

**PROTOCOL OF AN APMP SUPPLEMENTARY COMPARISON ON LARGE AREA SOURCES SURFACE
EMISSION RATE MEASUREMENTS
Version June 2021**

According to the technical requirements in ISO standard 8769, standard large area sources of different nuclides are used to calibrate the response of surface contamination monitors.

Until now, there are only two comparisons carried out at the international level of the primary or secondary standards for measurement of large area reference sources. The first comparison took place around the year of 2000, which was piloted by the National Metrology Institute of Japan (NMIJ) in the framework of APMP, therein only a ^{136}Cs source with an active area of $100\text{ mm} \times 100\text{ mm}$ was circulated among seven participants. Another more recent comparison was organized in 2011, identified as a CCRI(II)-S10 supplementary comparison. More National Metrology Institutes (NMIs) were involved, and different nuclides consisting of a low energy beta emitter ^{14}C , two higher energy beta emitters ^{147}Pm and $^{90}\text{Sr}/^{90}\text{Y}$, and an alpha emitter ^{241}Am were used for emission rate measurements in this comparison.

For those NMIs or Designated Institutes (DIs) who missed the above comparisons or have improved their facilities, a new comparison is still needed for the demonstration of equivalence at the international level. Therefore, a comparison with regards to the measurement of the emission rate of alpha/beta particles in 2π Sr solid angle of large area sources was proposed at the APMP meeting in November 2017.

Participants: This proposed comparison will be identified as an APMP supplementary comparison. Primary metrology institutes and other interested laboratories are also welcomed to be involved in this comparison. To be included in the KCDB the participants must be National Metrology Institutes, CIPM MRA designated Institutes for activity measurement. So far, the NMIs or Dis who have expressed an interest in this comparison are listed below,

NMI (DI)	Contact person	Email
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Measurand: the measurand of this comparison will be the emission rate of alpha/beta particles in 2π Sr solid angle. Measurements of the nuclide activity and its uniformity will be welcomed but will not be required. According to the ISO standard 8769, the energy threshold of 0.590keV will be set for beta particles measurement using a point ^{55}Fe source.

Measurement methods and equipment: Absolute or relative measurements will be made using windowless or windowed large area multi-wire proportional counters.

Sources: The sources will be used in this comparison are provided by NIM China, who purchased the sources in 2016 from Eckert & Ziegler. Nuclides include a low energy beta emitter C-14, an intermediate energy beta emitter Cl-36, a higher energy beta emitter Sr-90/Y-90 and an alpha emitter Am-241. Following the recommended characteristics of reference source described in ISO 8769, the sources are incorporated into the surface of an anodized Al foil, with an active area of 100 mm×150 mm, and the surface emission rate will be between 2k and 4k per second in 2π steradian per source, in order to optimize between background, statistical and dead-time errors. Each source will be packed separately in a polyethylene box with sponge inside, and together placed in a container with a size of 250mm × 200mm × 200mm and weight less than 2kg.

Source shipment: The same sources will be measured by all participants. These sources will be collated and measured by NIM China first, then they will be shipped to the second laboratory and so on up to the last participant. Each participant will be responsible for arranging shipment to receive the sources and send to the next participant, and costs in the process. Each participant will have one month including measurement and transportation arrangement to the next laboratory. After the questionnaire has been distributed and the final list of participants confirmed, a source circulation scheme will be made. When NIM China receives back the sources from the last participant, it will measure them again for integrity check.

Source check: The sources will be sent among the participants in circle shape distribution, but the sources may be sent back to the pilot laboratory for integrity check after three or four times transportation. The frequency depends on the final number of the participants. After one participant receives sources, it should unpack each package of sources and inspect the sources for any damage incurred in the transit. Participant should contact NIM (China) and the participant where the sources are from after source check. If any damage is observed, an assessment will made to determine whether the corresponding source is good enough to support following transportations and measurements.

Comparison report: NIM China will be responsible for the preparation of a report on this comparison. After NIM receives sources back from the last participant and completes results, it will send reporting form with NIM's results to the BIPM, then it is open to receive the results. The reporting form will be prepared by NIM, in which method of standardization, associated uncertainties, and any additional requested information will be included, and distributed to the participants during the comparison. All results of participants should be sent to the BIPM before the deadline. A result from a participant is not considered complete without an associated uncertainty, and is not included in the draft report unless it is accompanied by an uncertainty supported by a complete budget. Evaluation of the principal components of the uncertainty budget can refer to the Guide to the Expression of Uncertainty in Measurement.

After BIPM has collected all results from participants, NIM will analyze the equivalence and draft a comparison report. If, on examination of the complete set of results, NIM finds results that appear to be anomalous, the corresponding institutes are invited to check their results for numerical errors but without being informed as to the magnitude or sign of the apparent anomaly. If no numerical error is found the result stands and the complete set of results is sent to

all participants.

The first draft, draft A, is prepared as soon as all the results have been received from and, if necessary, confirmed by participants. At this stage the results are confidential to the participants. Any typographical errors, transcription errors or corrections for different units can be corrected, but individual values and uncertainties may not be changed or removed, or the complete comparison abandoned, unless with the agreement of all participants and on the basis of a clear failure of the comparison artifact or some other phenomenon that renders the comparison or part of it invalid, since all participants have been informed of the results.

Once the Draft A report has been agreed by participants, NIM will send the report to the APMP TC-IR for approval. NIM will then send the approved report to the CCRI Executive Secretary, at which point it becomes a Draft B report. The CCRI Executive Secretary will circulate the Draft B report to CCRI Section II and KCWG(II) for review for a period of at least 6 weeks. Any comments will be sent to the NIM to correct the document as appropriate (if any objections are received to the document, it may be necessary to re-circulate the revised Draft B for further review). The NIM will send the final version of the document to CCRI Section II Chair and the APMP TC-IR Chair for approval. Once the CCRI Executive Secretary has received the approvals by email, the CCRI Executive Secretary will arrange publication on the KCDB.

Pilot laboratory: *The pilot laboratory will be NIM China. The results in this comparison will be linked to the CCRI(II)-S10 comparison for equivalence, through laboratories who are also involved in that comparison.*

Schedule:

1) *This protocol will be submitted to CCRI(II) KCWG and APMP for review. After that, the protocol together with a questionnaire will be circulated to call for interest around December 2019.*

Due to COVID, this comparison has been postponed. The dates mentioned in following schedule are planned with expectation that the comparison could be restarted in early 2022.

2) *After confirmation of participants, the final version protocol will be formed including a source circulation scheme, and send to participants for agreement and call of shipping information. This is expected to be finished before March 2022.*

3) *Source circulation scheme sent to participants for agreement in May 2022.*

4) *NIM China will start measurement in July 2022, then send sources to the next participant.*

5) *Each participant will have one month at most for measurement and source transportation arrangement, and the sources are expected to be sent back to NIM China before December 2023.*

6) *Source check will be done in March 2024 and NIM result will be sent to BIPM in August 2024, then reporting form reception is open, with a dead line of December 2024.*

7) *Results will be analyzed starting in January 2025, and a Draft A report will come available in the mid of 2025.*

References:

ISO, "Reference sources – Calibration of surface contamination monitors - Alpha-, beta- and photon emitters", ISO Standard 8769, II Edition, 2010.

Coordinating laboratory:

The NIM China will serve as a pilot laboratory.

Contact person will be Dr. Ming Zhang.

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