

## **CALIBRATION AND MEASUREMENT CAPABILITY MONITORING PROCESS UNDER APMP ACTIVITIES**

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**Abstract** – With reference to CIPM-MRA (Mutual recognition of national measurement standards and of calibration and measurement certificates issued by national metrology institutes), APMP (Asia Pacific Metrology Programme) have established 11 TCs (Technical Committees) including TCM (Technical Committee of Mass related quantities) which discusses hardness related issues in APMP. Under the TC activities, the guidelines and procedures for accepting CMCs (Calibration and Measurement Capabilities) and QS (Quality System) have been drawn up by taking closer cooperation with the JCRB (Joint Committee of the RMOs and the BIPM). Therefore, the concept of the procedures and guidelines are effectively introduced in the course of intra-regional and inter-regional reviews for submitted CMCs within APMP and from other RMOs (Regional Metrology Organizations), respectively.

**Keywords** MRA, CMC, Metre Convention, inter-comparison, quality system

### **1. INTRODUCTION**

At a meeting held in Paris on 14 October 1999, the directors of the national metrology institutes (NMIs) of thirty-eight Member States of the Metre Convention and representatives of two international organizations signed a Mutual Recognition Arrangement (CIPM MRA) for national measurement standards and for calibration and measurement certificates issued by NMIs. A number of other institutes have signed since then.

This Mutual Recognition Arrangement (MRA) is a response to a growing need for an open, transparent and comprehensive scheme to give users reliable quantitative information on the comparability of national metrology services and to provide the technical basis for wider agreements negotiated for international trade, commerce and regulatory affairs. The CIPM MRA has now been signed by the representatives of 67 institutes – from 45 Member States, 20 Associates of the CGPM, and 2 international organizations – and covers a further 117 institutes designated by the signatory bodies as of June 2007.

The main objectives of the MRA [1] are

- to establish the degree of equivalence of national measurement standards maintained by NMIs;
- to provide for the mutual recognition of calibration and measurement certificates issued by NMIs;

· thereby to provide governments and other parties with a secure technical foundation for wider agreements related to international trade, commerce and regulatory affairs.

The outcome of the MRA is that the statements of the measurement capabilities of each NMI in a database maintained by the BIPM and publicly available on the Website. [2]

NMI directors sign the MRA are engaged to accept the process specified in the MRA for establishing the database, to recognize the results of international comparisons as stated in the database, and to recognize the CMCs of other participating NMIs as stated in the database.

The confidence of CMCs are confirmed through the result of international comparisons and demonstration of quality systems.

The MRA states that JCRB is charged on the operation of the MRA. Thus, to materialize the MRA, RMO activities are very important.

To date, there are 5 major RMOs, APMP (Asia-Pacific region), COOMET (Euro-Asian region), EUROMET (European region), SADC MET (Southern African region) and SIM (Inter-American region). Each RMO has different needs, situations (by means of technical, economical, social, geographical), and partners (e.g. accreditation body, private calibration/testing lab.). Thus each RMO has to demonstrate regional demands and requirements for participating MRA and has to harmonize those demands and requirements with other RMOs.

In this report, we describe the organization of APMP. We mention the regional characteristics compare to other RMOs. Then we describe technical guidelines, procedures to conduct regional comparisons and CMC review. As conclusions, we describe future subjects.

### **2. ORGANIZATION of APMP**

The Asia Pacific Metrology Programme (APMP) is primarily responsible for developing international recognition of the measurement capabilities of the region's national and territorial measurement laboratories. APMP has been operating in the Asia-Pacific since its inception as a Commonwealth Science Council initiative in 1977. As such, it is the oldest continually operating metrological grouping in the world. The Programme grew out of a need by participating members to develop their metrological capability. It was based on a true collaborative spirit of

mutual assistance and sharing of expertise and information, and this remains one of the major strengths of APMP to this day. The APMP membership has a diverse range of skills and capabilities and these are being developed to support the needs of individual economies. Activities are coordinated by a Chairperson who is elected for a two-year term of office and who is assisted by a Secretariat operating from the member laboratory of the Chairperson.

In its early years, the emphasis of the Programme was on training and calibration assistance aimed at raising the level of metrology and expertise in primary standards laboratories within the region. This was achieved on a collaborative basis, usually working bilaterally between members. More recently, the metrological requirements within the region have changed significantly. Rapid technological development and industrial growth within the region have placed increased demands on metrological services, and there is growing recognition of the importance of metrology to international trade through conformance testing and quality systems. In support of these developments the emphasis in APMP has shifted towards gaining international recognition and credibility for its members. To achieve this, APMP members are seeking to gain international recognition for traceability of their measurement standards in order to underpin their peak measurement systems.

With those regards, APMP established eleven Technical Committees (TCs) in 1998. The eleven TCs are;

TCAUV: Acoustics, Ultrasound and Vibration

TCEM: Electricity and Magnetism

TCFF: Fluid and Flow

TCL: Length

TCM: Mass and Related Quantities including Hardness

TCPR: Photometry and Radiometry

TCQM: Amount of Substance

TCIR: Ionizing Radiation

TCT: Temperature

TCTF: Time and Frequency

TCQS: Quality Systems

TC Chairman is elected from TC members of the member NMIs. Each TC has close relationship with relevant bodies such as other RMOs, BIPM, and APLAC. Table 1 shows their relationships.

TABLE 1. Relationship of each TC and relevant bodies

APMP-TC	Other RMOs	CIPM	Others
TCAUV	Relevant TC	CCAUV	
TCEM	Relevant TC	CCEM	
TCFF	Relevant TC	CCM	
TCL	Relevant TC	CCL	
TCM	Relevant TC	CCM	
TCPR	Relevant TC	CCPR	
TCQM	Relevant TC	CCQM	
TCIR	Relevant TC	CCIR	
TCT	Relevant TC	CCT	
TCTF	Relevant TC	CCTF	
TCQS	Relevant TC,		APLAC, ILAC

Figure 1 shows organization structure. The Chairperson, head of APMP, and the Executive Committee members, managing body of APMP, are elected from Director of member NMIs. General Assembly meets to review and discuss the aims and specific tasks of APMP. It is held once a year. Developing Economies' Committees tasked to help address the needs from developing economies. The Secretariat assists the Chairperson and the Executive Committees in the administration of APMP.

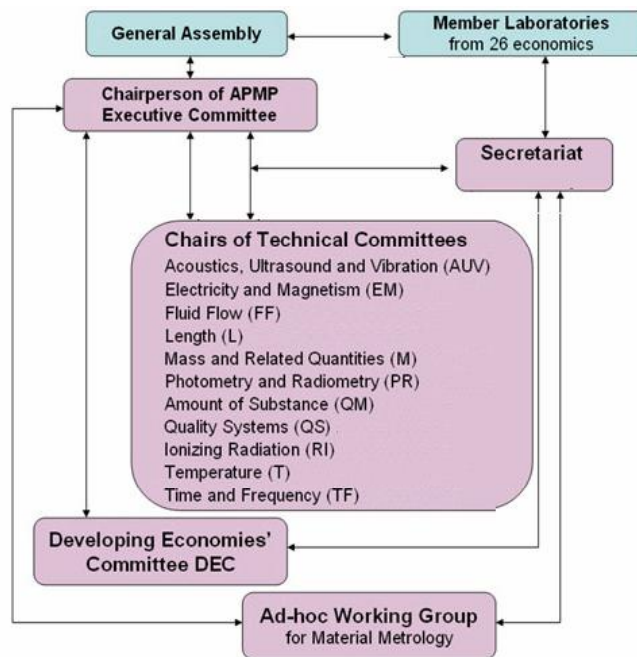


Fig. 1 APMP organization structure

One of the authors, Hidetaka IMAI served Chairperson from 2000 to 2004. One of other authors, Takashi USUDA served Executive Secretary from 2002 to 2005.

### 3. THE FACT OF APMP

By means of historical, social, economical and geographical reasons, APMP has some unique subjects and resources compare to other RMOs.

Subjects:

- Huge member area from continental to pacific rims, more than 50 % of global population, see Figure 2.
- Economical gap in member economies; per capital GDP from US\$1 k to US\$30 k
- Some developed NMIs and a large number of under developing NMIs

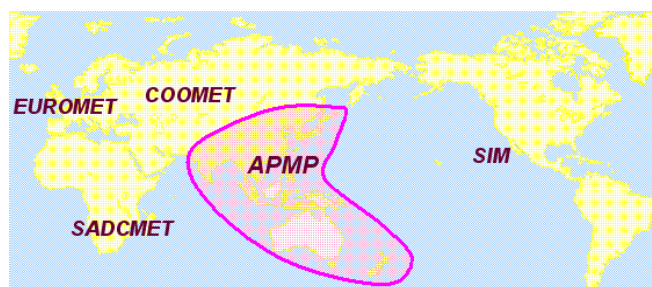


Fig. 2 APMP member area and other RMOs'

Resources:

- Close relation between NMI and NAB (National Accreditation Body)
- Thus close relation between APMP and other Special Regional Bodies such as APLAC (Asia Pacific Laboratory Accreditation Corporation)
- Active investment in NMI by the government (especially in developing economies)
- Potential for economical growth

Especially, the close relationship between NMI and NAB has effectively performed to disseminate national metrology standard to end users through private calibration/testing laboratories accredited by NAB. For example, NATA (National Association of Testing Authorities) in Australia has performed as NAB for 60 years. Now its accredited laboratories are more than thousands.

Accreditation provides a means of determining, recognising and promoting the competence of facilities to perform specific types of testing, measurement, inspection and calibration. Accreditation benefits testing and inspection facilities by allowing them to determine whether they are performing their work correctly and to appropriate standards, and provides them with a benchmark for maintaining that competence. Accreditation benefits also includes whether their measurement results are traceable to the National Metrology Standards explicitly.

The combination of NMI and NAB has ensured national measurement traceability to the end users as shown in Figure 3.

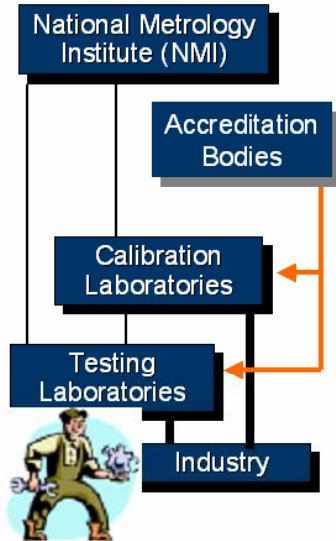


Fig. 3 National metrological traceability system

If we employ this traceability scheme to internationally, we can establish international traceability system, while the equivalency of national metrology standards of each NMI is ensured by the CIPM-MRA. Figure 4 shows such international traceability system. With this regard, accreditation schemes (procedures, check points, reassessment period, etc.) should be also determined by relevant bodies such as ILAC (International Laboratory Accreditation Corporation), APLAC. Today, they employ

ISO/IEC 17025 (General requirements for the competence of testing and calibration laboratories) or ISO Guide 34 (for reference materials) as a guideline for the accreditations.

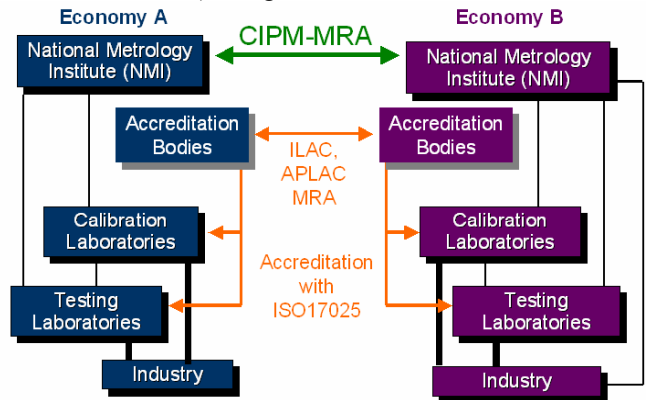


Fig. 4 International traceability system employing CIPM-MRA and accreditation

Table 2 shows major NAB of APMP region. They have close relationship with relevant NMI.

Table 2 Some NABs and relevant NMIs in APMP

Country	NAB	NMI
Australia	NATA	NMIA
New Zealand	IANZ	MSL,IR
Japan	NITE	NMIJ
Korea	KOLAS	KRISS

#### 4. MATERIALIZATION OF CIPM-MRA IN APMP

##### 4.1. General Scheme

The CIPM-MRA requests NMIs to demonstrate their calibration capability by international comparisons. It also requests NMIs to establish quality management system to ensure the necessary mutual confidence. NMIs can choose the way to demonstrate their quality management system with assessment by third accreditation body or assessment without accreditation body. (In any way, on site visit by an NMI and/or by peers selected by the local RMO is mandatory.)

With reference to the closer corporation between NMI and NAB in APMP, it is quite natural for us to employ third party accreditation to demonstrate ones quality management system. Figure 5 shows a hierarchy of national metrology standard and dissemination scheme in APMP. As we can see, a similar analogy to accredit private laboratory can be employed to demonstrate the requirements for the CIPM-MRA. With this scheme, NMI society can employ resources of NAB society to materialize the CIPM-MRA. This is also appropriate system for APMP because NMIs in APMP are widely spread geographically, and thus it is difficult to review NMIs.

Here, eligibility and impartiality of the reviewers in NMI accreditation process should be agreed in the region. APMP has established the guide lines to choose reviewers in NMI accreditation process as follows:[3]

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- Technical peers and quality system experts must be independent of the NMI being assessed/reviewed.
- Technical peers (assessors/ reviewers) must be acceptable to the relevant TC. It is recommended that this acceptance be obtained in advance.
  - Assessors/reviewers may be considered acceptable, if
    1. they have relevant technical competence,
    2. have had some formal training in laboratory assessments, and
    3. have laboratory assessment experience.

If, during the review, the technical assessors/peer reviewers work with or under the guidance of quality system experts, it may not be necessary to insist on 2 and 3 above.

- It is required that technical assessors/peer reviewers be selected from NMIs with capabilities similar to or higher than the NMI being assessed/reviewed.

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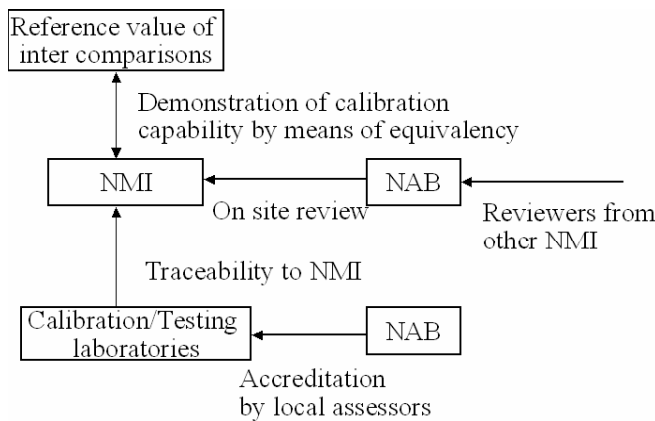


Fig. 5 Hierarchy of national metrology standard and dissemination scheme in APMP

**4.2. Guidelines for acceptance of CMC for publication**

There are a lot of developing NMIs in APMP. They have had few chances to participate the past international comparisons. Not only the developing NMIs, but also all member NMIs in APMP, may have some difficulties to participate the present and the future international comparisons because of geographical reasons. Thus, APMP established guide lines for acceptance of CMC for publication as follows[4]:

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The APMP requires that CMCs submitted for publication in Appendix C are supported by a fully implemented Quality System in accordance with APMP GUIDELINES FOR ACCEPTING A QUALITY SYSTEM (APMP-QS2).

The CMCs must be accompanied with the relative QS information.

All CMCs shall be supported by some comparison results\*1\*2. The range and uncertainty of the CMCs submitted may additionally be supported with information from some or all of the following sources:

1. Knowledge of technical activities by other NMIs, including publications

2. Active participation in RMO projects
3. Other available knowledge and experience

\*1 Guidelines of requested comparison for the range and uncertainty of the CMCs submitted should be provided by CC Working Group. If such guidelines are not fixed, decision is at the relevant TC.

\*2 NMIs that do not hold primary standards are required to have traceability of their national standards established through the BIPM or through NMI calibration services published in Appendix C of the CIPM MRA.

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**4.3. Procedures**

JCRB established CMC review procedures. The process consists of two steps, intra-regional review and inter-regional review. NMI should submit CMCs to local RMO. Then the local RMO review their acceptability (inter-regional review) of degree of equivalence and quality management systems. After the inter-regional review, the CMCs will be passed other RMOs for further review. Figure 6 shows the flow.

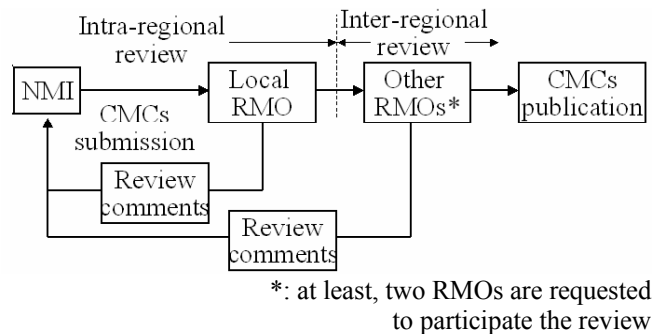


Fig. 6 CMC review general flow

Each RMO can employ its guidelines and procedures for its inter regional review, as far as the guidelines and the procedures meet the requirement addressed in the CIPM-MRA. As described in previous section, APMP intra-regional review is tighten with the review process by NAB.

Figure 7 shows APMP review process for CMCs publication.

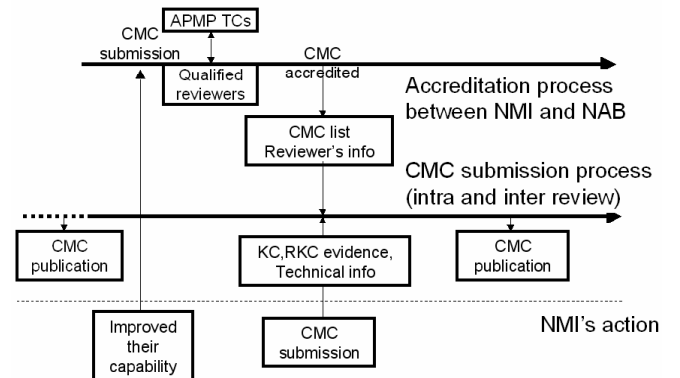


Fig. 7 APMP review process for CMCs publication

APMP also established annual review process for the confirmation of quality management system status[].

Figure 8 shows EUROMET review process for CMCs publication. As we can see, RMO plays much roles in EUROMET review process compare to APMP's.

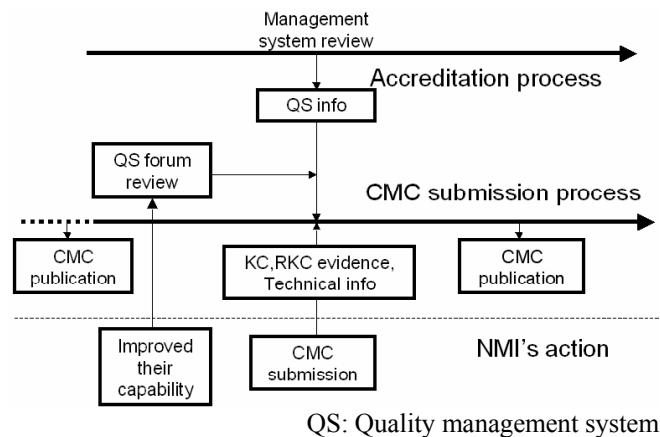


Fig. 8 EUROMET review process for CMCs publication

## 5. OUTCOMES AND FUTURE SUBJECTS

### 5.1. CMC publication

Among the full member states/economies in APMP, there are 14 signatories of the CIPM-MRA. To date (July 2007), 12 signatories in APMP published their CMCs. As for the hardness metrology, 6 member NMIs have published their CMCs. Table 3 shows the name of NMI and category of the measurement.

Table 3 CMC publication in hardness quantities

Economy	NMI	Category
China	NIM	Rockwell Vickers
Chinese Taipei	CMS	Rockwell
Hong Kong, China	SCL	Rockwell Vickers
Japan	NMIJ	Rockwell
Korea, Republic of	KRISS	Rockwell Vickers Brinell
Singapore	SPRING	Rockwell

The guidelines and processes established by APMP under the CIPM-MRA works well for CMC publication. Each TC has closer commitment to the review process. Technical capability of calibration is quite technical issue and the relevant TC member (i.e. a researcher in the same field who is belonging to other NMI) will adequately review the submitted CMCs. Criteria for CMC review in each technical field shall be also discussed among relevant RMOs' TC so that the equivalency of metrology standard shall be adequately examined. We see that the quality management system is another key issue to ensure sustainable calibration capability. The quality management system is assessed by NAB as a part of third party

accreditation. The combination of technical assessment by relevant TC and management system assessment by NAB performs well to materialize the CIPM-MRA in APMP.

### 5.2. Future subjects

CMCs publication pace is expected to be faster, as a lot of developing NMIs in APMP are expected to publish their CMCs. However, the resources for CMCs publication process are limited. For example, the number of international comparison is limited considering the cost and the time. Especially, developing economies NMI has less chance to participate international comparisons. Thus appropriate arrangement of international comparisons and support for developing NMIs are important.

On the other hand, equivalency of some engineering metrology standards can be examined by the results of other quantities international comparisons. In fact, many NMIs submitted Rockwell A, B, scale CMCs, while only Rockwell C scale key comparison has been performed. Thus we have to discuss "how far the light (present comparison result) shines (guarantees other relevant quantities)" among the relevant TC of each RMO.

The monitoring process of the present CMCs is also important. Up to year 2004, CIPM defines it "transition period" of the CIPM-MRA which started in 1999. During this transition period, a lot of technical issues are harmonized among RMOs. However, there are another subject to harmonize monitoring process of the present CMCs, e.g. reassessment period of quality management system. Actually, each NAB may specify different reassessment period while JCRB decided quality management system of each NMI should be examined at least every five year.

Those subjects shall be harmonized among the RMOs and other special bodies such as ILAC and APLAC.

## 6. CONCLUSIONS

The concept of the procedures and guidelines are effectively introduced in the course of intra-regional and inter-regional reviews for submitted CMCs within APMP and from other RMOs. Future subjects such as demands from developing NMIs, harmonization of monitoring process of present CMCs are expected to decide by closer corporation of RMOs and special bodies.

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