurement
    (this must include the uncertainty of the actual measurement, and also the uncertainty of the model used to drive the resistance from the measured values)
  - uncertainty of cell dimension (geometric cell constant)
  - effect of carbon di-oxide, if relevant; a standard uncertainty of 0.012 mS m^{-1} (0.12 µS cm^{-1}) is estimated for aqueous electrolyte solutions getting in contact with ambient air during the measurement process
  - other contributions resulting from the specific set-up and measurement procedure of the participant

  The uncertainty budget of secondary measurements must include the following contributions:
  - uncertainty of the conductivity measurement standard used
  - measurement repeatability
  - effect of carbon di-oxide, if relevant; a standard uncertainty of 0.012 mS m^{-1} (0.12 µS cm^{-1}) is estimated for aqueous electrolyte solutions getting in contact with ambient air during the measurement process
  - other contributions resulting from the specific set-up and measurement procedure of the participant
- The measurement results with the associated standard uncertainties, expanded uncertainties and the corresponding coverage factors *k*, referring to a 95% level of confidence. Note that *k* is 2 if an infinitive number of degrees of freedom can be reasonably assumed.

- The route of traceability; it must be emphasized that this KC can only serve as support for subsequent CMC submissions if primary standards provided by NMI/DIs holding adequate CMCs in the KCDB are used for the calibration of secondary measurement systems.

The report must be sent to the coordinating laboratory **before 28.02.2024 by e-mail**. It should preferably be sent as a pdf file in order to ensure data integrity. The coordinating laboratory will confirm the receipt of each report. If the confirmation does not arrive within two weeks, please contact the coordinating laboratory to identify the problem.
Additionally, a word template will be provided to summarise the results. Please be aware that only a single result may be provided for each kind of solution. The summary report can be sent individually, or it can be integrated into the measurement report.

8. Key comparison reference value

The degrees of equivalence will be calculated with respect to the KCRV of CCQM-K170, with SMU and NMIJ providing linking values.

9. How Far Does The Light Shines statement

The results are considered to be representative for electrolytic conductivity measurements of aqueous electrolyte solutions in the electrolytic conductivity range 0.15 S m^{-1} to 1.5 S m^{-1} and 5 S m^{-1} to 25 S m^{-1}, respectively.

CCQM WG on Electrochemical Analysis and Classical Chemical Methods

EURAMET.QM-K170: Electrolytic Conductivity at 0.5 S m^{-1} and 20 S m^{-1}

Measurement Report

1. Summary Results

Laboratory

Institute name	
Department (if relevant)	
Institute acronym	
Address	
Country	

Main contact

Name of main contact	
Contact person e-mail address	
Contact person telephone number	

Operator(s) of the measurement
(if different from main contact)

Name of operator	

Add lines as appropriate.

Others to be mentioned as co-authors of the final report

Name of co-author	

Add lines as appropriate.

0.5 S m^{-1} KCl solution

Sample data

Date received	Date of weighing	Temperature /°C	Pressure hPa	relative humidity /%

Bottle No.	Balance reading /g	solution mass corrected /g

Add lines as appropriate.

Summary Results:

Nominal conductivity / S m^{-1}	Date measured	Best estimate / S m^{-1}	Standard uncertainty / S m^{-1}	Coverage factor (95 %)	Expanded uncertainty / S m^{-1}

20 S m^{-1} KCl solution

Sample data

Date received	Date of weighing	Temperature /°C	Pressure hPa	relative humidity /%

Bottle No.	Balance reading /g	solution mass corrected /g

Add lines as appropriate.

Summary Results:

Nominal conductivity / S m^{-1}	Date measured	Best estimate / S m^{-1}	Standard uncertainty / S m^{-1}	Coverage factor (95 %)	Expanded uncertainty / S m^{-1}

2. Measurement details

(add details of the measurement set-up and the measurement method)

3. Traceability

(add detailed information on the source of traceability, if you have used a reference material from another NMI, please state the corresponding CMC identifier of the KCDB)

4. Uncertainty budget

(add a complete measurement budget, including

- *information on the main sources of measurement uncertainty, considering the mandatory contribution mentioned in the technical report*
- *the quantity values*
- *degrees of freedom*
- *assumed distribution functions*
- *standard uncertainties)*