

APOLLO
INTERLABORATORY COMPARISON
PROCEDURE

DRAFT SEPTEMBER 1966



N70-75824	(ACCESSION NUMBER)	(THRU)
	17	none
CR-13226	(PAGES)	(CODE)
(NASA CR OR TMX OR AD NUMBER)		(CATEGORY)

Prepared By

Quality Program
Apollo Support Department
General Electric Company
Daytona Beach, Florida

September 1966

PREFACE

This document outlines a method of performing interlaboratory comparisons to verify measurement accuracy capabilities among Apollo standards and calibration laboratories. These comparisons will be based on the comparison of data taken at participating Apollo laboratories with data from national reference standards, through the use of an established "comparison package" of standards and measuring instruments. The Apollo Interlaboratory Comparison Procedure is prepared as an element of the Apollo Metrology Program in accordance with paragraph 3.13 of the Apollo Metrology Requirements Manual (MIB 5300.2).

APOLLO
 INTERLABORATORY COMPARISON
 PROCEDURE

TABLE OF CONTENTS

<u>Paragraph</u>	<u>Page</u>
1.0 PURPOSE	1
2.0 SCOPE	1
3.0 APPLICABILITY	1
4.0 DEFINITIONS	1
4.1 Accuracy	1
4.2 Administrator	1
4.3 Calibration	2
4.4 Comparison Package	2
4.5 Comparison Report	2
4.6 Inspection, Measuring and Test Equipment	2
4.7 Interlaboratory Comparisons	2
4.8 Interlaboratory Comparison Summary	2
4.9 Laboratory	2
4.10 Metrology	2
4.11 Participating Laboratories	2
4.12 Reference	2
4.13 Representative	2
4.14 Standard	3
4.15 Test Review Form	3
5.0 RESPONSIBILITIES	3
5.1 Administrator	3
5.2 Participating Laboratory	4
6.0 COMPARISON PACKAGE	5
6.1 Selection	5
6.2 Packaging and Handling	5
6.3 Transportation	5
7.0 OPERATION	5
7.1 Measurement Tests	6
7.2 Measurement Test Review	6
7.3 Reference	7
7.4 IBS/NBS Relationship	7
7.5 Reports	7

APOLLO INTERLABORATORY COMPARISON PROCEDURE (Cont'd)

Figure 1 Flow of Report Forms

Figure 2 Test Review Form (Example)

Figure 3 Example of Comparison Results
 (Part of Interlaboratory Comparison Summary)

Figure 4 Example of Bar Chart Presentation
 (Part of Interlaboratory Comparison Summary)

APOLLO
INTERLABORATORY COMPARISON
PROCEDURE

1.0 PURPOSE

The purpose of this Procedure is to establish specific requirements for conducting measurement accuracy comparisons which will provide for determining the compatibility of measurements among participating laboratories.

2.0 SCOPE

The scope of this document includes detailed methods for conducting interlaboratory measurement comparisons as follows:

- a. Responsibilities of the participating laboratories and the administrator.
- b. The development and handling of the comparison package(s).
- c. Performance of the measurement tests.
- d. The required report forms.
- e. The comparison and evaluation methods.

3.0 APPLICABILITY

This Procedure is applicable to all Apollo Metrology Laboratories and will be utilized in the performance of accuracy comparisons of standards which are used to calibrate lower level standards or to calibrate inspection, measuring and test equipment.

4.0 DEFINITIONS

To promote mutual understanding and to assist in effective communication for implementing this Procedure, the following definitions are established.

- 4.1 Accuracy. The ability of an instrument (standard or measurement equipment) to indicate or record the exact value of a measured quantity. The accuracy of an instrument is expressed as the difference between the indicated value and the exact value of the measured quantity.
- 4.2 Administrator. The function responsible for the coordination and administration of the Interlaboratory Comparisons.

- 4.3 Calibration. Comparison between two instruments or devices (one of which is a standard of known accuracy) to detect, correlate, report, and/or adjust any variation in the accuracy of the instrument being compared.
- 4.4 Comparison Package. The group of selected standards and/or measurement equipment which is measured at a reference laboratory and at participating laboratories for comparing results to determine compatibility of measurement accuracies.
- 4.5 Comparison Report. The final individual participant's reports for each instrument or group of instruments. This report is derived from the Test Review Form (paragraph 4.15) and sent to the participating laboratory by the administrator.
- 4.6 Inspection, Measuring and Test Equipment. Equipment (including tooling) used to inspect, measure or test hardware to determine conformance to applicable design specifications. Tooling includes tools, gages, jigs and fixtures which measure dimensions, contours or locations affecting quality characteristics.
- 4.7 Interlaboratory Comparisons. The comparison of measurement data taken at the participating laboratories with data from a reference laboratory through the use of an established "comparison package" of standards and/or measuring equipment.
- 4.8 Interlaboratory Comparison Summary. The summary report issued by the administrator to all the participating laboratories. This report will summarize and compare all data taken at each laboratory with that recorded by the reference laboratory.
- 4.9 Laboratory. Any segregated area specifically equipped for calibration of standards and/or calibration of inspection, measuring and test equipment.
- 4.10 Metrology. The science and technology of measurement of any parameter of weight, mass, length, chemical and electrical unit, and physical constant. This technology includes the selection, utilization, and control of equipment used to provide measurements, and also, includes assurance of a valid relationship between measured values and values of measurement established by national reference standards and international agreements.
- 4.11 Participating Laboratories. The NASA (or contractor) laboratories performing the comparison tests as required by this Procedure.
- 4.12 Reference. The measurements made by a reference laboratory, usually the Institute of Basic Standards of the National Bureau of Standards (IBS/NBS) of all items included in the comparison package(s). This data will be recorded and will be the reference values from which comparisons will be made.
- 4.13 Representative. The person or persons representing the administrator who will be present at each participating laboratory during the performance of the measurement comparison tests.

- 4.14 Standard. An item which is established as an authorized or recognized measurement reference, and is used to calibrate other standards or to calibrate inspection, measuring and test equipment.
- 4.15 Test Review Form. The form supplied for an instrument or group of instruments for the recording of the required test data. This form will contain spaces for reference values as recorded by the reference laboratory, and will be used for the purpose of an oral comparison review with the participating laboratory, and for inputs to the Comparison Report and the Interlaboratory Comparison Summary.

5.0 RESPONSIBILITIES

The administrator and the participating laboratories are responsible for coordination of activities to assure successful interlaboratory comparisons.

- 5.1 Administrator. The administrator shall have the following responsibilities:
- a. Evaluate, maintain, and update the comparison package(s). The administrator will obtain the required equipment for the package(s) and will be responsible for:
 - (1) Equipment inventory.
 - (2) Evaluation of equipment, if required.
 - (3) Assigning and applying identifying numbers to each equipment item and associated adapters, cables, and instruction sheets.
 - (4) Maintaining required historical records.
 - (5) Calibration and maintenance, as required.
 - b. Assure that the outer case and all external adjustments of each comparison package item are adequately sealed to prevent unauthorized tampering.
 - c. Make all arrangements with the reference laboratory to schedule required reference tests.
 - d. Provide and maintain the special carrying containers required for each item. Identify each container with its associated equipment.
 - e. Label all comparison packages and instructions as part of the Apollo Interlaboratory Comparison.
 - f. Inform the participating laboratories of the contents of the comparison package(s) and measurement parameters, and schedule arrival of the package(s) at each participating laboratory on a mutually agreed upon basis. Time limits for processing the package(s) will be established at this time.

- g. Assure that the participating laboratory has all special instructions and required Test Review Forms for each item of equipment in the comparison package.
- h. Observe measurement tests at each participating laboratory and review results with laboratory management.
- i. Complete and issue the Comparison Reports for transmittal to each participating laboratory.
- j. Complete and issue the Interlaboratory Comparison Summary Report when all participating laboratories have completed one round of comparison tests.

5.2 Participating Laboratory. Each laboratory participating in the interlaboratory comparison has the following responsibilities:

- a. Provide information to the administrator regarding location of laboratory and any other special information he may need to facilitate shipment of comparison package(s).
- b. Schedule sufficient personnel, facilities, and priority to the measurements so as to be able to complete the tests in the allotted time. Coordinate this schedule with the administrator.
- c. Plan for receipt, handling, unpacking and temporary storage of the comparison package(s).
- d. Assure safe handling and storage of the special containers which are to be used for future transportation of the comparison items.
- e. Match each item of equipment and any associated adapters or leads with applicable instructions and Test Review Forms via identifying numbers.
- f. Acclimate individual equipments to the test area environments per instructions for each item.
- g. Estimate attainable accuracy for each item to be measured within the comparison package and record on applicable Test Review Form.
- h. Perform the measurement tests per written instructions using existing equipment, facilities, and personnel supplemented by any specific instructions from the administrator for any particular item. Record the measured values on the Test Review Forms supplied.
- i. Assure that repairs or adjustments are not made to any item in the comparison package(s).

- j. Prepare the comparison package(s) for shipment to the next participating laboratory using the special containers.
- k. Review Comparison Reports and the Interlaboratory Comparison Summary.

6.0 COMPARISON PACKAGE

The comparison package is composed of various items of selected equipment to properly sample the measurement capabilities at each participating laboratory. This package will be periodically updated as the comparison scope is changed by deletions or additions dependent upon experience, requirements and requests of participants.

6.1 Selection. The selection of the items comprising the comparison package(s) will be based on the following:

- a. Specific parameter(s) to be measured.
- b. Stability.
- c. Environmental effects.
- d. Size and weight.
- e. Availability and cost.

6.2 Packaging and Handling. The administrator will provide for the proper packaging, labeling and handling of the comparison items including individual protective instrument containers to safeguard the particular item. The administrator shall assure that packaging is designed to give adequate protection during transportation and handling and shall include locks or similar means of assuring only authorized access.

6.3 Transportation. The administrator will provide instructions for transporting the comparison package(s) to each of the participating laboratories and to the reference laboratory.

7.0 OPERATION

The operation of the interlaboratory comparison will commence with the reference laboratory measuring each comparison item and establishing initial reference values. The comparison package(s) will then be transported to the first participating laboratory for performance of measurement tests. When tests are completed at the first location, the package(s) will be transported per an established schedule to each of the subsequent participating laboratories. When the package(s) has made the rounds of all participants, it will be returned to the reference laboratory to detect damage, change, and to provide final reference values.

There will be no reference measurement values included in the comparison package(s); the reference laboratory will forward this data, under separate cover, to the administrator.

The participants will make the necessary arrangements for the performance of the measurement tests to the established schedules and instructions.

Detailed instructions for the handling, packaging and transportation of the comparison package(s) will be supplied to each participating laboratory by the administrator.

7.1 Measurement Tests. The measurement techniques of calibration utilized by the participant for the comparison measurements shall be in conformance with the participant's normal operations. This will provide an accurate measure of the participant's overall capability including facilities, personnel, standards, measuring equipment and operating procedures. Stipulations for the measurement tests are as follows:

- a. The comparison package containers will be opened in the laboratory by authorized personnel only.
- b. The containers will be retained for repacking and transporting the comparison package(s).
- c. Each component within the comparison package(s) will be acclimated in the laboratory per individual equipment instructions.
- d. Prior to connecting, energizing, or starting the measurement, the Test Review Forms (See 7.5 a) and instruction sheets will be reviewed to determine the conditions of measurement.
- e. The participant shall estimate the attainable accuracy for each measurement test. These deviations should be compatible with the equipment accuracy at that location and will be recorded on the applicable Test Review Form.
- f. Test Review Forms shall be completely filled out by the participant including a brief statement of the measurement technique used or a simple block diagram of the method used.
- g. Test data shall be obtained using the facilities' usual methods. All information required by the Test Review Forms shall be recorded. When environmental test conditions are other than those specified, data shall be corrected to the specified condition. Calculations for converting test data shall be included with the Test Review Forms.

7.2 Measurement Test Review. Measurement tests will be observed by the representative. After completion of the measurement tests an initial review will be made. This review will be performed by the representative as follows:

- a. Insert reference values on all Test Review Forms (See 7.5 a) after measurement data has been recorded.
- b. Calculate the participants actual deviation from the reference value for each measurement.

- c. Orally review results with the participant.
- d. Request a retest on all items in which the deviation is greater than the estimated accuracy for the item. Retests shall be performed as many times as it is deemed necessary by the representative to determine whether the deviation is due to systematic error, random error, instability, or an overestimation of the participant's measurement deviation limits. Every retest shall be recorded and identified on the Test Review Forms under "Rechecks and Remarks" and results reviewed with the participant. Copies of the Test Review Forms will be left with the participant.

Note: If the representative is not present during the performance of the tests and the subsequent review, the administrator will provide specific instructions to the participant to permit an initial comparison, and to determine if retests are required.

- 7.3 Reference. Reference values for the Interlaboratory Comparison shall be established by IBS/NBS, except for comparisons directed at lower accuracy levels which could be established by a selected contractor who is qualified through satisfactory traceability to national reference standards. Reference tests shall be performed at the start and finish of each round of interlaboratory comparisons.
- 7.4 IBS/NBS Relationship. When utilizing the facilities of the IBS/NBS for the purpose of establishing reference values, the administrator will:
 - a. Establish working relations with appropriate IBS/NBS personnel.
 - b. Arrange schedules for obtaining reference values for comparison items, including NBS schedules and fees.
 - c. Review test data requirements with NBS to ascertain if the test data requested of the participants is compatible with NBS data.
 - d. Obtain information from NBS on special situations of comparison items, i.e., special handling, packaging, temperature, shock, vibration limits, calibration intervals, unlisted calibration fees, etc.
- 7.5 Reports. Three types of reports are utilized to accumulate measurement comparison data and to disseminate information of comparison results to the participants. Figure 1 shows the sequence of use of these reports.
 - a. Test Review Form. These forms (Figure 2) are supplied for each comparison item. In some cases, several separate items may be listed on a single form. The form contains spaces for all pertinent information related to the laboratory location, equipment, and the measurement comparison. It is important that the estimated accuracy be given by the participant for each item listed.

b. Comparison Report. The Comparison Report is compiled by the administrator from data recorded on Test Review Forms, and is sent to the participant to provide information, and a basis for corrective action, if required. This report will be prepared as follows:

- (1) Address the Comparison Report to the person directly responsible for the participant laboratory operation.
- (2) Date the report at its completion date and state the dates the actual measurements were made.
- (3) Include a statement of interlaboratory comparison objectives.
- (4) Include explanatory comments concerning deviation limits for the program, if they have been established.
- (5) Include general comments summarizing the highlights of the comparison.
- (6) Tabulate the comparison of measurements and all pertinent retests that will help the participant find the source for large deviations.
- (7) Include a summary of areas in which retests were necessary.
- (8) Summarize separately any deviations that were not resolved by retest.

c. Interlaboratory Comparison Summary. This is a summary report of the results of the interlaboratory comparisons encompassing all of the participants, and will be prepared by the administrator. This report will be of interest to all the participants as it provides the comparative measure of measurement agreement among participants. This comparison information will assist the participants to assess themselves and take any required corrective action.

The Interlaboratory Comparison Summary report will contain the following.

- (1) A description of the program including:
 - (a) Program background and objectives.
 - (b) Identification of participating laboratories.
 - (c) Description of standards used and packaging utilized.
- (2) A section of brief comments on the highlights of the results of the overall interlaboratory comparisons.

- (3) Comparison results presented in tabular form (Figure 3).
 - (a) This tabulation is the heart of this report and is compiled from the previously issued Comparison Reports.
 - (b) The basic tabular data will be derived using the difference of recorded measurements from reference values on each of the items in the comparison package.
 - (c) For items that required rechecks, the final value will be used.
- (4) Deviations presented in a graphic form such as the bar charts as shown in Figure 4.

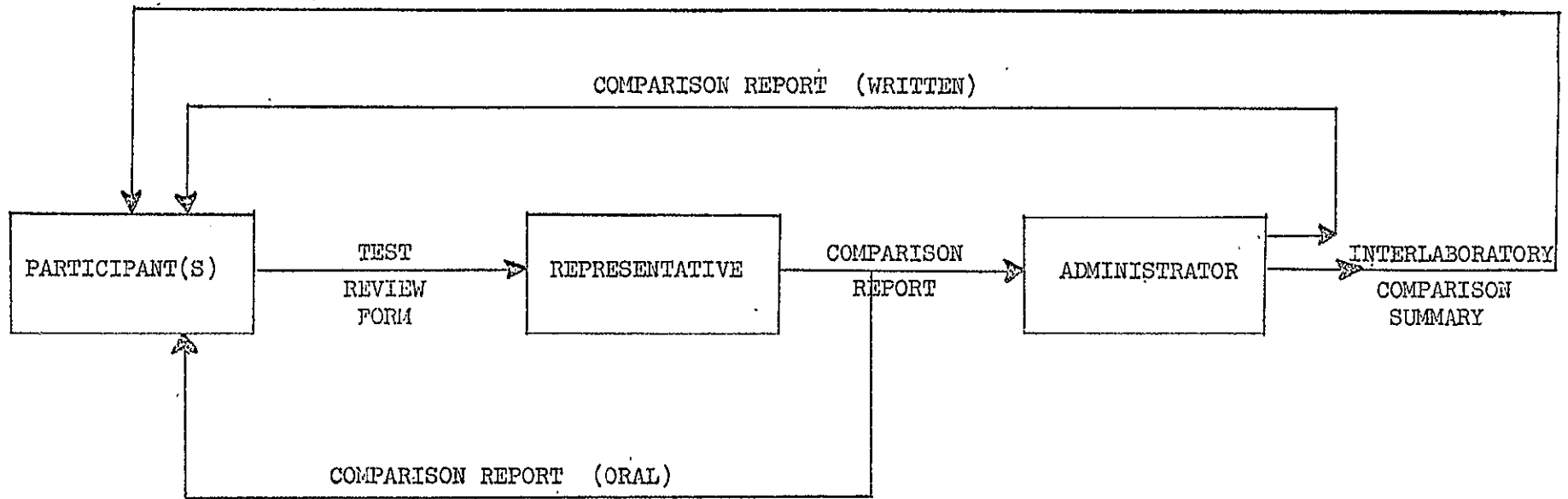


Figure 1. Flow of Report Forms

Test Review Form

STANDARD RESISTOR

Company _____
Address _____
Laboratory _____ Component _____
Calibration procedure title _____
Calibration procedure number _____ Source _____
Calibration technician _____ Date _____
Ambient temperature _____ and % relative humidity _____
Other pertinent environmental conditions _____

Test Conditions

Test resistor in circulating oil bath at 25° C
Power dissipation limit, 0.1 watt
If calibrated at some other temperature, calculate and report 25° value.

Leeds & Northrup, - 4040-B, Serial No. _____ 10,000 ohms
Estimated uncertainty _____
Measured value in ohms or PPM deviation _____
Reference value 1st _____
2nd _____

Rechecks and Remarks

Use reverse side for brief description of method or block diagram.

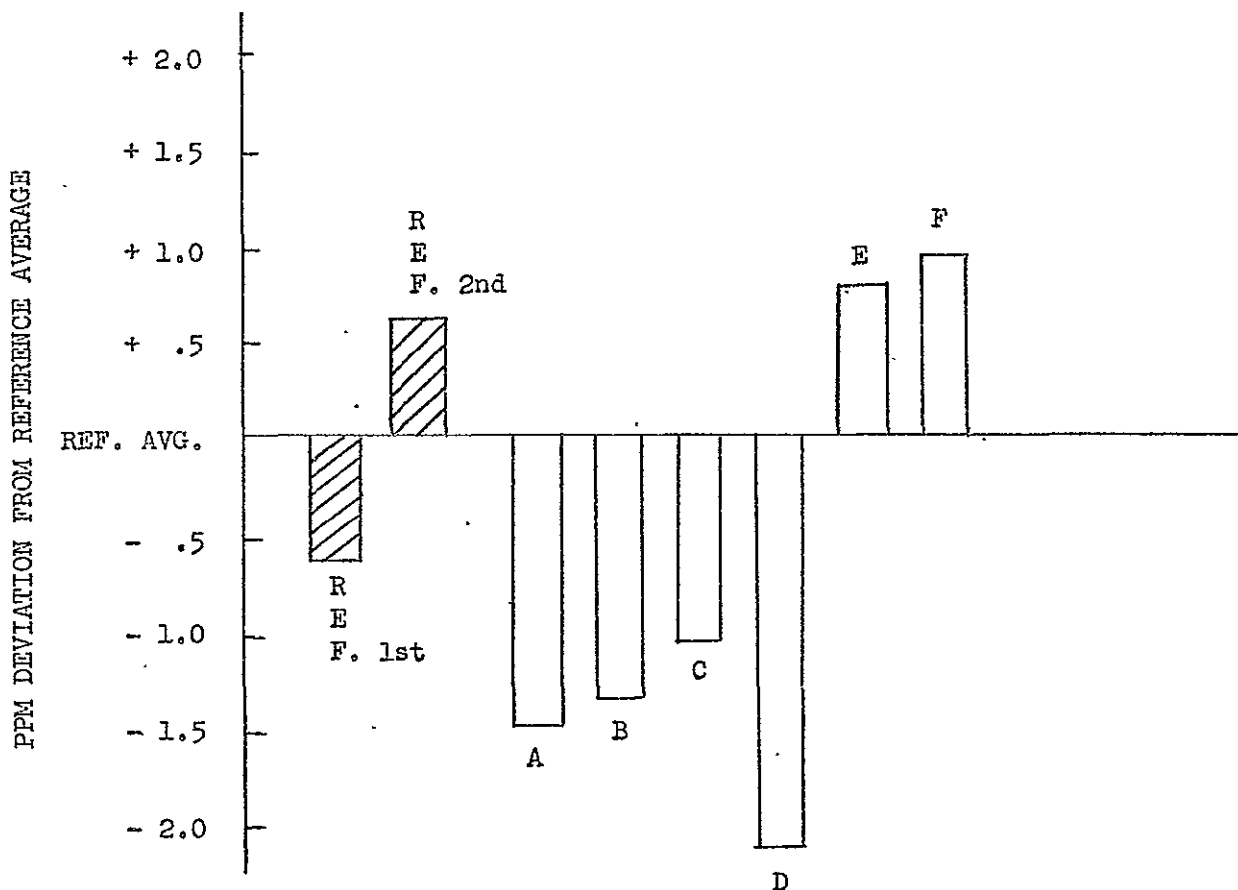
Figure 2. Test Review Form (Example)

1000 OHM RESISTOR			12.4 VOLTAGE REFERENCE	
LABORATORY	DEVIATIONS IN PPM	PPM DEVIATION FROM REF-AVG	DEVIATIONS IN VOLTS	VOLT DEVIATION FROM REF-AVG
REF - 1st	19.9	- .6	+ .6208	+ .04
REF - 2nd	21.1	+ .6	+ .5412	- .04
REF - AVG	20.5	0	+ .5810	0
A	19.0	-1.5	+ .6	+ .019
B	19.2	-1.3	+ .85	+ .269
C	19.4	-1.1	+ .42	- .161
D	18.4	-2.1	+ .35	- .231
E	21.2	+ .7	+ .5	- .081
F	21.4	+ .9	- .2	- .781

- . SIMILAR TABULATIONS WILL INDICATE COMPARISON AGREEMENT FOR ALL OTHER ITEMS IN THE COMPARISON PACKAGES.
- . "REF - 1st" IS REFERENCE VALUE AT START OF INTERLABORATORY COMPARISON.
"REF - 2nd" IS REFERENCE VALUE AT END OF COMPARISON ROUND.
- . A, B, C, ETC. ARE CODE SYMBOLS OF PARTICIPANTS.

Figure 3. Example of Comparison Results (Part of Interlaboratory Comparison Summary)

10000 OHM RESISTOR



- . REF. AVG. represents average reference value.
- . REF. 1st is reference value at start of comparison.
- . REF. 2nd is reference value at end of comparison round.
- . A, B, C, etc. are code symbols of participants.
- . Similar charts will be used for all comparison items.

Figure 4. Example of Bar Chart Presentation
(Part of Interlaboratory Comparison Summary)