ARAC INTERLABORATORY COMPARISONS

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ARAC INTERLABORATORY COMPARISONS

TABLE OF CONTENTS

1. PURPOSE

This document establishes requirements for ARAC interlaboratory comparisons, defines the responsibilities for the organization and provides guidance for the planning, preparation, execution and reporting.

2. INTRODUCTION

2.1 The purpose ARAC is to build up and maintain mutual confidence among the Accreditation Bodies in the region, in order to reach a state of mutual agreement on the equivalence of the operation of these Accreditation Bodies and of the certificates and reports issued by their accredited laboratories. This supports the removal of technical barriers to trade.

2.2 ARAC interlaboratory comparisons of calibrations and tests provide a forum for the comparability and traceability of measurements in the Arab countries, and are mandatory for ARAC members. They also provide confidence in the accreditation process of ARAC members, and in their ability to take appropriate corrective actions where an interlaboratory comparison reveals measurement deficiencies.

2.3 ARAC interlaboratory comparisons also lead to a flow of know-how among the participating Accreditation Bodies and help establish a common high level of measurement capacity within the region.

2.4 The costs related to interlaboratory comparisons must be determined as appropriate. According to study by TC and approved by Executive committee.

2.5 This document provides guidance on the organization and conduct of calibration and testing interlaboratory comparisons (Proficiency Testing Programs) and establishes the responsibilities for their organization.

3. ROLE OF ARAC Technical Committee (TC)

3.1 Overall responsibility for the interlaboratory comparisons lies with ARAC Technical committee that:

• after consultation with the ARAC members, proposes to the ARAC General Assembly the fields of test and calibration that must be priority for the organization of ARAC interlaboratory comparisons.

• selects and schedules interlaboratory comparisons, based on the priority fields and/or proposals of the Accreditation Bodies in the region that develop Interlaboratory Comparisons Programs or coordinate programs together with a proficiency testing provider approved by ARAC General Assembly;
- decides on the overall design and conduct of the interlaboratory comparisons;
- selects the Accreditation Body to organize each interlaboratory comparison;
- reviews the draft final report prior to publication;
- reviews any problems that may have arisen during an interlaboratory comparison;
- identifies technical development, training needs and follow-up action;
- establishes links with its proficiency testing counterparts in other Laboratory Accreditation Bodies Cooperations.

3.2 ARAC members are encouraged to take the initiative for proposing to the Technical committee any particular interlaboratory comparison. Proposals must be submitted by a full member or

associate member of ARAC. Even if the program is organized by an Accreditation Body member of ARAC, the Accreditation Body making the proposal is responsible for the program.

3.3 A proposal should include besides a schedule of the activity, at least the following information:

a) For calibration

- The physical quantities to be measured;
- The artifacts to be circulated (type, accuracy, resolution, stability, owner, etc.);
- The preset measurement range;
- The procedure or method of measurement (normal laboratory procedure or prescribed procedure);
- Means of transport.

b) For testing

- The sample type to be tested;
- Tests to be performed;
- Methods to be followed (if applicable);
- Total number of samples to be produced, number of laboratories that can be nominated by other regional cooperation (when possible);
- Reporting accuracy and units.

3.4 The Technical committee has the final technical responsibility for the decision on which interlaboratory comparisons will be organized, taking into account interlaboratory comparisons that will be of most benefit to the majority of the Accreditation Bodies members of ARAC and the priority fields approved by the ARAC General Assembly.

4. ROLE OF THE ORGANIZING BODY

4.1 Tasks

4.1.1 The Accreditation Body that has agreed to organize the interlaboratory comparison has the following tasks:

- Developing a budget and sending it to the TC and ARAC Secretariat;
- Providing suitable artifacts or samples and the appropriate packaging;
- Appointing a person responsible for coordinating all correspondence;
- Appointing a technical adviser; (*)
- Drafting the forms: Response Form (including the Declaration of Commitment of the participating accreditation bodies), Receipt Form of samples or devices, Results Form, interim and/or final instructions for the participating Accreditation Bodies and Laboratories;
- Inviting (through ARAC Secretariat) all full members and associates to participate;
- Inviting (through ARAC Secretariat) the members of other regional cooperations to participate;
- Defining, if relevant, the sequence of participating Accreditation Bodies;
- Defining which means of transportation is preferred;
- Assigning confidential code numbers to all participating laboratories;
- Minimizing problems concerning transportation e.g. by supplying a declaration to customs authorities (see Annex A);
- For calibration, to have artifacts calibrated by the reference laboratory, with adequate accuracy and at appropriate intervals;
- Organizing homogeneity testing and statistical analysis of the results; (**)
- Sending the samples to the participating Accreditation Bodies. Samples will only be sent directly to the participating laboratories where reasons justify this procedure; (**)
- Monitoring the progress of the interlaboratory comparison;
- Collecting the results of the participants;

• Drafting the provisional and final reports (**); and

• Sending the interim and final report to the ARAC Secretary and the TC Chair. The Secretary will send it to the Participating Bodies and to the contact person responsible for the participating regional cooperations.

(*) When the Accreditation Body coordinates the interlaboratory comparison with a proficiency testing provider, the technical adviser could be the program coordinator who is a member of the provider's personnel.

(**) When the Accreditation Body coordinates the interlaboratory comparison with a proficiency testing provider, these activities could be performed by the provider.

4.1.2 The interlaboratory comparison should be organized according to the current version of ISO/IEC 17043.

4.2 Planning an intercomparison

4.2.1 Selection and calibration of artifacts in calibration intercomparisons

4.2.1.1 Artifacts used in the interlaboratory comparison should be stable so that they can be expected to support their calibration throughout the interlaboratory comparison. If not possible, more frequent recalibrations will be needed.

4.2.1.2 The artifacts should have the appropriate accuracy in accordance with the best measurement capacity of the participating laboratories.

4.2.1.3 An important feature of an interlaboratory comparison is to have reference values for the required measurements against which laboratory results can be judged. The reference values are assigned by a Reference Laboratory which is usually the National Metrology Institute (NMI) of the organizing economy. It could also be the NMI of another economy. The organizing accreditation body must ensure that the Reference Laboratory that it chooses can achieve an uncertainty of measurement better than that of the participating accreditation bodies. Information on the best measurement capacity of the participating laboratories must be requested in the invitation to participate in the Program (see Annex B). They should also ensure that the artifacts are calibrated at intervals suitable for the required accuracy.

4.2.2 Design of a Testing Program

4.2.2.1 These programs usually involve the simultaneous distribution of sub-samples of a bulk material for testing by the participating laboratories. A program may also involve the circulation of one or more common samples for testing by participating laboratories.

4.2.2.2 The program design may involve the distribution of one or multiple samples to each participating laboratory. Each sample may be tested once, in duplicate, in triplicate or multiple times to suit specified methods. Samples may have characteristics that are nominally identical (blind duplicates) or be at slightly different levels (as with split-level design).

4.2.2.3 The samples used in the tests of interlaboratory comparisons should generally be typical of the sample types routinely tested in the participating laboratories.

4.2.2.4 The samples should be labeled and this identification referenced in the instructions provided to participants and in the results sheet which must accompany the sample when shipped.

4.2.2.5 Sufficient amount of sample should be supplied so that participants may adequately perform the requested tests.

4.2.3 Homogeneity testing

4.2.3.1 For testing interlaboratory comparisons the objective of homogeneity testing is to establish suitably small sample variability, where the samples are sufficiently homogenous.

4.2.3.2 Initial testing may be conducted during the sample preparation stage, however once the samples have been prepared and packaged, at least 10 samples are selected at random for homogeneity testing. The tests selected are those that are considered to best indicate any significant differences in the samples. All testing is performed at least in duplicate and under repeatability conditions i.e. same laboratory; same operator; same method; same equipment; over as short a time interval as possible.

4.2.3.3 For the samples to be accepted as suitable for use, the results of this testing and any applicable statistical analysis (e.g. ANOVA) of the results must indicate that no significant variability existed. Thus any outlier results subsequently identified in a program will not be attributable to sample variability.

4.2.4 Invitation to participants

4.2.4.1 The organizing Accreditation Body should prepare an invitation to participate in the intercomparison. This invitation should detail the program and include information about the calibration or tests to be performed, the features of the artifacts or samples and any other information that may assist participating Accreditation Bodies to decide which laboratories may participate (see example in Annex B). Instructions to the participating Accreditation Bodies and Laboratories, the Response Form (including the Declaration of Commitment of the participating accreditation bodies), the Receipt Form and the Results Form should be sent with the invitation.

4.2.4.1.1 **Declaration of Commitment.** The participating Accreditation Body is accountable to the TC for ensuring that its nominated laboratories send the results of the analysis of samples / calibration of artifacts received in the framework of the interlaboratory comparison. If the delivery of results should be prevented for any reason, the participating Accreditation Body should inform the reasons to the TC Chair and to the organizing Accreditation Body. The participating Accreditation Body should complete the Declaration of Commitment included in the Response Form (see Annexes C1 and C2) indicating its data and the name of its nominated laboratories. This is a prerequisite for registering the appointed laboratories by the participating accreditation body.

4.2.4.2 The invitation and all the above-mentioned forms should be sent through the ARAC Secretary to ARAC full members and associated members. For those countries that do not have an Accreditation Body member of ARAC, ARAC Secretary should send the invitation to all the partners and members of ARAC stakeholders in that country. Copies of the invitations should be sent to TC members as information.

4.2.4.3 For calibration intercomparisons, each Accreditation Body may appoint up to four laboratories except for the organizing Accreditation Body that may include all its accredited laboratories. For testing intercomparisons, each Accreditation Body should be allowed to appoint at least four laboratories, excluding the organizing AB that may include all its accredited laboratories.

Note: For countries where there is no Accreditation Body member of ARAC, members that are partners or stakeholders of ARAC are entitled to appoint collectively the participation of laboratories in the country.

4.2.4.4 After consultation with the TC Chair, the organizing accreditation body can then send the invitations and relevant forms to the Accreditation Bodies of other regional cooperations through the ARAC Secretary. The invitation should clearly indicate how many laboratories may be nominated by members of these cooperations. However, existing ARAC members will always have priority regarding the number of nominations that they can make.

4.2.5 Circulation schedule in calibration intercomparisons

4.2.5.1 From the responses received to the *invitation,* the organizing Accreditation Body creates and distributes a *Circulation Schedule* which describes when the Accreditation Body will participate. This schedule is based on the following factors:

• The total circulation should be limited to a maximum of 18 months. Where the number of participants is large, sufficient artifacts with the same ranges/values should be acquired so that multiple loops can be used in order to maintain the 18 month schedule.

• The allocated time per laboratory should be approximately 10 working days (including transport to and from the laboratory within an economy);

• The maximum period the artifacts are with an accreditation body is 6 weeks;

• A period of three weeks should be included for each international transportation medium;

• Where possible, international travel distances in each loop should be minimized;

• The Accreditation Bodies that are part of other regions should normally be added at the end of the *Circulation Schedule*.

4.3 Instructions

4.3.1 The organizing accreditation body and its technical adviser draft the instructions in English or Spanish. The final instructions are sent to all participating accreditation bodies. A copy accompanies the artifacts and samples.

Note: For countries where there is no Accreditation Body member of ARAC, the instructions should be sent directly to the participating laboratories.

4.3.2 The organizing accreditation body can request any information deemed necessary to assist in the interpretation of the results reported, but the instructions should contain at least the following information:

a) For calibration intercomparisons

• Name and address of the convenor at the organizing Accreditation Body:
• Name of the Reference Laboratory;
• Any special recommendations for transportation;
• Any special recommendations for the technical handling and set up of the artifact;
• Any technical information about the artifact;
• If necessary, special instructions for reporting the results. It is strongly recommended that pro-forma result sheets are prepared to summarize the results in a simple format. In addition, formal calibration certificates should be requested;
• Unless otherwise stated, each participant should be instructed to calibrate the artifacts according to their routine (accredited) procedure.

An example of an instruction for a calibration intercomparison can be found in Annex D.

b) For testing intercomparisons

• Name and address of the coordinator at the organizing accreditation body;
• Sample description and identification;

• Names of the tests to be performed on the samples;
• Test methods to be used.

Note: The instructions should normally allow the use of the laboratory's accredited routine method, unless this is not feasible from a technical point of view.

• Accuracy and reporting units of the results;
• Reference to a standardized results sheet (Results Form);
• Measurement of uncertainty instructions.

An example of an instruction for testing intercomparison can be found in Annex E

4.4 Packaging and transport

4.4.1 Calibration artifacts

4.4.1.1. Rugged containers and packaging must be supplied. It is recommended that a separated case be used for housing the artifacts and that this be placed inside a cardboard box for extra protection during transport. The organizing accreditation body has to cover the risk of damage or loss of the artifacts.
4.4.1.2 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.

4.4.2 Test samples

4.4.2.1 The following guidelines shall be adhered to:

• samples shall be packaged to avoid damage during transportation.

• the time between dispatch of samples and receipt by laboratories should be limited to one month;

• the organizing accreditation body distributes the packaged samples to the participating accreditation bodies, who in turn address them to their nominated laboratories. Samples will only be sent directly to the participating laboratories if there are reasons for it;
(alternative samples should be directly dispatched to the laboratories)

• the organizing body should include a customs declaration with each sample dispatch;

Note: The customs declaration should include details of the sender's and receiver's address, a description and value of the goods, the reason for sending the goods (i.e. interlaboratory testing program) and a statement that the goods are not dangerous or hazardous.

4.5 Receipt of results

4.5.1 The participating Accreditation Bodies should send the completed results sheet of each participating laboratory to the organizer before the due date. If any results are not received by the due date, the organizing Accreditation Body should contact the ARAC Secretary for him to make a reminder via e-mail to the participating Accreditation Bodies.

Note: For countries where there is no Accreditation Body member of ARAC, the participating laboratories should send the results directly to the organizing accreditation body.

4.5.2 Once all the results are received, the organizing accreditation body is responsible for data entry and reviewing the preparation of the interim and final reports.

4.6 Interim reports

4.6.1 As soon as possible, after receiving the results, the organizing Accreditation Body must send the *Interim reports* (marked CONFIDENTIAL) to the ARAC Secretariat and the TC Chair. The ARAC Secretary sends these reports to the participating bodies. The participating Accreditation Bodies then will send the reports to the participating laboratories. The organizing accreditation bodies may submit the interim report to both the participating accreditation bodies and the laboratories.

Note: For countries where there is no Accreditation Body member of ARAC, the *Interim Reports* should be sent by the ARAC Secretary directly to the participating laboratories.
4.6.2 These *Interim Reports* inform about the consensus value for testing and preliminary reference values for calibration according to the initial calibration of the artifacts by the Reference Laboratory. The interim report may provide an indication of each participating laboratory's performance in terms of its agreement (or otherwise) with the consensus value. An example of *Interim Report* is given in Annex I. This interim report will enable participating Accreditation Bodies and laboratories to investigate unsatisfactory results and to initiate corrective actions. The participating laboratories shall review the transcription of the results and inform the organizing accreditation body about any findings regarding the transcription.

4.7 Final reference values in calibration intercomparisons

4.7.1 The organizing Accreditation Body needs to monitor the results throughout the program and request return of the artifacts if there is a problem.

4.7.2 The artifacts must be recalibrated at the end of the circulation schedule. In establishing the final reference values, consideration must be given to any deviation caused by insufficient stability or damage of the artifact. If necessary, different reference values may be specified for different laboratories, taking into account any shift of values with time.

4.7.3 Where drift has occurred, the organizing Accreditation Body must be very careful in its assumptions so that no laboratory is unfairly disadvantaged.

Options include:

• using the mean of the before and after reference values;

• reporting two sets of E_n ratios, based on before and after reference values;

• if drift is known to be linear, using interpolated reference values (with respect to time);

• where a "step" change is suspected, using the most appropriate of the before and after reference values;

• in extreme cases not giving a reference value.

4.8 Analysis of results

4.8.1 For calibration intercomparisons – E_n Ratio

4.8.1.1 A convenient and internationally accepted method of judging the quality of each measurement result is by calculating the normalized error (**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 artifact). The reference value uncertainty must be calculated in a manner consistent with the ISO *Guide for the expression of uncertainty in measurement*.
Both uncertainties are at a 95% confidence level.

4.8.1.2 Values of $|E_n|>1$ indicate unsatisfactory results and require investigation.

4.8.1.3 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.

4.8.1.4 In addition to such a tabular presentation of the measurement results, they should also be presented graphically whereby the difference between the laboratory's result and the reference value is plotted along with bars indicating their uncertainty of the measurement.

4.8.2 Z-scores

4.8.2.1 A convenient and internationally accepted statistical method for analyzing test results is to calculate a z-score for each laboratory's result. A z-score is a normalized value which gives a "score" to each result, relative to the other numbers in the data set.

4.8.2.2 A standard form for the calculation of z-scores is:

$$z_i = \frac{x_i - \bar{x}}{s}$$

Where $\bar{x}$ is the assigned value (e.g. mean or median)
S is an estimate of the dispersion of all the results (e.g. the standard deviation or interquartile range)

4.8.2.3 A z-score value close to zero therefore means that the result agrees well with those from the other laboratories. A z-score > 3 indicates an unsatisfactory result and needs investigation. While a 2 < z-score < 3 indicates a questionable result and may also requiere investigation.

4.8.2.4 The z-score approach described above may be based on the mean ($\bar{x}$) and the standard deviation (*s*) of the set of results. However, these "classical" statistics are significantly influenced by the presence of extreme results (i.e. inordinately high or low values) in the data set.

4.8.2.5 A robust alternative to the mean and standard deviation is the median and normalized interquartile range (IQR) respectively. Both the median ($\bar{x}$) and the IQR (*s*) are based on the ordered results.

4.8.2.6 Other statistics can be used for the analysis of results (e.g. ISO 13528 Statistical methods for use in proficiency testing by interlaboratory comparisons).

4.9 Confidentiality

4.9.1 It is the responsibility of the organizing Accreditation Body to keep confidential at all times the identity of the participating laboratories. Code numbers are to be randomly assigned, i.e. not in chronological order of participation, and should not identify economies or Accreditation Bodies.

4.9.2 The organizing Accreditation Body must prepare a list, in which the code number and name of each laboratory is linked to the relevant Accreditation Body. This list should be marked CONFIDENTIAL and sent to the TC Chair and Vice Chair.

4.9.3 When the Accreditation Bodies of other regions participate in an ARAC intercomparison, the TC Chair should send a similar list to the Chair of the relevant Committee in the region.

4.9.4 Furthermore, the organizing Accreditation Body sends to the ARAC Secretary a list with the names of the participating Accreditation Bodies, and the code numbers assigned to their laboratories, without their names. This information will be placed by the ARAC Secretary in the ARAC website so that it is available for peer assessors of ARAC and the Executive Committee.

4.10 Draft Final Report

4.10.1 Once results have been received from all participants the organizing Accreditation Body will write a draft *Final Report* which identifies participating laboratories only by a random code number. For calibration intercomparisons, this Report must be issued after the final calibrations have been carried out by the Reference Laboratory.

4.10.2 This draft *Final Report* shall be forwarded to the members of the TC and all the participating Accreditation Bodies by the ARAC Secretary. The participating Accreditation Bodies will send the draft Final Report to their participating laboratories. Both the participating Accreditation Bodies and laboratories will have up to four weeks to review and send their comments back to the organizing Accreditation Body through the participating Accreditation Bodies. Or, the organizers may send the draft Final Report to both the participating Accreditation Bodies and laboratories.

Note: For countries where there is no Accreditation Body member of ARAC, the Final Report should be directly sent to the participating laboratories.

4.10.3 The Draft Report should include:

a) For calibration intercomparisons

- The reference values;
- the participating economies and the number of Accreditation Bodies and laboratories;
- a list of the participating Accreditation Bodies and the dates of receipt and dispatch;
- the reported calibration results for each participating laboratory identified by code number only;
- identification of the non accredited laboratories;
- En ratios;
- a graph for each measured parameter of laboratory's errors and uncertainty bars, as appropriate;
- a copy of the measurement instructions and results sheet;
- a statement of any measurement results that require investigation;
- technical commentary on results, possible sources of error, methods, uncertainties of measurement).

b) For testing intercomparisons:

- the assigned values (consensus mean or median);
- the participating economies, the participating Accreditation Bodies and the number of laboratories;
- reported test results for each participating laboratory identified by code number only;
- identification of the non accredited laboratories;
- identification of outlier results;
- graphical displays of the test data (e.g. histograms, Youden diagrams and z-score charts), where appropriate;
- a copy of the instructions and results sheet;
- a statement of any measurement results that require investigation;
- technical commentary (e.g. sources of error, method effects and overall performance).

4.11 Final Report

4.11.1 The organizing Accreditation Body incorporates comments from the TC, the participating Accreditation Bodies and laboratories, and sends the Final Report to the ARAC Secretariat and the TC Chair. The ARAC Secretary sends the Final Report to the participating Accreditation Bodies, who will send the Final Report to the participating laboratories. Or the organizers may send the Final Report to both the participating Accreditation Bodies and laboratories.

4.11.2 In order to maintain all ARAC members informed about the technical activities of ARAC, the Final Report will be distributed to the TC members, the full members and the associate members of ARAC that did not participate in the intercomparison.

4.11.3 Summaries of individual performance can also be provided to each participating laboratory.

5. ROLE OF THE PARTICIPATING ACCREDITATION BODIES

5.1 Tasks

5.1.1 Each Accreditation Body is responsible for the following actions (see Annex H):

- Responding to the *invitation to participate* in the intercomparison and designating the laboratories in its economy. To that effect, it must complete the Response form that includes the Declaration of Commitment and then submit this form to the organizing Accreditation Body;
- translating the measurement instructions into the economy's language, if necessary;
- informing the organizers and the previous Accreditation Body about any circulation requirement of the customer;
- arranging for the dispatch of the samples or artifacts to each of the participating laboratories in their economy;
- Collecting the results and, where relevant, the calibration certificates or test reports of each participant; translating them into English or Spanish, if necessary, and sending them to the organizing Body along with details of any problems that occurred;
- Conducting and documenting any necessary follow-up related to unsatisfactory performance of its participating laboratories and take control over any corrective actions needed.

5.1.2 In addition, for calibration intercomparisons, the participating Accreditation Body is responsible for:

- Ensuring that the time schedule for its laboratories is kept (maximum 6 weeks); a delay caused by one of the participants should not result in a delay in sending the artifacts to the next Accreditation Body so it may be necessary to reduce the number of participants if a delay occurs;
- Sending by fax or e-mail the standard *Dispatch Form* (Annex G) to the next Accreditation Body and organizing Body;
- Sending the artifact to the next participating Accreditation Body using a door-to-door courier service ("free domicile"). The Accreditation Body must ensure that their shipper is capable of doing this (many only send it to the nearest airport).

5.1.3 For countries where there is no Accreditation Body member of ARAC, members that are partners or stakeholders of ARAC must ensure that the actions detailed in 5.1.1 and 5.1.2 are carried out, as necessary, to ensure appropriate execution of the intercomparison and prevent any damage to the samples or artifacts.

5.2 Participating laboratories

5.2.1 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 interlaboratory comparison. Where no applicant laboratory exists, the Accreditation Body may nominate laboratories that are neither accredited nor applying for accreditation. The accreditation status of the participant must be identified in the formal nomination of laboratories.

5.2.2 In order that a representative sample of laboratories can be compared, the Accreditation Body should, where possible, avoid selecting the same laboratories that have participated in previous ARAC programs.

5.2.3 A National Metrology Institute in ARAC regions usually is involved in ARAC interlaboratory comparisons providing the reference values. The national Accreditation Body may also designate another National Metrology Institute to participate in ARAC interlaboratory comparisons if it is accredited or seeking accreditation for that particular calibration.

5.2.4 The participating laboratories receive the samples or artifacts, instructions and results sheet from their Accreditation Body. The samples may also be sent to the laboratories directly by the organizers, only when there is a justified reason.

5.3 Confidentiality

5.3.1 The laboratories must keep the preliminary reference values (in the Interim Report) strictly confidential until the program has been completed in all economies.

5.4 Transport

5.4.1 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 Annex A. It is the responsibility of the Accreditation Body to liaise with their Customs authorities when artifacts or samples are held by Customs.

Note: For countries where there is no Accreditation Body member of ARAC, partners and stakeholders of ARAC should ensure that customs procedures in their country are followed and paid, and that these procedures do not affect the execution of the intercomparison.

5.4.2 Transport to the next Accreditation Body should be by a reliable international courier with a user accessible tracking system. Door-to-door delivery ("free domicile") must be specified.

5.5 Corrective action

5.5.1 Corrective action, if required, is the responsibility of the laboratory and its Accreditation Body and should be undertaken as soon as possible. Corrective action may vary from a discussion with the laboratory to withdrawal of the accreditation for the measurements involved. Corrective action may be taken at the following stages:

- after having received the *Interim Report* which is based on preliminary reference values;
- after receiving the draft *Final Report*.

5.5.2 As a general rule, any laboratory z-score outside the range -3 a +3 for any test or a ratio $|E_n|$ > 1 for any calibration would normally require corrective action. Where the $|E_n|$ ratios are marginally greater than 1, the Accreditation Body may decide to wait for the draft *Final Report* which will be based on the final reference values.

6. REFERENCES

(1) MD 002 – Policies and procedures for a Multilateral Recognition Agreement among Accreditation Bodies
(2) ARAC MR001 *Procedures for establishing and maintaining mutual recognition agreements between Accreditation Bodies*
(3) ISO/IEC17043 (2010) *Proficiency testing by interlaboratory comparisons.*
(4) ISO/IEC 17025 (2005) *General requirements for the competence of testing and calibration laboratories.*
(4) BIPM/IEC/IFCC/ISO/IUPAC/IUPAP/OIML (1995) *Guide to the expression of uncertainty in measurement.*

Annex A

ARAC INTERLABORATORY COMPARISON - C00# 20##_

STATEMENT FOR CUSTOMS OFFICIALS AND SHIPPING AGENTS

This box contains scientific equipment for an international interlaboratory comparison coordinated by ***name of the organizing Accreditation Body*** on behalf of the ARAB Accreditation (ARAC)

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 each country for approximately 4 weeks and then it will be re-exported, hence no import duty or taxes are payable. Details of the participating Laboratory Accreditation Bodies in each country are given on the next page.

Content of the Box

1- ……. model **SN. ……..**
2- ……. model **SN ……..**

Commercial value ……. $

Total Box weight …….. Kg
Box dimension … m x … m x … m

I declare that the above particulars are true and correct

……. **Date ……**
Organizer name
For ARAC TC committee

Date of issue: March 2013

Annex B

Example of invitation to participate in an intercomparison
INVITATION TO PARTICIPATE IN ARAC INTERCOMPARISON PROGRAM - C00# 20## – CALIBRATION OF YY

To: Contact persons of ARAC members and members of ARAC TC

Subject: Invitation to participate in the YY ARAC -C00# Interlaboratory Comparison

Dear Colleagues,

ARAC TC has approved the interlaboratory comparison ARAC-C00# in the calibration of YY to be organized by [name of the organizing Accreditation Body].
In order to program the schedule of circulation, please answer the following questions using the Response form.
Please send your answers by e-mail to [name, telephone, fax and e-mail] before {DATE}.
The comparison will begin in [month when the intercomparison is planned to begin].

Yours truly,
[Name, organization, position, address, telephone, fax and e-mail]

Enclosed:
1. Response form
2. Instructions to Accreditation Bodies
3. Instructions to Laboratories
4. Receipt form
5. Dispatch form

Annex C1
RESPONSE FORM FOR THE PARTICIPATION IN ARAC INTERCOMPARISON PROGRAM
ARAC - C00# 20##– CALIBRATION OF YY

Accreditation Body	
Country	
Address to which samples to be sent	
Name of contact	
Telephone (with country code and area code)	
Fax (with country code and area code)	
Email	

Details of the participating laboratory

Name of the lab	
Address	
Name of contact	
Telephone (with country code and area code)	
Fax (with country code and area code)	
Email	

Please repeat as many times as necessary

Will your Accreditation Body take part in this intercomparison?	
If yes, how many laboratories? (maximum 4)	
Which is the best measurement capacity of the participating laboratories in your country?	
How long must the package remain in your country (no longer than 4 weeks, excluding international transportation and custom procedures)?	
How many days do you need to manage the customs procedures?	
Does the Customs Agency Office in your country requiere fulfilment of a specific Import/Export procedure by your Accreditation Body or by the sender/receiver, regarding the measurement equipment? (If yes, please send us details of the procedure).	
In which months do you prefer to receive the package?	
During what period would not be possible for your Accreditation Body to receive the package?	
Do you agree with the proposed instructions (see enclosed documents)? If no, please write down your Comments.	

Date of issue: March 2013

Name: _____- Date: ____/____/____

Note: Please send your answers by e-mail to [Name, telephone, fax, e-mail] before [DATE]

Declaration of Commitment

The Accreditation Body…… participant in the proficiency testing program No …… undertakes to submit to the Accreditation Body……(name), coordinator of the program, the following:

• Confirmation of receipt of the artifacts through the receipt form.

• The results of the calibration of the artifacts by the nominated laboratories, namely:

Nominated laboratories:
1-……..
2-…….
3-…….
4-…….
Any problem that prevents receiving the artifacts or sending the results, will be informed immediately to the TC Chair and the Accreditation Body that organizes/coordinates the proficiency testing indicating the relevant reasons.

……..

Name and Surname of the Person in Charge

Annex C2
RESPONSE FORM FOR THE PARTICIPATION IN ARAC INTERCOMPARISION PROGRAM
ARAC - T00# 20##– TEST OF XX

Accreditation Body	
Country	
Address to which samples to be sent	
Name of contact	
Telephone (with country code and area code)	
Fax (with country code and area code)	
Email	

Details of the participating laboratory

Name of the lab	
Address	
Name of contact	
Telephone (with country code and area code)	
Fax (with country code and area code)	
Email	

Please repeat as many times as necessary

Note: Please send your answers by e-mail to [name, telephone, fax and e-mail] before {DATE}.

Declaration of Commitment
The Accreditation Body…….. participant in the proficiency testing program "Provider-OA-ARACT00# 20##" undertakes to submit to the Accreditation Body…….(name), coordinator of the program, the following:

• Confirmation of receipt of the samples through the receipt form.

• The test results of the samples by the nominated laboratories, namely:

Nominated laboratories:
1-……..
2-……
3-……
4-……
5-……
6-……
Any problem that prevents receiving the samples or sending the results, will be informed immediately to the TC Chair and the Accreditation Body that organizes/coordinates the proficiency testing indicating the relevant reasons.

……

Name and Surname of the Person in Charge

Annex D

EXAMPLE OF INSTRUCTIONS FOR A CALIBRATION INTERCOMPARISON ARAC C 00# 20## - INTERLABORATORY COMPARISON OF STANDARD WEIGHTS (Conventional Mass)

INSTRUCTIONS TO ACCREDITATION BODIES AND LABORATORIES

1. General Information

This intercomparison was approved by ARAC TC in the meeting held on [DATE].

1.1 Organizer of the interlaboratory comparison

[Name of the organizing Accreditation Body]

Address]

Contact Persons:

[Name, telephone, fax and e-mail]

1.2 Reference laboratory

[Name of the organization that provides the reference value]

Technical Support: [Name, organization, position, telephone, fax and e-mail)

2. Traveling standards

The traveling standards to be circulated include the following items, packaged in a box. The approximate dimensions of the box are: 16 cm x 12 cm x 8 cm. The total mass of the package is almost 5 kg.

Nominal Value	Signaling	Form	Material
1Kg		OIML	Stainless steel
100g		OIML	Stainless steel
10g		OIML	Stainless steel
1g		OIML	Stainless steel
100mg		OIML (sheet)	Albata
10mg		OIML (sheet)	Albata

1mg		OIML (sheet)	Aluminum

Two series will be circulated to two separated groups of participants.

3. Transport

Traveling standards should be carried by car, bus, train, plane or other means, whatever is considered the safest way for the standards. The items should be unpacked by an expert in mass calibration immediately after being received by the calibration laboratory and inspected for damage. In particular, a visual inspection of the surfaces should be carried out and the results registered in the Receipt Form.

4. Handling and storage

Reference weights should be handled with appropriate tongs. Upon arrival at the laboratory, they should be removed from the transportation box and stored under hood. Reference weights should be stored in the balance room for three days before the determination of mass.

5. Measurements

Measurements should be carried out according to the normal procedure agreed with the Accreditation Body. The participating laboratories should determine the conventional mass of the traveling standards, as specified in the Accreditation scope, or as agreed with the Accreditation Body. Before determining the conventional mass, dust particles should be removed from the surface of the standards with a soft brush.
In some cases, the determination of conventional mass does not requiere a correction for air buoyancy. However, this correction should be made, e.g. if the densities of the compared weights are unequal or if the air density is very different from the conventional value 1,2 kg/m3. For information refer to OIML R 111, Annex B.

6. Circulation scheme

At the beginning and at the end of the circulation scheme, measurements will be performed by the Reference Laboratory. Each country has 30 days to circulate the traveling standards among the participating laboratories. A period of fifteen days has been allowed for transportation to the following country.

Transportation from one country to the next should be coordinated and paid by the country of origin using the “door–to-door” courier service, unless otherwise agreed among the Accreditation Bodies involved.

Each participating Accreditation Body should send a completed Receipt Form (see the enclosed file, Recepción-ARAC-C001.doc) to the organizer of the interlaboratory comparison immediately upon receipt of the weights. The form can be sent by fax [FAX NUMBER] or e-mail [E-MAIL ADDRESS]. The organizing Accreditation Body will assign a code number to each laboratory. This code number will be transmitted to each Accreditation Body before circulation is launched, and the laboratories should use it when reporting results.

If a delay occurs within a country, the number of participating laboratories in that country will have to be reduced, so that transportation to the next country can be performed within the time specified in the schedule.

Each participating Accreditation Body must send the completed Dispatch Form (see enclosed file Envío-ARAC-C001.doc) to the organizer of the interlaboratory comparison and the next Accreditation Body upon dispatch of the weights. The form can be sent by fax [FAX NUMBER] or e-mail [E-MAIL ADDRESS].

7. Report

Each participating laboratory should issue a formal calibration certificate, should fill in the interlaboratory comparison form (see enclosed file, Resultados-ARAC-C001.doc) and submit them within two weeks after the calibration, to the headquarters of its Accreditation Body. The form can be sent by fax [FAX NUMBER] or e-mail [E-MAIL ADDRESS].

The Accreditation Body will send copies of these documents to the organizers' office at the address mentioned above within one month after conclusion of the circulation in its country. In case of damage to the weights, the organizing Accreditation Body should be notified as soon as possible.

8. List of participating Accreditation Bodies with contact persons

Enclosed is the pdf file (ARACLoopA.pdf y ARACLoopB.pdf)

Annex E
EXAMPLE OF INSTRUCTIONS FOR A TESTING INTERCOMPARISON
ARAC T00# 20## PROFICIENCY TESTING PROGRAM
INSTRUCTIONS TO ACCREDITATION BODIES

1. DECLARATION OF COMMITMENT

The participating Accreditation Body as the body responsible to the TC for the delivery of results by its nominated laboratories, should complete the Declaration of Commitment attached to the Receipt form (see Annexes C1 and C2). This is a prerequisite for starting the registration process of the laboratories nominated by the participating accreditation body. On the other hand, if something prevents the delivery of the results, the participating Accreditation Body shall inform the reasons to the Chair of the TC and the organizing Accreditation Body.

2. SAMPLES

Each laboratory is supplied (sample description). Upon receipt of the samples, fill in the enclosed “RECEIPT FORM” and send it by fax or e-mail to {ORGANIZING BODY}.

3. TESTS TO BE PERFORMED

Please refer to your copy of the "INSTRUCTIONS TO PARTICIPANTS" and “RESULTS SHEET" enclosed.

4. SAMPLE DISTRIBUTION

The mailing tubes are addressed to each participating laboratory and contain the (*samples*), instructions and results sheet (marked with their confidential laboratory code No.). These are to be sent to the laboratories within one week of receipt date. There is no need to open the packaging.

5. DOCUMENTS TO BE SUBMITTED

a) **No later than (date)** participating laboratories are required to send the following to their Accreditation Body:

(i) completed results sheet;
(ii) any supporting documentation to assist in the interpretation of the results.

b) **Also no later than (date)** participating laboratories are required to send by fax a copy of the results sheet to the [ORGANIZING BODY].
The Accreditation Body is required to ensure that the above information has been supplied by their participating laboratories and should provide translations into English or Spanish, where necessary.

6. GENERAL INFORMATION

Additional information may be obtained from:

Contact details of the organizer (name, fax, telephone, e-mail)

Annex E (continuation)
EXAMPLE ARAC T00# 20## PROFICIENCY TESTING PROGRAM
INSTRUCTIONS TO PARTICIPANTS

To ensure that results from this program can be analyzed properly, participants are asked to adhere carefully to the following instructions.

1. Two 175 gram sachets of milk powder samples labeled ARAC 1 and ARAC 2 have been supplied to each laboratory *(sample description)*.

2. Testing may commence as soon as samples are received. Store your samples in the original packaging at room temperature until testing commences.

3. The following tests are to be performed on each sample in the reporting units and accuracy stated on the results sheet: *(list of tests)*
• Moisture
• Ash
• Fat
• Protein [calculated % Nitrogen x 6.38]
• Free Fat (Solvent Extraction)
• Insolubility Index
• Titratable Acidity (Lactic acid)

Analysts should be aware of analyte stability and perform the tests in an appropriate order

4. Participants should use routine test methods which would normally be used to test customer supplied samples and record the method used on the results sheet *(Method details).*

Report the Measurement Uncertainty (± % base) for each result. Refer to the attached Instructions – Measurement Uncertainty.

5. Send the completed result sheet and any supporting documentation to your Accreditation Body and fax or e-mail a copy of the results sheet no later than *(Date)* to:

Contact details of the organizer (name, fax, telephone, e-mail)

Annex E (continuation)
INSTRUCTIONS – MEASUREMENT UNCERTAINTY

Part (1) Background information & justification for this change

ISO/IEC 17025 requires that, except under specified conditions, the uncertainty of measurement associated with the results of tests and measurements must be estimated.

What is uncertainty of measurement?

Uncertainty of measurement is defined as a "parameter, associated with the result of a measurement that characterizes the dispersion of the values that could reasonably be attributed to the measurand" (the measurand is the particular quantity subject to measurement).

The result of a test or measurement is our best estimate of the true value of the measurand. The result is imperfect. The true value of the measurand is contained within a range of values of the measurement result and the "uncertainty of measurement" is an estimate of the magnitude of that range expressed at a given level of confidence (confidence interval). Uncertainty of measurement is usually given as a 95% confidence interval and would normally be expressed in the appropriate SI units (i.e. mm, °C, g/l, MPa etc).

For example, the result of a measurement might be 5.1 mg/l with an uncertainty of ±0.2 mg/l at a 95% level of confidence. This means that there is an estimated 95% probability that the true value

is in the range 4.9 mg/l to 5.3 mg/l. The 95% probability means that there is an estimated one in twenty chance that the true value is outside that range.

Uncertainty of measurement may also be expressed as a percentage where appropriate.

To help laboratories to comply with the requirements of ISO/IEC 17025 for estimating uncertainty and to promote a uniform methodology in its estimation, information packages for ARAC PT testing program participants now include general guidance relating to estimating uncertainties for the specific test involved. Final program reports will now include relevant worked examples. All program participants are required to report their estimates of uncertainty to their accreditation bodies along with their results unless the Technical Adviser to the program specifically waives any requirement to estimate uncertainties. The estimates of uncertainty provided by participants will be incorporated into the final program reports enabling direct comparison of uncertainty estimates across the program participants. The uncertainty estimates will not be used in the evaluation of the results on the primary samples.

How is uncertainty of measurement to be estimated?

ARAC expects that program participants' uncertainties of measurement would be estimated in accordance with the requirements of the respective member accreditation bodies. There are different approaches and methodologies available. Worked examples provided in ARAC PT program reports will generally be based on ISO GUM but will recognize other methodologies in accordance with 5.4.6.3 NOTE 3 in ISO 17025.

Estimates of uncertainty of measurement provided by program participants are generally required to be given at the 95% level of coverage.

ISO GUM methodology

An estimate of uncertainty of measurement would usually be based on the combination of a number of influencing parameters (components of uncertainty) such as errors in reference values, instrument errors, repeatability, thermal effects, weighing errors, inhomogeneity etc. ISO GUM methodology requires that the influence of each component of uncertainty on the measurement result be quantified and expressed numerically as a standard deviation. These values are then combined according to the rules of the propagation of uncertainty to produce a combined standard deviation (combined standard uncertainty) and the combined standard uncertainty is multiplied by a coverage factor to produce an expanded uncertainty at the required level of confidence. Detailed descriptions and information on the implementation of this methodology have been published by ISO[2], UKAS[3] and Eurachem/CITAC[4] and made available over the internet.

Uncertainty of measurement is best estimated within the individual laboratory environment. All factors which will have a significant influence on the test or measurement result must be included in the estimation process. There must be suitable programs using reference standards, instruments and materials to ensure ongoing and adequate quality control and repeatability and reproducibility of methods and equipment over time. In many instances, it will be possible to use quality control data in assessing uncertainty components such as precision. Where these data are not available, it may be necessary to carry out precision studies or to rely on published information about the method or portions of it until the laboratory can obtain its own estimates.

ARAC is aware of the general need for better estimates of uncertainty, and estimates that are obtained under similar conditions in all laboratories. PT programs are useful mechanisms for spreading awareness of uncertainty of measurement and the effects of different ways of estimating it. We anticipate that the information made available through PT programs will help focus discussions on uncertainty of measurement.

ARAC TC will interpret the information and report on current practices. They will also make recommendations for improving the collection of uncertainty data, the estimation of uncertainties and incorporating data and information on uncertainty of measurement into PT program reports. Therefore we anticipate an evolution in the mechanisms for collecting and reporting uncertainty data and associated information over the next few years.

Participation in ARAC Proficiency Testing programs should assist laboratories to develop appropriate estimates of uncertainty, help to guide accreditation bodies to adopting common and consistent approaches leading to enhanced understanding and international comparability of measurements among the member nations.

ARAC will consider the use of estimates of uncertainty of measurement in the evaluation of its PT testing program results after it is satisfied that participating laboratories are estimating uncertainties of measurement in an appropriate and consistent manner.

Here are a few important terms:

Standard uncertainty ($u(x_i)$) is an input component of uncertainty x_i expressed as a standard deviation. It should be expressed in the units of the influencing parameter, but may be expressed as a percentage where convenient.

Type A evaluation estimates of standard uncertainty are evaluated by applying statistical techniques to a series of repeatability or curve fitting data. For example, a standard uncertainty estimated from the repeatability of measurements on replicate samples is a Type A evaluation.

Type B evaluation estimates of standard uncertainty are based on assumed probability distributions, experience, laboratory records, or other information. For example, a standard uncertainty estimated using data provided on a calibration certificate is a Type B evaluation.

Sensitivity coefficient (c_i) is the mathematical relationship between an influencing parameter and its effect on the result of a measurement. In many instances it is unity. That is, there is a one to one relationship between the value of the influence and its effect on the measurement result. For example, when weighing a sample of material, any uncertainty due to errors in the balance

reading will have a one to one effect on the measurement result. On the other hand, if we are considering the influence of temperature on the length of a metal bar then the sensitivity coefficient is equal to the coefficient of linear thermal expansion for the metal bar multiplied by the length of the bar. It is important to note that a sensitivity coefficient has units. It is also important to note that the calculation methodology used by Eurachem/CITAC4 incorporates sensitivity coefficients in a manner which does not require their specific evaluation.

Combined standard uncertainty ($u_c(y)$) is the final estimate of uncertainty for the test or measurement result *y* expressed as a standard deviation. It is calculated by multiplying the standard uncertainty $u(x_i)$ for each input component (x_i) with its respective sensitivity coefficient c_i to produce $c_i u(x_i)$ and then combining those values by taking the square root of the sum of their squares. Note that the products $c_i u(x_i)$ must each be expressed in the same units as those required for expressing the combined estimate $u_c(y)$.

Expanded uncertainty (*U*) is the final result of our estimate of uncertainty expressed as a confidence interval or coverage. It is calculated by multiplying the combined standard uncertainty by a coverage factor to produce the desired level of confidence (usually 95%).

Coverage factor (*k*) is a multiplier used to expand the combined standard uncertainty $u_c(y)$ to an interval that is estimated to contain the true value of the measurand at a given level of confidence ($U = k.u_c(y)$). The coverage factor then represents the number of standard deviations in the expanded uncertainty and is determined according to the Student-t distribution. A coverage factor of 2 is commonly used to approximate the expanded uncertainty to the 95% confidence level.

Annex F
RECEIPT FORM
INTERLABORATORY COMPARISON ARAC C00# 20##

In order to monitor the progress of the interlaboratory comparison, we kindly ask each Accreditation Body, on receipt of the artifacts, to fill in this RECEIPT FORM and fax it to:

Contact details of the organizer (name, fax, telephone, e-mail)

Thank you in advance for your cooperation.

The artifacts C00_ were received on: _____*(date)*

After inspection, are the contents damaged? _____ *(yes/no)*

Date of issue: March 2013

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:_____
_____
_____
_____
_____

Participating Accreditation Body: _____

Contact person: _____

Fax: _____

e-mail: ----------

Annex G
DISPATCH FORM
INTERLABORATORY COMPARISON ARAC C00# 20##

In order to monitor the progress of the interlaboratory comparison, we kindly ask each Accreditation Body, on dispatch of the artifacts, to fill in this DISPATCH FORM and fax it to:

Contact details (name, fax, telephone)

and **also** fax it to the next participating Accreditation Body:

Name : ---------- Proficiency contact ----------

Date of issue: March 2013

Accreditation body: ----------

Fax: ----------

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 artifacts C00_ were sent on: _____ *(date)*

The artifacts have been inspected after return from our laboratories and were found to be in good condition. _____ *(yes/no)*

Please give details of any problems:
_____
_____
_____

Shipping agent: ___ Telephone: _____ Fax: _____ e-mail: _____

Air waybill No. (or consignment note No.):_____

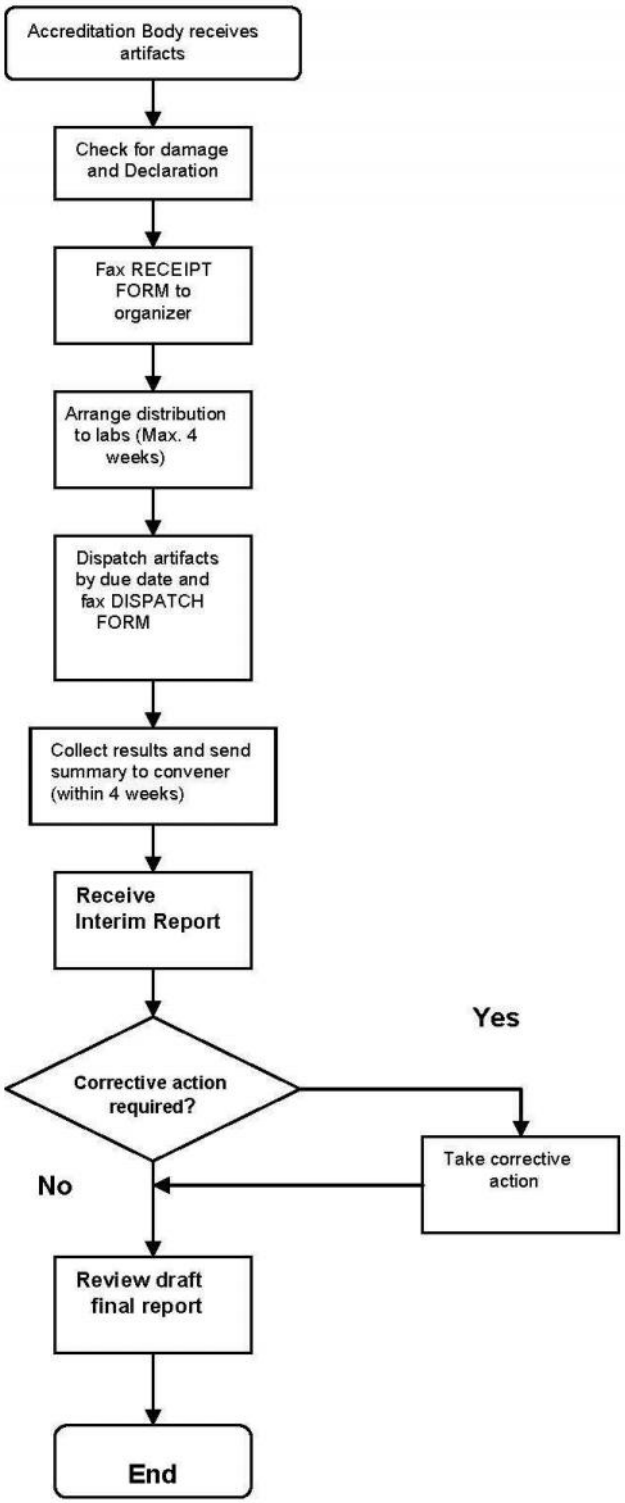
Your Accreditation Body: _____

Contact person: _____

Fax: _____

e-mail: _____

Annex H
FLOWCHART OF SAMPLE RECEIPT BY PARTICIPATING ACCREDITATION BODIES



Annex I
PROFICIENCY TESTING PROGRAM ARAC T0_## 20##

Date of issue: March 2013

Test	Summary statistics	ARAC Sample 1	ARAC Sample 2
Moisture	No. of Results	123	123
g/100g	Median	3,350	3,170
	Normalized IQR	0,252	0,230
Ash	No. of Results	119	119
g/100g	Median	6,080	6,179
	Normalized IQR	0,063	0,074
Fat	No. of Results	119	119
g/100g	Median	22,960	22,910
	Normalized IQR	0,511	0,493
Protein	No. of Results	120	120
g/100g	Median	24,445	24,800
	Normalized IQR	0,465	0,543
Insolubility	No. of Results	34	35
Index	Median	0,100	0,110
mL	Normalized IQR	0,067	0,074