REPORT OF THE INTER-LABORATORY COMPARISON ON IRON AND FLUORIDE DETECTION IN WATER(2021)

THE THIRD ROUND OF AN INTERNATIONAL STUDY

Research Center for Eco-Environmental Sciences
Chinese Academy of Sciences

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Title

Report of the Inter-laboratory Comparison on Iron and Fluoride Detection in Water （2021）

Authors

Min YANG, Hong-yan LI, Bei ZHENG, Xin WANG, Lu-dan SI

Standards

ISO 13528: 2015

Statistical Methods for Use in Proficiency Testing by Interlaboratory Comparison

CNAS-GL032: 2018

Guidance on the Selection, Review and Use of Proficiency Testing

Keywords: Inter-laboratory Comparison, Iron, Fluoride, Water

Contents

Summary

The Inter-laboratory Comparison on Iron and Fluoride in Water (2021) was jointly implemented by Water Quality Analysis Laboratory, RCEES, CAS and Centre of Excellence for Water and Environment (CEWE), CAS-TWAS in 2021. This activity was supported by the Certification and Accreditation Administration of the People's Republic of China, CNCA (Approved as CNCA[2021]25) and the Alliance of International Science Organizations (ANSO-CR-KP-2020-05).

This study included determining iron and fluoride in two different water items, which were both distributed to the participating laboratories with two testing samples at the same concentration, respectively. The objectives of this proficiency testing were

A. To offer a tool for quality assurance to the participating laboratories.

B. To assess the reproducibility of inter-laboratory.

C. To elevate the quality control system of the laboratories in the countries along the Belt and Road.

D. To provide a general overview of the analytical performance of laboratories in the countries along the Belt and Road.

Eighty-four testing samples were sent to 22 different laboratories from 12 countries. Because of the ongoing epidemic prevention and control, 29 sets of data, including 16 sets for iron and 13 sets for fluoride, have been returned from 18 laboratories of 9 countries.

The standard value for each analyte in the testing samples was determined by the National Institute of Metrology, China. All values exceeding ±50% of the assigned value (hereby the standard value) were removed from the calculation. The standard deviations (SD) were calculated using the remaining data. Thereby this SD and the standard value were used to subsequently calculate z-scores.

For the iron samples (-a and -b), z-scores within ±2 were obtained by 81.2% of the reporting participants (corresponding to 13 of the total 16 participants).

For the fluoride samples (-a and -b), z-scores within ±2 were obtained by 84.6% of the reporting participants (corresponding to 11 of the total 13 participants).

Introduction

The analytical laboratories with skills and abilities are required to perform related measurements that are accredited according to ISO standards or some other related standards. Inter-laboratory comparison is one of effective ways to improve the quality control system for the analytical laboratories through external measures, which is particularly becoming of increasing importance in the background of globalization of the world economy.

This is the third round of the study on water quality analysis in countries along the Belt-and-Road, jointly organized by Water Quality Analysis Laboratory and CAS-TWAS Centre of Excellence for Water and Environment (CAS-TWAS CEWE), both of which are affiliated with the Research Center for Eco-environmental Sciences (RCEES), Chinese Academy of Sciences (CAS).The main objective of the activity is to assess the laboratory reproducibility on water quality analysis and provide a QA/QC tool for each participating laboratory to improve their performance.

This activity took place from October 2021 when testing samples were delivered to the laboratories for analysis and ended in March 2022 when all the reported results were received. Eighty-four testing samples were sent to 22 different laboratories from 12 countries. Finally, 18 laboratories from 9 countries (presented in Table 1) have submitted the testing results. A draft report was made available to the participants in April 2022.

The worldwide COVID-19 epidemic has brought significant challenges to the implementation of this work. We sincerely appreciate all the participants and individual analysts for overcoming difficulties and providing support to this activity. We will continue this effort, and are expecting suggestions from the participants to improve this inter-laboratory comparison activity. Through our joint efforts, we hope to establish a big laboratory network to share knowledge, experiences, and ideas in the future.

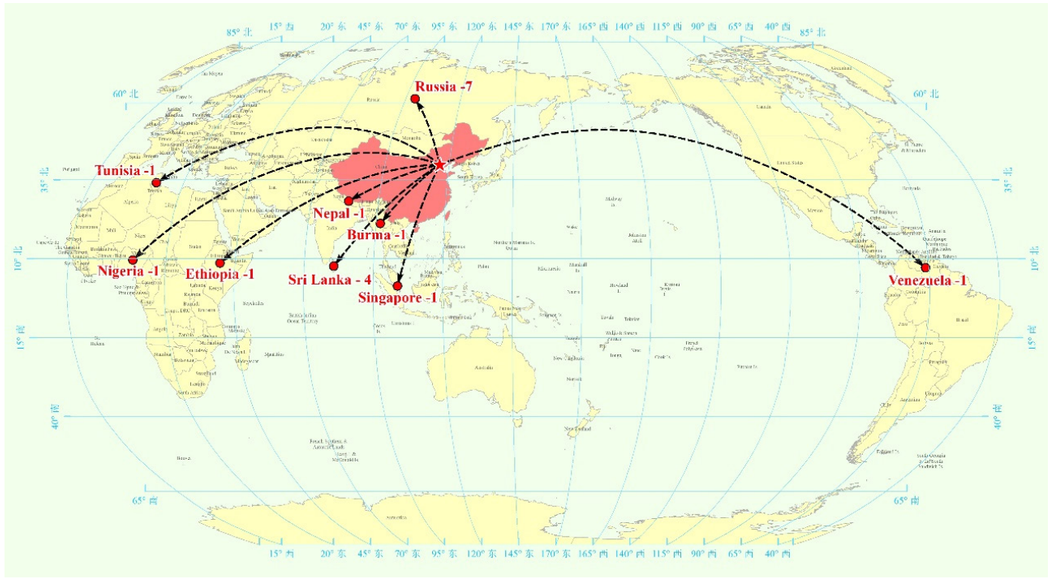

Figure 1 Distribution of the Participating Laboratories

Table 1. Participants that reported results in the Inter-laboratory Comparison on Iron and Fluoride in Water 2021

Region	Countries
Asia	Singapore, Sri Lanka, Burma, Nepal
Africa	Ethiopia, Nigeria, Tunisia
South America	Venezuela
Europe	Russia
Total	9 countries (18 laboratories)

Design and practical implementation

Study design and reporting of results

The analysis should be performed using the laboratories' methods for instrumental analysis, their quantification standards, and quantification procedures. Table 2 shows the testing methods from the participants that reported results.

The laboratories were to report the concentration of each analyte and the measurement uncertainty according to the Reporting form for the 3rd inter-laboratory comparison.

Table 2. Testing methods from the participants in the Inter-laboratory Comparison on Iron and Fluoride in Water 2021

Items	Testing Methods	Countries
Iron	Spectrophotometry	Nigeria (1), Russia (1), Nepal (1)
	Atomic Absorption Spectroscopy (AAS)	Burma (1), Venezuela (1), Russia (4)
	Inductively Coupled Plasma Optical Emission Spectrometer(ICP)	Ethiopia (1), Tunisia (1), Singapore (1), Russia (2), Sri Lanka (2)
Fluoride	Spectrophotometry	Venezuela (1), Nigeria (1), Sri Lanka (2), Nepal (1)
	Potentiometric Titration	Ethiopia (1), Russia (1)
	Ion Chromatography	Tunisia (1), Singapore (1)
	Capillary Electrophoresis	Russia (3)
	Ion Selective Electrode	Sri Lanka (1)

Confirmation of reported results

Before the statistics, it was found that seven laboratories didn't reserve three significant digits according to the operation instruction. Therefore, a confirmation form of reported results (shown in Appendix D 1-2) was sent to the seven laboratories to round their results. Therefore, results without 3 significant digits were used for analysis and result evaluation in this report.

Confidentiality

To ensure the fairness of this inter-laboratory comparison work, each participating laboratory was given a random laboratory code by coordinators. The participants have access to their code only, and laboratory codes were not revealed to any third parties. The distribution and result for each paired sample are transmitted by code. When received by the coordinators, the raw data from participating laboratories were entered into a database for analysis and the report draft. In this report, the participants are presented in the tables and figures by their unique codes.

Statistical analysis and evaluate

Statistical analysis

The statistical method for this inter-laboratory comparison is based on the "Guidance on the selection, review and use of proficiency testing CNAS-GL032:2018". According to the distribution frequency of the results, the histogram graph presented a normal distribution, as shown in Appendix B. Then, the classical statistical method could be adopted. Hereby the standard value indicated the assigned value (as shown in Table 3).

Table 3. The assigned values of Iron and Fluoride in Water in the Inter-laboratory Comparison 2021

Items	The standard value / The assigned value (mg/L)	Solvent
Iron	35.1	2%HNO_3
Fluoride	15.0	H_2O

The standard deviation (s) indicated the standard deviation for proficiency assessment (σ_{pt}), where the value of "$\bar{x}$" and "s" were calculated according to the equations (1) and (2):

$$\bar{x} = \sum_{i=1}^{p} \frac{x_i}{p} \quad \text{.....(1)}$$

$$s = \sqrt{\sum_{i=1}^{p} \frac{(x_i - \bar{x})}{(p-1)}} \quad \text{.....(2)}$$

Where p = number of the remaining data; x_i = reported value; $\bar{x}$ = mean of the remaining data; s = standard deviation (SD).

Result evaluation

Z-score was adopted to evaluate the results in the inter-laboratory comparison, according to "Statistical methods for use in proficiency testing by inter-laboratory comparison ISO 13528:2015". Z-score was calculated according to the equation (3):

$$z = \frac{x_i - x_{pt}}{\sigma_{pt}} \quad \text{.....(3)}$$

Where x_i= reported value; x_{pt} = standard value (assigned value); σ_{pt}= SD. $|z| \leqslant 2.0$ means a satisfied result; $2.0<|z|<3.0$ means a problematic result; $|z| \geqslant 3.0$ means an unsatisfied result.

There were three kinds of evaluation results: satisfied, problematic, and unsatisfied. A satisfied result will be achieved for each laboratory only when paired sample (both sample-a and sample-b) meet the conditions of "$|z| \leqslant 2.0$". Otherwise, the result will be evaluated as problematic or unsatisfied. Table 4 shows the acceptable range of testing results on iron and fluoride in water.

Table 4. The acceptable range of results on Iron and Fluoride in Water in the Inter-laboratory Comparison 2021

Items	Assigned value(mg/L)	$\|z\| \leqslant 2.0$	Minimum Concentration(mg/L)	Maximum Concentration(mg/L)
Iron-a	35.1	Satisfied	27.0	43.2
Iron-b	35.1		28.5	41.7
Fluoride-a	15.0	Satisfied	10.2	19.8
Fluoride-b	15.0		10.7	19.3

With a rough statistical analysis after receiving the returned results, the measurement error(D) was calculated according to "Statistical methods for use in proficiency testing by inter-laboratory comparison ISO 13528:2015", which was applied to identify the potential risks of data for the laboratories. D and δ_E were calculated according to the equations (4) and (5).

$$D = x_i - x_{pt} \quad \text{.....(4)}$$

$$\delta_E = 3\sigma_{pt} \quad \text{.....(5)}$$

Where D means measurement error; δ_E means maximum permissible error; x_i = reported value; x_{pt} = standard value (assigned value); σ_{pt}= SD.

If the participating laboratory obtained a result of $D \geqslant \delta_E$, we would arrange additional samples delivery for retesting on the will of voluntary participation. At the same time, the laboratories that have received an "unsatisfied" or "problematic" evaluation result would also receive additional samples for retesting on the will of voluntary participation.

The returned retesting results were evaluated according to the above statistical analysis results directly with no further calculation of SD, and the analysis results for each laboratory in this report were based on the initially returned testing results. Both the initial results and the resting results would be supplemented by the notice of the the study results.

The final report and certificate

The final report was drafted by the coordinators and published in April 2022.

A certificate with analysis results will be sent to each laboratory who has contributed to the results by the end of March 2022.

Coordination

This activity was initiated by CNCA and RCEES, and jointly carried out by the Water Quality Analysis Laboratory and CAS-TWAS Centre of Excellence for Water and Environment (CEWE), RCEES. Members of the coordination committee were:

Prof. Hongyan LI, Senior engineer
Prof. Min YANG, Director
szfxsys@126.com; cas_twas@rcees.ac.cn

Results

General

According to the equations (1) and (2), the standard deviation (SD=σ_{pt}) was calculated based on the classical statistical method, which could be used to reasonably express the dispersion of returned results (shown in Table 5).

Table 5. The standard deviation of Iron and Fluoride in Water in Inter-laboratory Comparison 2021

Items	The standard value/Assigned value(mg/L)	The standard deviation (SD) / Standard deviation for proficiency assessment
Iron-a	35.1	4.04
Iron-b	35.1	3.30
Fluoride-a	15.0	2.42
Fluoride-b	15.0	2.14

For the samples of iron, results from 16 laboratories were received. After calculating SD of returned results, σ_{pt} for iron (-a and -b) were obtained up to 4.04 (Iron-a) and 3.30(Iron-b), respectively.

For the samples of fluoride, results from 13 laboratories were received. After calculating SD of returned results, σ_{pt} for fluoride (-a and -b) were obtained as 2.42 (Fluoride -a) and 2.14 (Fluoride-b), respectively.

Iron

For the samples of iron, the assigned value is 35.1 mg/L, and the SD were 4.04 (Iron-a) and 3.30(Iron-b), respectively.

Figure 2 shows the study results of iron. Of the 16 participating laboratories, 13 achieved z-scores within ±2 as satisfied results, and one obtained z-scores over ±3 as unsatisfied results. One laboratory submitted the testing results with z-score of 1.26 for Iron-a as a satisfied result and z-score of 2.09 for Iron-b as a problematic result, and one laboratory submitted the testing results with z-score of 3.07 for Iron-a as an unsatisfied result and z-score of -0.18 for Iron-b as a satisfied result.

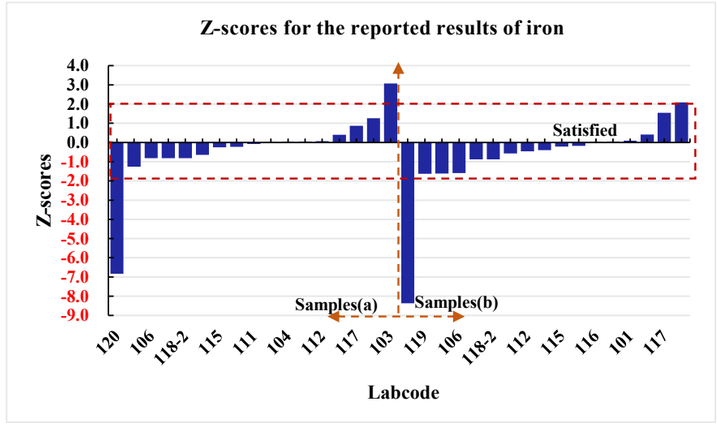

Figure 2 Study results of iron

2 laboratories (Lab 103, Lab 122) with unsatisfied and problematic results applied for a retest, satisfied (Lab 103) and unsatisfied (Lab 122) results were obtained in the two laboratories after retesting. The results of each participant are presented in Appendix F 1-1.

Fluoride

For the samples of fluoride, the assigned value is 15.0 mg/L, and the SD were 2.42 (Fluoride-a) and 2.14 (Fluoride-b), respectively.

Figure 3 shows the study results of fluoride. It could be seen that of the 13 participating laboratories, 11 achieved z-scores within ±2 as satisfied results, one laboratory reported both testing results with z-score of 2-3 as problematic results, and one laboratory submitted the testing results with z-score of 2.60 for Fluoride-a as a problematic result and z-score of 0.14 for Fluoride-b as a satisfied result.

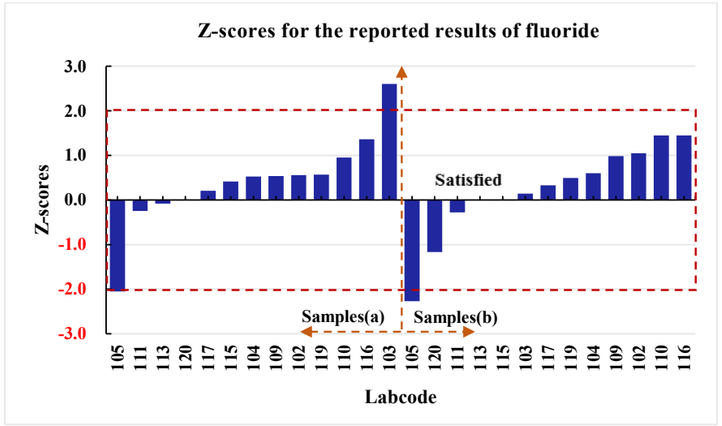

Figure 3 Study results of fluoride

2 laboratories (Lab 103, Lab 105) with problematic results applied for a retest, and both of them achieved satisfied results after retesting. The results of each participant are presented in Appendix F 1-2.

Statistics of testing methods

Based on the technical traceability of original records, the testing methods of all laboratories are summarized in Figure4.

For the iron testing, three methods of spectrophotometry (3), atomic absorption spectroscopy (AAS) (6) and inductively coupled plasma spectrometer (ICP) (7) were adopted for testing. Two laboratories with unsatisfied results used the method of spectrophotometry, and one laboratory with problematic result used ICP for testing.

For the determination of fluoride, three methods of spectrophotometry (5), Ion chromatography (2) and electrochemistry method (6) were adopted for testing. The problematic results were obtained by 2 laboratories using the method of spectrophotometry and Ion chromatography, respectively.

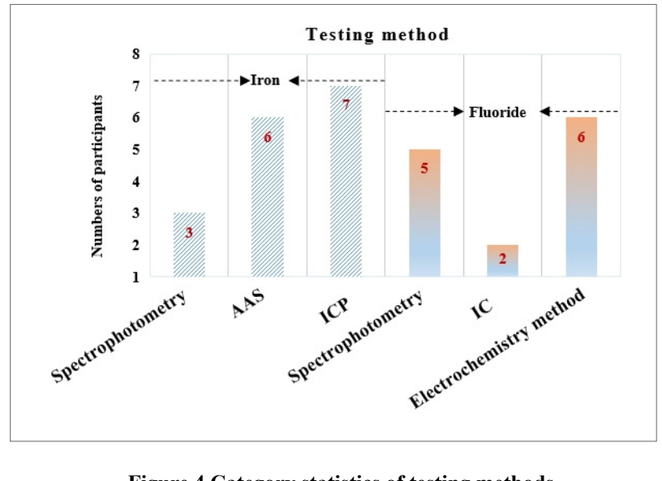

Figure 4 Category statistics of testing methods

Through the traceability of original records, it could be found that 14 of 18 participating laboratories returned the measurement uncertainty associated with testing results, accounting for 78% of the total participants. On the other hand, several laboratories provided only the testing results or incomplete records of quality control process, such as only the calibration curve. It is recommended that the laboratories further focus on the traceability of the original records and improve the quality control system, including more information, like measurement recovery, instrumental conditions, and preparation of reagents and reference materials, and so on.

Acknowledgment

The laboratories are acknowledged for their participation in this inter-laboratory comparison and in their interest in its overall objectives. All the individual analysts are acknowledged for their contributions to the results.

Thanks for the support from Certification and Accreditation Administration (Grant No. [2021] 25) and support from the Alliance of International Science Organizations (Grant No. ANSO-CR-KP-2020-05); Thanks Prof. Jingbo CHAO from the National Institute of Metrology, China, for providing the standard solutions and her technical guidance; Thanks Prof. Yanchun TONG from the China NIL Research Center for Proficiency Testing for her valuable suggestions on statistical analysis.

国家认证认可监督管理委员会

认秘函〔2021〕25号

认监委秘书处关于组织开展水质和电子电器国际检验检测机构能力验证活动的通知

中国科学院生态环境研究中心，中国家用电器研究院，威凯检测技术有限公司，各有关检验检测机构：

为贯彻落实《共同推动认证认可服务“一带一路”建设的愿景与行动》部署要求，充分发挥认可和检验检测对“一带一路”建设的技术支撑作用，经研究，认监委决定在水质和电子电器检验检测领域组织开展国际能力验证活动，组织国内相关检验检测机构并邀请“一带一路”沿线国家检验检测机构参与，推动检验检测数据、结果的采信和互认，为后续双边多边合作、业务交流和技术能力提升奠定基础。现将有关事项通知如下：

一、能力验证项目和参加要求

本次能力验证活动，委托中国科学院生态环境研究中心承担“水中铁和氟化物的检测”项目实施，委托中国家用电器研究院承担“窗式空调器制冷量试验”项目实施，委托威凯检测技术有限公

附件：1. 水中铁和氟化物的检测能力验证报名表

2. 窗式空调器制冷量试验能力验证报名表

3. 分体式空调能效测试（T3气候）能力验证报名表

国家认证认可监督管理委员会 秘书处

认监委秘书处

2021年8月2日

（此件公开发布）

Appendix B Distribution Histogram of Returned Testing Results

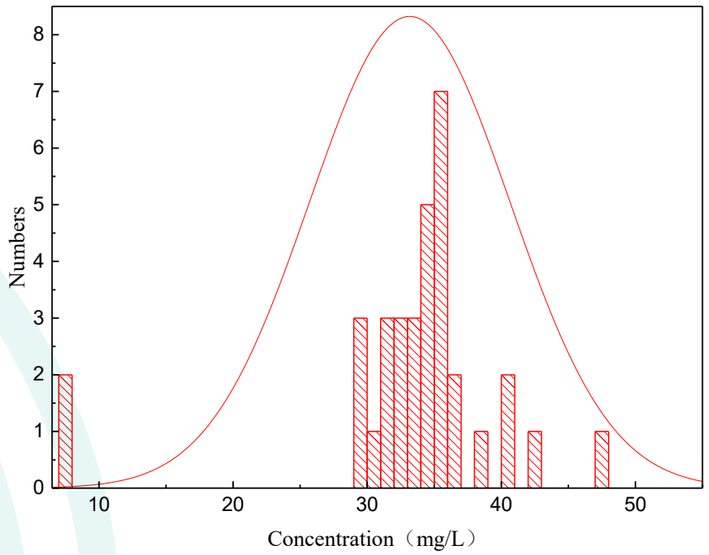

Figure B-1 Distribution histogram of testing results of iron

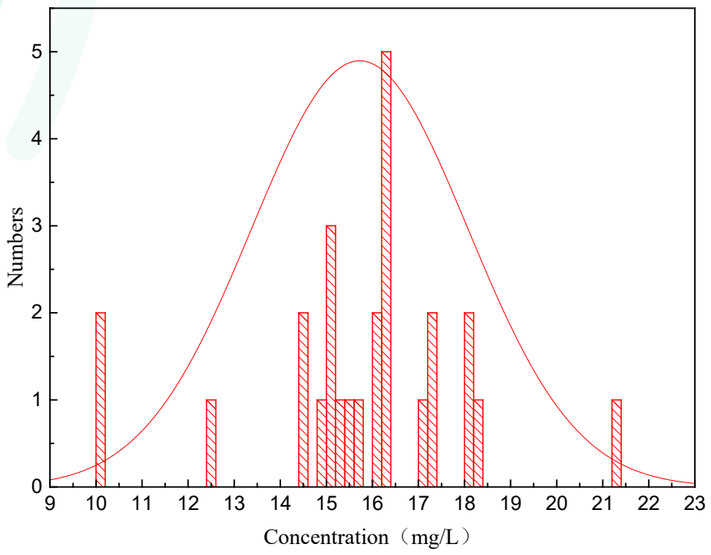

Figure B-2 Distribution histogram of testing results of fluoride

Appendix C 1-1 Operation Instruction for Testing of Iron

Operation Instruction for Testing Samples of the 3rd Inter-Laboratory Comparison (2021)- Iron

Participating laboratories:

The 3rd Inter-laboratory Comparison on Water Quality Analysis (2021), which is focused on the Proficiency Testing of Iron and Fluoride in Water, is organized and implemented by the CAS-TWAS Center of Excellence for Water and Environment, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences. In this project, your laboratory code is **1XX**. The relevant information of the project is as follows:

To ensure the smooth implementation of the capacity verification, please read the following instructions carefully before testing:

1. Description of the testing samples

1.1 This operation instruction is prepared for the testing of **Iron in water**, and the testing samples will be provided randomly according to the registration information.

1.2 Two samples provided for this test are packaged in ampoules with volume about 20 mL, numbered **I1XXa** and **I1XXb**. The matrix is 2% HNO_3. The reference concentration of the Iron in samples is between 5.00 mg/L~50.0 mg/L (before the dilution).

1.3 The samples will be delivered from the CAS-TWAS Center of Excellence for Water and Environment, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences.

1.4 Upon receipt, please confirm that the sample is in good condition. Please fill in the **Confirmation Form for the Receiving Status of Testing Samples** within 7 days after receipt and then please send the scanned copy of this form to **szfxsys@126.com**. If the sample received is damaged, please contact us through email **szfxsys@126.com** in time and apply for replacement (Note: The replacement is only for damage caused by transportation, but not that caused by experimental operations).

1.5 Store in dark with room temperature, and test as soon as possible.

2. Testing

2.1 Dilution method: Use a clean and dry pipette to accurately remove 10 mL of the sample from the ampoule, transfer it to a 250 mL volumetric flask, dilute to volume with ultrapure water or as required by the test method, and test immediately after mixing. Each sample must be tested in duplicate.

2.2 The actual testing methods of each laboratory should be consistent with that in the registration form. If there is any change, instructions for the change should be submitted and the registration form should be resubmitted.

3. Result report

3.1 The results of "**Iron in water**" should be reported in mg/L with **the concentration before dilution** in the **Results Form for the 3rd Inter-laboratory Comparison (2021).** At the same time, the average results should be calculated and retained 3-digit valid numbers. If the laboratory can evaluate the uncertainty of the results, please give the extended uncertainty (U) (k=2) in the report.

3.2 Each laboratory please send both the completed **Results Form for the 3rd Inter-laboratory Comparison (2021) and the detailed original records** to **cas_twas@rcees.ac.cn** within 30 natural days (including weekends and national holidays) since the receipt of the samples. The results will not be count and evaluated if the results report form is not returned in time.

3.3 During the implementation of this proficiency testing program, each laboratory should pay attention to confidentiality, independently complete the experiment and submit the report.

Note: The original records should include quality control samples, standard samples, parallel samples and other quality control measures. Quality control measures should reflect the reliability of test results.

4. Contact information

If you have any question during the competency verification process, please contact with the CAS-TWAS Center of Excellence for Water and Environment, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences.

Contact: Si, Ludan

Contact number: +86-10-62849800

E-mail: cas_twas@rcees.ac.cn

Contact address: CAS-TWAS Center of Excellence for Water and Environment,

Research Center for Eco-environmental Sciences, Chinese Academy of Sciences,

Beijing 100085, CHINA

Operation Instruction for Testing Samples of the 3rd Inter-Laboratory Comparison (2021)-Fluoride

Participating laboratories:

The 3rd Inter-laboratory Comparison on Water Quality Analysis (2021), which is focused on the Proficiency Testing of Iron and Fluoride in Water, is organized and implemented by the CAS-TWAS Center of Excellence for Water and Environment, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences. In this project, your laboratory code is **1XX**. The relevant information of the project is as follows:

To ensure the smooth implementation of the capacity verification, please read the following instructions carefully before testing:

1. Description of the testing samples

1.1 This operation instruction is prepared for the testing of **Fluoride in water**, and the testing samples will be provided randomly according to the registration information.

1.2 **Two** samples provided for this test are packaged in plastic bottle with volume about 20 mL, numbered **F1XXa** and **F1XXb**. The matrix is H_2O. The reference concentration of the Fluoride in samples is between 3.00 mg/L~25.0 mg/L (before the dilution).

1.3 The samples will be delivered from the CAS-TWAS Center of Excellence for Water and Environment, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences.

1.4 Upon receipt, please confirm that the sample is in good condition. Please fill in the **Confirmation Form for the Receiving Status of Testing Samples** within 7 days after receipt and send the scanned copy of the form to **szfxsys@126.com**. If the sample received is damaged, please contact us through email **szfxsys@126.com** in time and apply for replacement (Note: The replacement is only for damage caused by transportation, but not that caused by experimental operations).

1.5 Store in dark with room temperature, and test as soon as possible.

2. Testing

2.1 Dilution method: Use a clean and dry pipette to accurately remove 10 mL of the sample from the plastic bottle, transfer it to a 250 mL volumetric flask, dilute to volume with ultrapure water or as required by the test method, and test immediately after mixing. Each sample must be tested in duplicate.

2.2 The actual testing methods of each laboratory should be consistent with that in the registration form. If there is any change, instructions for the change should be submitted and the registration form should be resubmitted.

3. Result report

3.1 The results of "**Fluoride in water**" should be reported in mg/L with **the concentration before dilution** in the **Results Form for the 3rd Inter-laboratory Comparison (2021)**. At the same time, the average results should be calculated and retained 3-digit valid numbers. If the laboratory can evaluate the uncertainty of the results, please give the extended uncertainty (U) (k=2) in the report.

3.2 Each laboratory please send both the completed **Results Form for the 3rd Inter-laboratory Comparison (2021) and the detailed original records** to **cas_twas@rcees.ac.cn** within 30 natural days (including weekends and national holidays) since the receipt of the samples. The results will not be count and evaluated if the results report form is not returned in time.

3.3 During the implementation of this proficiency testing program, each laboratory should pay attention to confidentiality, independently complete the experiment and submit the report.

Note: The original records should include quality control samples, standard samples, parallel samples and other quality control measures. Quality control measures should reflect the reliability of test results.

4. Contact information

If you have any question during the competency verification process, please contact with the CAS-TWAS Center of Excellence for Water and Environment, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences.

Contact: Si, Ludan

Contact number: +86-10-62849800

E-mail: cas_twas@rcees.ac.cn

Contact address: CAS-TWAS Center of Excellence for Water and Environment, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing 100085, CHINA

Appendix D 1-1 Testing Results for the 3rd Inter-laboratory Comparison (2021)

Testing Results for the 3rd Inter-laboratory Comparison (2021)

"Iron"

Laboratory: _____ Laboratory code:_____

Report date: _____

Sample number	Testing results (mg/L)			Extended uncertainty (k=2)	Title and issued No. of the testing method	Ambient temperature	Instrument and model	Date of inspection	Signature of the inspector	Signature of the certifier
	1	2	Average							

Problems or anomalies that occur during the experiment: _____

_____ (Not enough, please attach a page)

Person in charge (signature):

Official seal:

Testing Results for the 3rd Inter-laboratory Comparison (2021)

"Fluoride"

Laboratory: _____ Laboratory code:_____

Report date: _____

Sample number	Testing results (mg/L)			Extended uncertainty (k=2)	Title and issued No. of the testing method	Ambient temperature	Instrument and model	Date of inspection	Signature of the inspector	Signature of the certifier
	1	2	Average							

Problems or anomalies that occur during the experiment: _____

_____ (Not enough, please attach a page)

Person in charge (signature):

Official seal:

Appendix D 1-2 Confirmation Form of Reported Results

Confirmation of the Testing Results for the 3rd Inter-laboratory Comparison (2021)

"Iron"

Laboratory: _____ Laboratory code:_____

Report date: _____

Sample number	Testing results (mg/L)		Signature of the certifier
	Reported results	Rounding results	

*The rounding results present 3 significant digits (e.g. 34.5, 7.81, 0.892).

Person in charge（signature）:

Official seal:

Confirmation of the Testing Results for the 3rd Inter-laboratory Comparison (2021)

"Fluoride"

Laboratory: _____ Laboratory code:_____

Report date: _____

Sample number	Testing results (mg/L)		Signature of the certifier
	Reported results	Rounding results	

*The rounding results present 3 significant digits (e.g. 34.5, 7.81, 0.892).

Person in charge（signature）:

Official seal:

Appendix E Confirmation Form for the Receiving Status of Testing Samples

Confirmation Form for the Receiving Status of Testing Samples

Laboratory		
Code of Laboratory		
Accepted Date		
Accepted Samples	Amount of Samples	☐ 2 ☐ 4
	No. of Samples	
	Status of Samples	☐ in good condition ☐ broken Note: If the samples are broken, please attach photos of the sample when returning this form.
Recipient	Name	
	E-Mail	

Appendix F 1-1 Z-scores of Results for Iron

Lab code	Item	Comprehensive assessment conclusion	Testing method	Sample code	Conc 1 (mg/L)	Conc 2 (mg/L)	Mean value (mg/L)	z-scores	Conclusion	Sample code	Conc 1 (mg/L)	Conc 2 (mg/L)	Mean value (mg/L)	z-scores	Conclusion
101	Iron	satisfied	AAS	I101a	35.5	34.9	35.2	0.02	satisfied	I101b	36.4	34.4	35.4	0.09	satisfied
102		satisfied	AAS	I102a	32.923	32.071	32.497	-0.64	satisfied	I102b	29.991	29.514	29.753	-1.62	satisfied
103		unsatisfied	Spectrophotometry	I103a	47.0	48.0	47.5	3.07§	unsatisfied	I103b	34.0	35.0	34.5	-0.18	satisfied
104		satisfied	ICP	I104a	35.25	35.25	35.25	0.04	satisfied	I104b	35.25	35.25	35.25	0.05	satisfied
105		satisfied	ICP	I105a	36.44	36.98	36.71	0.40	satisfied	I105b	35.98	36.98	36.48	0.42	satisfied
106		satisfied	AAS	I106a	31.64	31.94	31.79	-0.82	satisfied	I106a	29.92	29.77	29.84	-1.59	satisfied
111		satisfied	ICP	I111a	33.3	36.3	34.8	-0.07	satisfied	I111b	34.4	33.2	33.8	-0.39	satisfied
112		satisfied	AAS	I112a	35.5	35.3	35.4	0.07	satisfied	I112b	32.3	34.8	33.6	-0.45	satisfied
113		satisfied	AAS	I113a	34.3	34.0	34.2	-0.22	satisfied	I113b	33.3	33.0	33.2	-0.58	satisfied
115		satisfied	ICP	I115a	34.2	34.8(33.4)	34.1	-0.25	satisfied	I115b	35.4	34.4(33.5)	34.4	-0.21	satisfied
116		satisfied	Spectrophotometry	I116a	35.1	35.4	35.3	0.05	satisfied	I116b	35.3	35.0	35.2	0.03	satisfied
117		satisfied	ICP	I117a	38.7	38.5	38.6	0.87	satisfied	I117b	40.9	39.4	40.2	1.55	satisfied
118		satisfied	AAS	I118a	31.2	32.3	31.8	-0.82	satisfied	I118b	32.2	32.1	32.2	-0.88	satisfied
		satisfied	AAS	I118a	31.2	32.3	31.8	-0.82	satisfied	I118b	32.2	32.1	32.2	-0.88	satisfied
119		satisfied	ICP	I119a	29.66	30.36	30.01	-1.26	satisfied	I119b	29.23	30.23	29.73	-1.63	satisfied
120		unsatisfied	Spectrophotometry	I120a	7.5	7.5	7.5	-6.83§	unsatisfied	I120b	7.5	7.5	7.5	-8.36§	unsatisfied
122		problematic	ICP	I122a	41.2	39.3	40.2	1.26	satisfied	I122b	42.1	41.9	42.0	2.09*	problematic
Retesting Results															
103	Iron	satisfied	Spectrophotometry	I103a	35.5	34.5	35.0	-0.02	satisfied	I103b	34.5	35.0	34.8	-0.09	satisfied
122		unsatisfied	ICP	I122a	23.5	23.0	23.25	-2.93*	problematic	I122b	24.0	23.5	23.75	-3.44§	unsatisfied
Notes	Iron testing: the assigned value = 35.1 mg/L, the standard deviation of Iron-a = 4.04, the standard deviation of Iron-b = 3.30. $\|z\| \leqslant 2.0$ means a satisfied result; $2.0 < \|z\| < 3.0$ means a problematic result, which is marked with * in the table; $\|z\| \geqslant 3.0$ means an unsatisfied result, which is marked with § in the table. The evaluation is “unsatisfactory”, when any result in the paired sample gets a $\|z\| \geqslant 3.0$.														

Appendix F 1-2 Z-scores of Results for Fluoride

Lab code	Item	Comprehensive assessment conclusion	Testing method	Sample code	Conc 1 (mg/L)	Conc 2 (mg/L)	Mean value (mg/L)	z-scores	Conclusion	Sample code	Conc 1 (mg/L)	Conc 2 (mg/L)	Mean value (mg/L)	z-scores	Conclusion
102	Fluoride	satisfied	Spectrophotometry	F102a	16.425	16.275	16.350	0.56	satisfied	F102b	17.050	17.425	17.238	1.05	satisfied
103		problematic	Spectrophotometry	F103a	21.0	20.5	21.3	2.60*	problematic	F103b	15.5	15.0	15.3	0.14	satisfied
104		satisfied	Potentiometric titration	F104a	16.25	16.30	16.27	0.52	satisfied	F104b	16.27	16.30	16.28	0.60	satisfied
105		problematic	Ion chromatography	F105a	9.944	10.134	10.039	-2.05*	problematic	F105b	10.007	10.269	10.138	-2.27*	problematic
109		satisfied	Spectrophotometry	F109a	16.2	16.4	16.3	0.54	satisfied	F109b	17.2	17.9	17.1	0.98	satisfied
110		satisfied	Spectrophotometry	F110a	17.3	17.3	17.3	0.95	satisfied	F110b	18.1	18.1	18.1	1.45	satisfied
111		satisfied	Ion chromatography	F111a	14.3	14.5	14.4	-0.25	satisfied	F111b	14.3	14.4	14.4	-0.28	satisfied
113		satisfied	Potentiometric titration	F113a	14.8	14.8	14.8	-0.08	satisfied	F113b	15.0	15.0	15.0	0.00	satisfied
115		satisfied	Fluoride Ion Selective Electrode	F115a	16	16	16	0.41	satisfied	F115b	15	15	15	0.00	satisfied
116		satisfied	Capillary electrophoresis	F116a	18.3	18.2	18.3	1.36	satisfied	F116b	18.0	18.2	18.1	1.45	satisfied
117		satisfied	Capillary electrophoresis	F117a	15.4	15.5	15.5	0.21	satisfied	F117b	15.6	15.7	15.7	0.33	satisfied
119		satisfied	Capillary electrophoresis	F119a	16.42	16.32	16.37	0.57	satisfied	F119b	16.04	16.08	16.06	0.50	satisfied
120		satisfied	Spectrophotometry	F120a	15	15	15	0.00	satisfied	F120b	12.5	12.5	12.5	-1.17	satisfied
Retesting Results															
103	Fluoride	satisfied	Spectrophotometry	F103a	14.8	15.2	15.0	0.00	satisfied	F103b	15.2	15.4	15.3	0.14	satisfied
105		satisfied	Ion chromatography	F105a	11.75	11.250	11.212	-1.57	satisfied	F105b	10.921	11.350	11.136	-1.81	satisfied
Notes	Fluoride testing: the assigned value = 15.0 mg/L, the standard deviation of Fluoride-a = 2.42, the standard deviation of Fluoride-b = 2.14. $\|z\| \leqslant 2.0$ means a satisfied result; $2.0 < \|z\| < 3.0$ means a problematic result, which is marked with * in the table; $\|z\| \geqslant 3.0$ means an unsatisfied result, which is marked with § in the table. The evaluation is "unsatisfactory", when any result in the paired sample gets a $\|z\| \geqslant 3.0$.														