



# MEASUREMENT AUDITS

## **PURPOSE**

This document sets out the requirements for APLAC Measurement Audits, stipulates the responsibilities for their organisation and gives guidance on their planning, preparation, execution and preparation of reports.

## **AUTHORSHIP**

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## **FURTHER INFORMATION**

For further information about this publication, contact the APLAC Secretariat, who may be contacted at:

NATA  
71-73 Flemington Road  
North Melbourne VIC 3051  
Australia  
Tel: +61 3 9329 1633  
Fax: +61 3 9326 5148  
Email: [aplac@nata.asn.au](mailto:aplac@nata.asn.au)  
Website: [www.aplac.org](http://www.aplac.org)

**TABLE OF CONTENTS**

<b>PURPOSE</b>	<b>2</b>
<b>AUTHORSHIP</b>	<b>2</b>
<b>COPYRIGHT</b>	<b>2</b>
<b>FURTHER INFORMATION</b>	<b>2</b>
<b>1. INTRODUCTION</b>	<b>4</b>
<b>2. ROLE OF THE APLAC PROFICIENCY TESTING COMMITTEE</b>	<b>4</b>
<b>3. ROLE OF THE ORGANISING BODY</b>	<b>5</b>
3.1 Tasks	5
3.2 Selecting the artefacts	6
3.3 Calibration of the artefacts	6
3.4 Request to participate	6
3.5 Artefact distribution	6
3.6 Instructions	7
3.7 Packaging and transport	7
3.8 Measurement Audit Reports	7
3.9 $E_n$ ratio	8
<b>4. ROLE OF THE PARTICIPATING ACCREDITATION BODIES</b>	<b>8</b>
4.1 Tasks	8
4.2 Participating laboratories	9
4.3 Confidentiality	9
4.4 Transport	9
4.5 Corrective action	9
<b>5. REFERENCES</b>	<b>10</b>
Appendix A Declaration to customs officials and shipping agents	11
Appendix B Request to participate	12
Appendix C Instructions to accreditation bodies	13
Appendix D Instructions to laboratories	14
Appendix E Receipt form	15
Appendix F Dispatch form	16
Appendix G Flowchart for participating accreditation bodies	17
Appendix H Measurement Audit Report	18
Appendix I Corrective action flowchart	19

## 1. INTRODUCTION

The purpose of the Asia Pacific Laboratory Accreditation Cooperation (APLAC) is to build up and maintain mutual confidence between national calibration and testing services in order to reach and maintain a state of mutual agreement on the equivalence of the operation of the accreditation bodies and of the certificates issued by their accredited laboratories. This supports the removal of technical barriers to trade.

Calibration activities underpin all testing and measurement activities. APLAC Measurement Audits provide a forum for the comparability and traceability of measurements in the Asia-Pacific region and they are mandatory for APLAC members<sup>(1)</sup>. They also provide confidence in the accreditation process of the APLAC members and also in their ability to take the appropriate corrective actions where the measurement audit reveals measurement deficiencies.

APLAC Measurement Audits also result in a flow of know-how between the participating accreditation bodies and help establish a common high level of measuring capability within the region.

This document provides guidance for the organisation and conduct of APLAC calibration Measurement Audits (proficiency testing activity) and lays down the responsibilities for their organisation. It has been prepared by the APLAC Proficiency Testing Committee. Equivalent documents have been prepared for the conduct of APLAC calibration interlaboratory comparisons<sup>(2)</sup> and APLAC testing interlaboratory comparisons<sup>(3)</sup>.

APLAC defines a Measurement Audit as:-

*A well characterised and calibrated artefact usually sent to only one laboratory where their results are compared to a reference value which is normally supplied by a National Measurement Institute.*

Note that procedures are similar to a normal interlaboratory comparison except that a simplified report is generated. This activity provides the obvious benefit of a more timely response to both the laboratory and their accreditation body.

## 2. ROLE OF THE APLAC PROFICIENCY TESTING COMMITTEE

Overall responsibility for Measurement Audits lies with the APLAC Proficiency Testing Committee who:-

- maintain a listing and description of available artefacts and associated accreditation bodies responsible for such artefacts;
- provide the Measurement Audit listing to APLAC members;
- approve the conduct and review operation of each Measurement Audit;
- review the Measurement Audit Report prior to publication;
- maintain a record of conducted Measurement Audits;
- review any problems which may have arisen in the Measurement Audits;
- identify technical development and training needs and follow-up action;

- liaise with their proficiency testing counterparts in the European cooperation for Accreditation (EA) and other regional bodies.

APLAC members are encouraged to take the initiative for making available suitable artefacts to be listed and organisation of the Measurement Audits. The APLAC Proficiency Testing Committee shall consider at least the following information for the approval and review of each Measurement Audit:-

- the physical quantities to be measured;
- the artefacts to be circulated (type, accuracy, resolution, stability, owner, etc);
- the prescribed measurement points;
- measurement procedure (normal laboratory procedure or prescribed procedure);
- transportation method.

The Committee has the final responsibility for the decision on which Measurement Audits will be organised taking into account activities that will be of most benefit to the majority of APLAC members. The Committee has no financial responsibility for costs associated with the Measurement Audits.

### **3. ROLE OF THE ORGANISING BODY**

#### **3.1 Tasks**

The accreditation body that has agreed to organise the Measurement Audits has the following tasks:-

- provide an updated listing and description of artefacts available to the APLAC Proficiency Testing Committee (artefacts listed are not required to have current calibration);
- providing appropriate artefact containers for transportation;
- appointing a convenor who coordinates all correspondence;
- appointing a technical adviser;
- drafting the preliminary instructions and editing the final instructions;
- act on the requests for participation from accreditation bodies and to timetable participation of each laboratory;
- selection of the preferred method of transportation;
- minimising problems concerning transportation e.g. by supplying a declaration to Customs authorities (refer Appendix A);
- having their artefacts calibrated by the reference laboratory to a suitable accuracy and at suitable intervals (calibration may need to be organised upon request);
- having control over the progress of the Measurement Audit;
- collecting the results of the participants and writing the Measurement Audit Report;
- providing the Measurement Audit Report to the participating accreditation body and to the APLAC Proficiency Testing Committee. (alternatively the Measurement Audit report may be produced by the participating accreditation body)

The organising body must comply with the requirements of ISO/IEC Guide 43-1<sup>(4)</sup>.

The costs for the organisation of the Measurement Audit, and transport of the artefacts to the accreditation body are to be covered by the organising accreditation body.

### **3.2 Selecting the artefacts**

The artefacts used in the Measurement Audit shall be stable so that they can be expected to adequately hold their calibration for the period of the activity. If this is not possible, more frequent re-calibrations will be necessary.

The quantities to be measured should avoid all being "exact" values, e.g. precise decade values, which often do not show up errors in the measurements.

The artefacts should be of an accuracy appropriate to the best measurement capability of the participating laboratories (refer Q5 of Appendix B).

It is an advantage if the artefacts have already been used for an interlaboratory comparison or Measurement Audit by the organising accreditation body. In this way a history of the performance and stability of the artefacts is known.

The choice of the artefacts and basic ideas for the procedure to be followed should be such that it will take each participant no more than eight hours to complete the measurements.

### **3.3 Calibration of the artefacts**

An important feature of each measurement audit is that there should be reference values for the requested measurements against which the laboratories' results can be judged. The reference values are provided by a Reference Laboratory which normally will be the National Measurement Institute for the organising accreditation body. It may also be the national standards laboratory of another economy. Where possible, the organising body should ensure that the Reference Laboratory they select can achieve an uncertainty of measurement that is better than the participating accredited laboratories. Information on the best measurement capability of the participating laboratories is available from Q.56 in the *Request to Participate* (Appendix B). They must also ensure that the artefacts are calibrated at intervals suitable to the accuracy required. The reference calibrations of the artefacts is at the participating accreditation bodies expense.

### **3.4 Request to participate**

The organising accreditation body may accept a request to participate in a Measurement Audit from another accreditation body which is based on their listing of available APLAC artefacts.

A full listing of available APLAC artefacts and the accreditation body responsible for such artefacts can be obtained from the APLAC Proficiency Testing Committee.

### **3.5 Artefact distribution**

Upon a request to participate in a Measurement Audit, the organising accreditation body will organise and pay for the costs of transportation of the artefact to the accreditation body. This distribution is based on the following factors:-

- the total distribution should be limited to a maximum of 6 weeks;
- the allocated time per laboratory should be approximately 2 weeks (including transport from the accreditation body to the laboratory within an economy);
- a period of 2 weeks should be included for international transportation.

### **3.6 Instructions**

The organising accreditation body technical adviser shall draft the instructions in English (refer Appendix C and D) and then has them reviewed by the Proficiency Testing Committee. These instructions should contain at least the following information:-

- name and address of the organising accreditation body;
- name of the Reference Laboratory;
- any special recommendations for transportation;
- any special recommendations for the technical handling and set-up of the artefact;
- any necessary technical information on the artefact;
- if necessary special instructions for reporting the results. Pro-forma result sheets may be prepared where necessary to summarise the results in a simple format. In addition, formal calibration certificates may be requested;
- unless otherwise stated, each participant should be instructed to calibrate the artefacts to their best measurement capability (their accredited least uncertainty of measurement) according to their routine (accredited) procedure.

The final instructions are sent to the participating accreditation body with the artefact.

### **3.7 Packaging and transport**

Rugged containers and packaging must be supplied. It is recommended that a metal case be used for housing the artefacts and that this be placed inside a cardboard box for extra protection during transport. APLAC funding will cover the risk of damage or loss of the artefacts.

A reliable international courier with a user accessible tracking system is recommended. Door-to-door delivery (“free domicile”) must be specified. An example *Declaration to Customs Officials and Shipping Agents* appears in Appendix A.

### **3.8 Measurement Audit Reports**

As soon as possible, the organising body shall send a *Measurement Audit Report* (stamped CONFIDENTIAL) for each participating laboratory to their accreditation body. These reports will give an indication of each participating laboratory's performance in terms of their agreement (or otherwise) with the preliminary reference values based on the initial calibration of the artefacts by the Reference Laboratory. An example *Measurement Audit Report* appears in Appendix H.

### 3.9 $E_n$ ratio

A convenient and internationally accepted method of judging the quality of each measurement result is by calculating the error normalised ( $E_n$ ) with respect to the stated uncertainty:-

$$E_n = \frac{LAB - REF}{\sqrt{U_{LAB}^2 + U_{REF}^2}}$$

where  $U_{LAB}$  is the uncertainty reported by the participating laboratory and  $U_{REF}$  is the total uncertainty of the reference value (including any allowance for drift or instability of the artefact). The Reference value uncertainty must be calculated in a manner consistent with the ISO *Guide to the expression of uncertainty in measurement*<sup>(4)</sup>. Both uncertainties are at a 95% confidence level.

Values of  $|E_n| > 1$  require investigation. Where laboratories make a number of similar measurements the method of analysis can be refined by comparing the distribution of the values of  $E_n$  with a normal distribution.

## 4. ROLE OF THE PARTICIPATING ACCREDITATION BODIES

### 4.1 Tasks

The accreditation body is responsible for the following actions (refer Appendix G):-

- initiate a *Request to Participate* (refer Appendix B) and designating the laboratories (maximum of 4) in the economy that will participate in the Measurement Audits;
- upon arrival of the artefacts faxing the standard RECEIPT FORM (refer Appendix E) to the organising accreditation body;
- translating the measurement instructions into the economy's language, if necessary;
- arranging and paying for the costs of the transportation in its own economy and return to the organising accreditation body;
- ensure that the time schedule for its laboratories is kept;
- when dispatching the artefacts faxing the standard DISPATCH FORM (refer Appendix F) to the organising accreditation body;
- sending the artefact back to the organising accreditation body using a **door-to-door courier service (“free domicile”)**. The participating accreditation body must ensure that their shipper is capable of doing this (many only send it to the nearest airport);
- collecting the result sheets and calibration certificates/ reports of the participants (within two weeks), translating into English where necessary and forwarding them to the organising accreditation body along with details of any problems that occurred;
- conducting and documenting any necessary follow-up associated with unsatisfactory performance ( $|E_n| > 1$ ) by their participating laboratories;
- may also provide the Measurement Audit report.

The costs of any import duties or taxes, transport within their economy and return of the artefact to the organising accreditation body is to be covered by each particular participating accreditation body.

#### 4.2 Participating laboratories

The participating laboratories should be accredited by their national accreditation body, or be applying for accreditation, for the particular measurements which are covered by the Measurement Audit. In order that a representative sample of laboratories be compared, the accreditation body should, where possible, avoid selecting the same laboratories that have participated in previous APLAC interlaboratory programs or Measurement Audits.

National standards laboratories participate in the Asia Pacific Metrology Program (APMP) interlaboratory comparisons and therefore should normally not participate in APLAC Measurement Audits.

When the APLAC Proficiency Testing Committee considers it useful and feasible, laboratories outside APLAC may participate in a Measurement Audit, for example, laboratories covered by EA (European cooperation for Accreditation). Application should be made through their national accreditation body. However, existing APLAC members must be given first priority.

#### 4.3 Confidentiality

Participating accreditation bodies are to advise their laboratories that the reference values (in the Measurement Audit Report) are to be kept **strictly confidential**.

#### 4.4 Transport

Participating accreditation bodies should make every effort to determine from the Customs authorities in their economy the most reliable method for expediting Customs clearance. A sample declaration appears in Appendix A. It is the responsibility of the accreditation body to liaise with their Customs authorities when artefacts are held by Customs.

Transport back to the organising accreditation body should be by a reliable international courier with a user accessible tracking system. Door-to-door delivery (“free domicile”) must be specified.

#### 4.5 Corrective action

Corrective action, if required, is the responsibility of the laboratory and their accreditation body and should be undertaken as soon as possible (refer Appendix I). Corrective action may vary from a discussion with the laboratory to withdrawal of the accreditation for the measurements involved. Corrective action may be taken:-

- where outliers or other anomalies have been identified in the the *Measurement Audit Report*.

Where  $|E_n|$  ratios are marginally greater than 1, the accreditation body may decide to seek further technical advice.

5. **REFERENCES**

- (1) APLAC MR001 (2006) *Procedures for establishing and maintaining mutual recognition agreements between laboratory accreditation bodies.*
- (2) APLAC PT001 (2006) *Calibration interlaboratory comparisons.*
- (3) APLAC PT002 (2006) *Testing interlaboratory comparisons.*
- (4) APLAC PT005 (2004) *Artefacts for Measurement Audits*
- (5) ISO/IEC Guide 43-1(1997) *Proficiency testing by interlaboratory comparisons - Part 1: Development and operation of proficiency testing schemes. Part 2: Selection and use of proficiency testing schemes by laboratory accreditation bodies.*
- (6) ISO/IEC 17025 (2005) *General requirements for the competence of testing and calibration laboratories.*
- (7) BIPM/IEC/IFCC/ISO/IUPAC/IUPAP/OIML (1995) *Guide to the expression of uncertainty in measurement.*
- (8) ISO 13528 (2005) *Statistical methods for use in proficiency testing by interlaboratory comparisons.*

Appendix A

*This document must stay with the box*

ASIA PACIFIC ECONOMIC COOPERATION (APEC)

**APLAC MEASUREMENT AUDIT - MA00\_**

**DECLARATION TO CUSTOMS OFFICIALS AND SHIPPING AGENTS**

This box contains scientific equipment for a Measurement Audit coordinated by [organising accreditation body] on behalf of the Asia Pacific Laboratory Accreditation Cooperation (APLAC). APLAC is classed as a Specialist Regional Body under the APEC Sub-Committee on Standards and Conformity Assessment.

This instrument is of the highest accuracy and should not be dismantled. If a customs inspection is required then please contact the person nominated on the back of this form so that they can be present. Details of the contents of the box are listed below. The contents are not hazardous in any way.

The equipment is for scientific purposes only and no commercial transactions will take place. The box will remain in the country for approximately 4 weeks and then it will be returned, hence no import duty or taxes are payable.

**CONTENTS OF THE BOX**

Item No.	Description	S/No.
1.	<input type="text" value="make, model"/>	_____
2.	<input type="text" value="make, model"/>	_____

**COMMERCIAL VALUE :** \$ NIL

**MATERIAL VALUE:** \$

**TOTAL BOX WEIGHT:** \_\_\_ kg

**BOX DIMENSIONS:** \_\_\_ m x \_\_\_ m x \_\_\_ m

I declare that the above particulars are true and correct.

\_\_\_\_\_  
*organiser's name*  
for APLAC Proficiency Testing Committee

\_\_\_\_\_  
DATE

Appendix B

# Request to participate in a APLAC MEASUREMENT AUDIT

Organising Accreditation Body :

Q1. Name the artefact(s): \_\_\_\_\_

Q2. Name the preferred period to receive the artefact ? \_\_\_\_\_

Q3. How many accredited laboratories in your country will participate (maximum 4) ? \_\_\_\_\_

Q4. How long do you estimate you would require the artefacts (maximum 4 weeks) ? \_\_\_\_\_

Q5. For the artefact, what is the **best** measurement capability of participant laboratories in your country ?  
(e.g. *least uncertainty of measurement of 0.01% of reading*) \_\_\_\_\_

Please provide below current details of the most appropriate contact person in your organisation to receive the artefacts and all future correspondence for this APLAC Measurement Audit.

Name: \_\_\_\_\_

Title : \_\_\_\_\_

Organisation: \_\_\_\_\_

Physical Address: \_\_\_\_\_  
(not a PO Box)

\_\_\_\_\_

\_\_\_\_\_

Phone No: \_\_\_\_\_ Fax No: \_\_\_\_\_

Email Address: \_\_\_\_\_

Please complete and fax to:

## Appendix C

**APLAC MEASUREMENT AUDIT MA00\_  
INSTRUCTIONS TO ACCREDITATION BODIES****1. EQUIPMENT**

On receipt, unpack the artefact(s) and inspect them for any defects.

List other specific checks.

Complete the attached "*RECEIPT FORM*" and fax to the organising body. Please note, these instructions and attached *Result Sheet* are master copies and must remain in the box. The national accreditation body should make copies for distribution to the participating laboratories in their country.

**2. TRANSPORT**

The artefacts can be carried by hand, car or by plane, whatever is considered the safest way.

**3. CUSTOMS**

**NO** ATA Carnet is provided with these artefacts. A *Declaration to Customs Officials and Shipping Agents* is enclosed in the plastic envelope attached to the outside of the box. Please make it is in place before returning to the [organising accreditation] otherwise it will not pass through their Customs authorities. Please attach 3 extra photocopies of the *Declaration*.

**4. MEASUREMENTS TO BE CARRIED OUT**

Please refer to *INSTRUCTIONS TO LABORATORIES* enclosed. If necessary, these should be translated into the appropriate language by the accreditation body.

**5. ARTEFACT DISTRIBUTION**

Measurements have been performed by the reference laboratory   
It is the responsibility of the accreditation body to make sure that the artefacts are returned by the participating laboratory and then returned to [organising accreditation body] by the date specified. Two weeks have been allowed for each international transport and customs clearance. When ready for dispatch, fill in the attached *DISPATCH FORM* and fax to the organising body:

**6. DOCUMENTS TO BE SUBMITTED**

Within one week of the completion of the measurements, participating laboratories are required to fax or send the *Result Sheet* to their accreditation body. No other documentation is required. The accreditation body is required to ensure that the *Result Sheet* has been filled in correctly and completely. The accreditation body should provide details of any problems that their laboratories had. The accreditation body is required to fax the documentation to the organising body within two weeks of dispatching the artefacts. On receipt of the information, the organising accreditation body, will prepare a *Measurement Audit Report* for the participating laboratory which will then be sent back to the national accreditation body.

**7. GENERAL INFORMATION**

For general queries, please contact:

Appendix D

APLAC MEASUREMENT AUDIT MA00\_  
**INSTRUCTIONS TO LABORATORIES**

**1. EQUIPMENT**

*Full list of equipment, accessories & documentation*

On receipt, unpack the artefacts and inspect them for any defects.

*List other specific checks.*

Contact your accreditation body if there is any damage.

**2. MEASUREMENTS TO BE CARRIED OUT**

*Detailed instructions for setting-up and conditioning the artefacts  
Either clearly specify method or ask laboratory to use normal method  
Refer to an attached Result Sheet*

**3. DOCUMENTS TO BE SUBMITTED**

Within one week of the completion of the measurements, participating laboratories are required to send the attached *Result Sheet* and their calibration report to their accreditation body. No other documents are required. Laboratories should make a copy of the *Result Sheet* for their own records.

*In some cases a calibration report may not be required.*

Where possible, uncertainties should be calculated using the method in the *ISO Guide to the Expression of Uncertainty in Measurement*.

**4. GENERAL INFORMATION**

For general queries, please contact your accreditation body. Additional information may be obtained from *organiser's contact details*

Appendix E

RECEIPT FORM

APLAC MEASUREMENT AUDIT MA00\_

In order to monitor the progress of the Measurement Audit, we kindly ask the accreditation body on receipt of the artefacts, to fill in this RECEIPT FORM and fax it to:

<i>organiser's contact details</i>
------------------------------------

Thank you in advance for your cooperation.

The MA00\_ artefacts were received on: \_\_\_\_\_ (date)

After inspection, are the contents damaged? \_\_\_\_\_  
(yes/no)

If yes, is this serious? \_\_\_\_\_  
(yes/no)

are the contents still suitable for use? \_\_\_\_\_  
(yes/no)

Was there a "Declaration to Customs Officials and Shipping Agents" enclosed in the plastic envelope attached to the outside of the case? \_\_\_\_\_  
(yes/no)

Remarks:

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Participating Accreditation Body: \_\_\_\_\_

Contact Person: \_\_\_\_\_ Fax: \_\_\_\_\_

Appendix F

# DISPATCH FORM

## APLAC MEASUREMENT AUDIT MA00\_

In order to monitor the progress of the Measurement Audit, we kindly ask the accreditation body, on dispatch of the artefacts, to fill in this DISPATCH FORM and fax it to:-

<i>organiser's contact details</i>
------------------------------------

Please ensure that the "*Declaration to Customs Officials and Shipping Agents*" is attached to the outside of the case. Thank you in advance for your cooperation.

The MA00\_ artefacts were dispatched on: \_\_\_\_\_(date)

The artefacts have been inspected after return from our laboratories and were found to be in good condition. \_\_\_\_\_(yes/no)

Please give details of any problems:-

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Shipping agent: \_\_\_\_\_ Phone: \_\_\_\_\_ Fax: \_\_\_\_\_

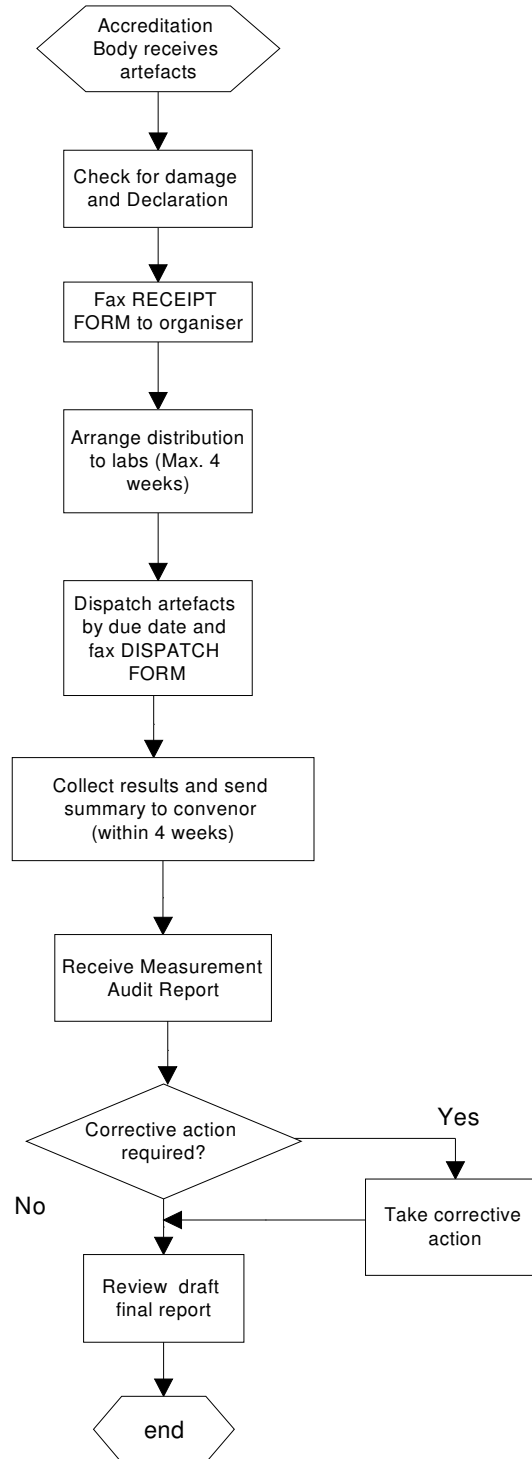
Airwaybill no. (or consignment note no.): \_\_\_\_\_

Your accreditation body: \_\_\_\_\_

Contact person: \_\_\_\_\_ Fax: \_\_\_\_\_

### Appendix G

#### FLOWCHART FOR PARTICIPATING ACCREDITATION BODIES



Appendix H

*name of organising body*

**APLAC MEASUREMENT AUDIT MA00\_**  
**MEASUREMENT AUDIT REPORT**

Laboratory name :

**GAUGE BLOCKS**

REPORT NO. \_\_\_\_\_ dated \_\_\_/\_\_\_/\_\_\_  
SPECIFICATION: ISO 3650 - 1978 (E)

	NOMINAL (mm)	DEVIATION FROM NOMINAL (µm)				LAB-REF (µm)	E <sub>n</sub> RATIO
		REF	U <sub>REF</sub>	LAB	U <sub>LAB</sub>		
GAUGE LENGTH	1	0.17	0.05	0.09	0.06	-0.08	-1.02
	10	0.11	0.05	0.02	0.06	-0.09	-1.15
	50	-0.01	0.07	-0.13	0.09	-0.12	-1.05
	100	0.19	0.09	0.06	0.16	-0.13	-0.71
FLATNESS	1	0.12	0.03	0.06	0.07	-0.06	-0.79
	10	0.12	0.03	0.05	0.05	-0.07	-1.20
	50	0.12	0.03	0.08	0.05	-0.04	-0.69
	100	0.12	0.03	0.05	0.05	-0.07	-1.20
VARIATION IN LENGTH	1	0.03	0.03	0.06	0.03	0.03	0.71
	10	0.02	0.03	0.05	0.03	0.03	0.71
	50	0.02	0.03	0.06	0.03	0.04	0.94
	100	0.02	0.03	0.08	0.03	0.06	1.41

**Notes:** All results and uncertainties are in µm.

Uncertainty of measurement is at a 95% confidence level (U<sub>95</sub>)

$$E_n = \frac{LAB - REF}{\sqrt{U_{LAB}^2 + U_{REF}^2}}$$

Values of |E<sub>n</sub>| >1 require investigation.

Reference Laboratory :

Appendix I

CORRECTIVE ACTION FLOWCHART

