

# Summary of the replies to the CCU questionnaire on the implementation of the revised SI

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CCU meeting

21-23 September 2021

**Bureau**  
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# Background

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- In January 2019, the CCU WG-S suggested to send a questionnaire to CCU members, stakeholders and universities to collect feedback on implementation of the revised SI
- Draft questionnaires for NMIs, liaison organizations and universities were presented and discussed at the CCU meeting in 2019
- They were discussed at the meetings of the CIPM and the NMI Directors in 2019
- Questionnaires were finalized by CCU President, Executive Secretary and BIPM Director in early 2021
- Questionnaires were sent in March 2021 to NMIs of member states, CCU liaison organizations and teaching organizations (through the NMIs)
- Deadline for replies was 31 May 2021

## Who replied to the questionnaire – 18 NMIs

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<b>A*STAR:</b>	Tan Siew Leng, Head of Metrology Office
<b>BFKH:</b>	Zsófia Nagyné Szilágyi, Head of Metrological and Technical Supervisory Department
<b>BMM:</b>	Goran Vikoslavović, Assistant of Director
<b>GUM:</b>	Prof. Dr Hab. Jacek Semaniak, President GUM
<b>INM-Co:</b>	Edwin Cristancho-Pinilla, General Director
<b>INPL:</b>	Dr. Nadya Goldovsky, Manager of Time and Frequency Laboratory
<b>JV:</b>	Geir Samuelsen, Director General
<b>LATU :</b>	Daniel Volpe, Analysis, Testing and Metrology Manager
<b>LNE:</b>	Maguelonne Chambon, R&D Director, in charge of French metrology network
<b>NIMT:</b>	Dr. Sivinee Sawatdiaree, Working Group on preparing for revised SI of NIMT and Head of Electrical Metrology Department
<b>NIST:</b>	Claire Saundry, Director, International and Academic Affairs Office
<b>NMIJ:</b>	Dr. Saito Norio, Manager of NMIJ International Cooperation Office
<b>NMISA:</b>	Dr Aletta Karsten, Program Manager – Revised SI Program
<b>NPL:</b>	Robert Gunn, Head of International
<b>NRC:</b>	Georgette Macdonald, Director General
<b>PTB:</b>	Dr. Kai Stoll-Malke, Quality Manager
<b>SASO:</b>	Ismail AlFaleh, General Director of NMCC
<b>VSL:</b>	Marc Pieksma, Operational Director

## Who replied to the questionnaire – 7 liaison organizations

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- IAU:** Nicole Capitaine, Member of the IAU and of the Organizing Committees of IAU Commission A3 “Fundamental Standards” and WG “Time Metrology standards” within Division A “Fundamental Astronomy” – Also current representative of the IAU to the CCU; *The input to the questionnaire comes from these two IAU scientific bodies, which are the most involved in matters concerned with units, fundamental constants, time, and timescales*
- ICRU:** David Burns, BIPM staff, Commissioner of the ICRU
- IEC:** Pierre Sebellin, Director of Standardization
- IFCC:** Prof. Philippe Gillery, Scientific Division Chair
- ISO/TC12 (Quantities and Units):** Sven Radhe, Committee Manager ISO/TC12 (also 6 individual answers from members)
- ISO/TC334 (Reference materials):** Veronica Malapane, Committee Manager ISO/TC334 (also 14 individual answers from members)
- IUPAC:** Prof. Dr. Roberto Marquardt, Secretary of Commission I.1, Representative of IUPAC to CCU|

# Who replied to the questionnaire – 5 schools, 12 universities, 3 NMIs, 1 Ministry

**Elementary School Stampar Makarije (Montenegro):** Srdjan Jovanovic, Physics teacher

**Gymnasium Cetinje (Montenegro):** Katarina Boreicic, Professor of chemistry

**Primary school “Boško Strugar” (Serbia):** Razije Nikočević, Teacher

**Primary school “Dusan Bojovic” (Serbia):** Svetlana Bijelovic, Chemistry teacher

**Primary school “Dusan Bojovic” (Serbia):** Milena Zivkovic, Physics teacher

**Imam Abdulrahman Bin Faisal University (Saudi Arabia):** Ridha Hamdi, Assistant Professor

**King Abdelaziz University (Saudi Arabia):** Soliman Abdalla, Professor of Physics

**King Fahd University of Petroleum and Minerals (Saudi Arabia):** Mutaz M. Hamdan, Post-doctoral fellow

**King Saud University (Saudi Arabia):** Abdulaziz Nasser AlHazaa, Associate Professor

**King Saud University, Physics&Astronomy:** Nasser S. Alzayed, faculty member and researcher

**Russian Technological University MIREA:** Michael Prilepko, Senior Lecturer

**The Open University (UK):** Jimena Gorfikiel, Head of Physics research Discipline and Scholarship Lead

**United Arab Emirates University UAEU:** Naser Qamhieh, faculty member

**University of Cape Town (UCT):** Andy Buffler, Professor and Head of Department; Director of the Metrological and Applied Sciences University Research Unit (MeASURE)

**University of Ha'il (Saudi Arabia):** Mohamed Aichouni

**University of Strathclyde (UK),** Ashleigh Fletcher, Professor

**University of Surrey (UK),** Prof. Justin I. Read, Head of Physics

**Belgim:** Valery Hurevich, Director

**NMIJ:** Dr. Saito Norio, Manager of NMIJ International Cooperation Office, (Please note that these answers were made not by teaching organizations but by an NMIJ staff in charge of SI promotion who had exchanged views with an educator.)

**PTB:** Dr. Jens Simon, Head of Press and Information Office

**Ministry of Education (Singapore):** Dr Darren Wong, Assistant Director, Master Specialist/Physics

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In the following I present summaries of the replies for some selected questions.

For full details, please consult the CCU working documents

CCU-21-06\_a: Replies from NMIs (28 pages)

CCU-21-06\_b: Replies from liaison organizations (5 pages)

CCU-21-06\_c: Replies from teaching organizations (11 pages)

**Q1: Did you experience any difficulties in implementing the revised SI ? If yes, please describe.**

None of the NMIs reported difficulties in implementing the revised SI, if the realization of the units is excluded. The redefinition has no significant effect on dissemination, except for the change in value of the Josephson and the von Klitzing constant.

**Q3: Did you use this event to promote metrology and the SI in your country? If yes, how?**

All NMIs, except one, reported the organization of promotional events: presentations at conferences and in Universities, on the radio and the TV, publications and press articles, use of social media, posters for Universities and schools, exhibitions, open days, workshops and theme days. Several institutes made special efforts to reach out to school children. One institute, INM-Co, used the occasion to argue for a transition of volume measurement (in gas stations) from gallon to liter, which however has not yet been achieved.

### **Q4: Did you find all the information required to implement the revised SI? Has the information campaign organized by the BIPM and the CIPM been effective?**

In general, sufficient information was available and the communication campaign was very effective. Several NMIs cited as useful information sources the BIPM web site and the Brand Book. One comment was that all scientific details were published in scientific articles, but they needed to be explained by senior metrologists to less experienced colleagues.

### **Q5: Were any of your customers affected by the changes? If yes, how did you inform them and how did they react?**

There was no significant impact on the calibration customers of the NMIs. In many cases the calibration uncertainties of the NMIs were not affected by the redefinition. In some cases, the uncertainty of mass calibrations increased but this did not have a practical impact on the customer. Customers with electrical standards were informed about the step changes of the volt and the ohm.



### **Q9: Do you see new possibilities for innovative approaches and technologies to be implemented based on the revised SI? If yes, what are those?**

- Direct realization of small masses
- Table-top Kibble balances for customers, eliminating the need for NMI calibrations
- SI realizations fit for purpose directly on the factory floor
- More stable mass standards based on ultra-pure and ultra-round  $^{28}\text{Si}$ -spheres
- Quantum current standard based on SET or JVS & QHR
- Atomic clock on a chip
- Quantum based measurement for gravimetry
- Spectroscopy of vibrational/rotational lines for temperature, for determination of rel.humidity
- Real-time optical radiation measurements
- SET sensor for particle counting in aerosols
- Single molecule counting for ultra-low amount of substance
- Measurements over the internet

### **Q1: Was the work of your organization impacted by the revision, and if yes, in which way?**

Only IEC, IUPAC and some of the member bodies of ISO/TC12 (Quantities and Units) and TC334 (Reference Materials) were impacted by the revision. There was no impact on IAU, ICRU and IFCC.

### **Q2: Did you find all the information required to implement the revised SI? Has the information campaign organized by the BIPM and the CIPM been effective?**

In general, the liaison organizations and their members found the necessary information. Some of the members of ISO/TC334 (Reference Materials) felt not well informed (SA Australia, SCC Canada) or were not aware of the implementation (SABS South Africa). Those who replied for TC334 were less well informed than those who replied for TC12.

### **Q4: Do you consider that your organization was sufficiently consulted in the process towards the revision?**

The majority feels sufficiently consulted. One member body of ISO/TC334 does not feel sufficiently consulted (SCC Canada). One liaison organization found the process not fully transparent (IEC).

### **Q5: Did you receive any questions or comments from your member organizations?**

Questions were received by some liaison organizations (IAU, ISO TC/12, ISO/TC334, IUPAC), but not by all of them (ICRU, IFCC, IEC). In the case of IAU the discussion was about the impact of the redefinition on the accuracy of astronomical observations.

## Questionnaire for teaching organizations- 1

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### **Q1: Did the revision of the SI have any impact on your curriculum?**

Of the five primary/elementary schools which replied, only one reports a slight impact on the curriculum. The Universities present a varied picture: whereas some have not incorporated the revised SI, others have done so. In some cases this is due to a close relationship with an NMI, which provided the information. In Japan, the revised SI was even touched upon in the Common Test for University Admission.

### **Q2: Has the information campaign organized nationally by your NMI and internationally by the BIPM and the CIPM been effective?**

Most of the institutions have been well informed. Several replies underline the importance of links between the national NMI and educational institutions to spread the information. Lecturers from two Universities in Saudi Arabia and two in the UK had not heard about the redefinition.

## Questionnaire for teaching organizations- 2

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### **Q3: Did you experience any difficulties in teaching the principles of the revised SI?**

In general, those Universities which included the revised SI in their curriculum had no great difficulties with teaching it. However, the difficulty of explaining the new definition of the kilogram was mentioned several times.

### **Q4: Would you need other, more or better teaching material? If yes, what should be provided?**

Several replies mentioned the need for additional pedagogical material:

- Videos about the new SI and the effects of the redefinition
- Video in Russian
- Material which is understandable for students with visual illustrations
- Teaching tutorials for teachers, specifically on the SI
- Updated school books
- Hands-on activities for students

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