Barbados Civil Aviation Department

BCAD Document AAC-003

AIRWORTHINESS

ADVISORY

CIRCULAR

CALIBRATION OF TOOLS, EQUIPMENT AND TEST EQUIPMENT

CALIBRATION OF TOOLS, EQUIPMENT AND TEST EQUIPMENT

I. PURPOSE.

This Advisory Circular provides guidance on calibration of tools, equipment and test equipment to standards acceptable to the DCA. It outlines one method of compliance with Civil Aviation (Approved Maintenance Organisation) Regulation (CA(AMO)R Regulation 18 (3) of the Regulations. Instead of following this method, the applicant may elect to follow an alternate method, provided the method is acceptable to the DCA for compliance with CA(AMO)R Regulation 18 (3).

II. RELATED SECTIONS OF BCARs.

CA(AMO)R Regulation 18 (3) requires that at all applicable tools, equipment and test equipment used for product acceptance and/or for making a finding of airworthiness be calibrated to a standard acceptable to the DCA and traceable to the State National Standards or other International Standards.

III. ACRONYMS.

The following acronyms apply to this Advisory Circular.

1. ***AMO.*** Approved Maintenance Organisation.
2. ***DCA*** Director of Civil Aviation
3. ***BCAR.*** Barbados Civil Aviation Regulations.
4. ***PPM.*** Parts Per Million.
5. ***SI.*** International System of Units.

IV. DEFINITIONS.

The following definitions apply when these terms appear in the BCARs or this Advisory Circular.

1. ***Accreditation***. The granting of an approval to a calibration laboratory or other facility by a recognized authority indicating that the calibration laboratory or facility is qualified to calibrate a measurement device to a stated accuracy.

2. ***Accuracy (Measurement Accuracy).*** A number which indicate that closeness of a measured value to the true value, or the ability of a measurement device to make measurements with a small uncertainty. (Meteorologists or Calibration Laboratory's prefer to use the uncertainty of a measurement (e.g., uncertainty of ±12ppm). Instead of accuracy (e.g., accurate to 99.9988%).

3. ***Aeronautical Product.*** Any aircraft, aircraft engine, propeller, or subassembly, appliance, material, part, or component to be installed thereon.

4. ***Approval for Return to Service.*** A certification by an approved maintenance organisation representative that the maintenance, preventive maintenance, or modification performed on an aircraft, airframe, aircraft engine, propeller, appliance, or component part thereof was accomplished using the methods, techniques and

practices, prescribed in the current manufacturer's maintenance manual or instructions for continued airworthiness prepared by its manufacturer, or by using other methods, techniques and practices acceptable to the DCA.

5. ***Calibration.*** A set of operations, performed in accordance with a definite documented procedure, that compares the measurement performed by a measurement device or working standard for the purpose of detecting and reporting or eliminating by adjustment errors in the measurement device, working standard, or aeronautical product tested.

6. ***Calibration label.*** A label affixed to a measurement device, precision tool and/or test equipment that shows its calibration status. The label typically indicates the measurement device, identification, who performed the last calibration and when.

7. ***Calibration facility or laboratory.*** A workspace, provided with calibrated measurement device(s), controlled environment and trained personnel established for the purpose of maintaining proper operation and accuracy of measurement devices.

8. ***Calibrator.*** A secondary standard that supplies outputs with a known uncertainty for use in checking the accuracy of measurement devices.

9. ***Maintenance.*** Tasks required to ensure the continued airworthiness of an aircraft or aeronautical product including any one or combination of overhaul, repair, inspection, replacement, modification and defect rectification.

10. ***Maintenance Release.*** A maintenance organisation document signed by an authorized maintenance organisation representative that states that the article worked on is approved for return to service for the maintenance, preventive maintenance, or modification performed.

11. ***Measurement Device.*** A calibrated calibrator, standard, tool, equipment and test equipment that is intended to be used to test, measure, or calibrate working standards or other measurement devices. It is not to be used to test, measure, or calibrate an aircraft or aeronautical product. (See Figure 1)

12. ***Metrology.*** The science of and the field of knowledge concerned with measurement. Metrology includes all aspects of measurements, whatever their level of accuracy and in whatever fields of science or technology they occur.

13. ***Mutual Recognition Agreement.*** An agreement between signatory national measurement laboratories in different countries concerning acceptance of each other's measurement capabilities.

14. ***National Laboratory.*** A laboratory that is legally responsible for maintaining the physical standards on which all measurements in the nation are based.

15. ***Primary Standard.*** A standard defined and maintained by a State Authority and used to calibrate secondary standards.

16. ***Reference Standard.*** A standard that is used to maintain working standards.

17. ***Secondary Standard.*** A standard maintained by comparison with a primary standard.

18. ***Specification (Measurement Device Specification or Spec).*** A documented presentation of the parameters, including accuracy or uncertainty, describing the capability of an instrument.

19. ***Standard***

a. ***Standard - Measurement Standard.*** An object, artifact, Measurement Device, system or experiment that stores, embodies, or otherwise provides a physical quantity, which serves as the basis for measurements of the quantity.

b. ***Standard - Paper or Protocol Standard.*** A Document describing the operations and processes that must be performed in order for a particular end to be achieved. Called by Europeans a "protocol" to avoid confusion with a physical standard.

20. ***Test Report (Calibration Report/Record or Report of Calibration).*** A document describing a calibration, including the results, what was done, by whom, under what conditions and using what equipment and procedures. It could also include any attachments, such as, data sheet(s), graph(s), etc.

21. ***Tools, Equipment, and Test Equipment.*** Used by an AMO for the performance of maintenance or calibration on an aircraft or aeronautical product. (Also see Working Standard).

22. ***Traceability.*** A characteristic of a calibration, analogous to a pedigree. A traceable calibration is achieved when each Measurement Device and Working Standard, in a hierarchy stretching back to a national or international standard, was itself properly calibrated and the results properly documented. The documentation provides the information needed to show that all calibrations in the chain of calibrations were properly performed.

23. ***Transfer Standard.*** Any standard that is used to compare a measurement process, system or device at one location or level with another measurement process, system or device at another location or level.

24. ***Uncertainty.*** A numerical value that indicates the dispersion of values that could be reasonably assigned to the measured quantity. Usually expressed as a standard deviation or some multiple standard deviation.

25. ***Working Standard.*** A calibrated standard that is used in the performance of maintenance and/or calibrations in any work area for the purpose of forming the basis for product acceptance or for making a finding of airworthiness (approval for return to service) to an aircraft or aeronautical product. A working standard may be

maintained by comparison to reference standards, transfer standards, secondary standards, primary standards, etc. A working standard is not to be used to test, measure, or calibrate other working standards or measurement devices. (See figure 1)

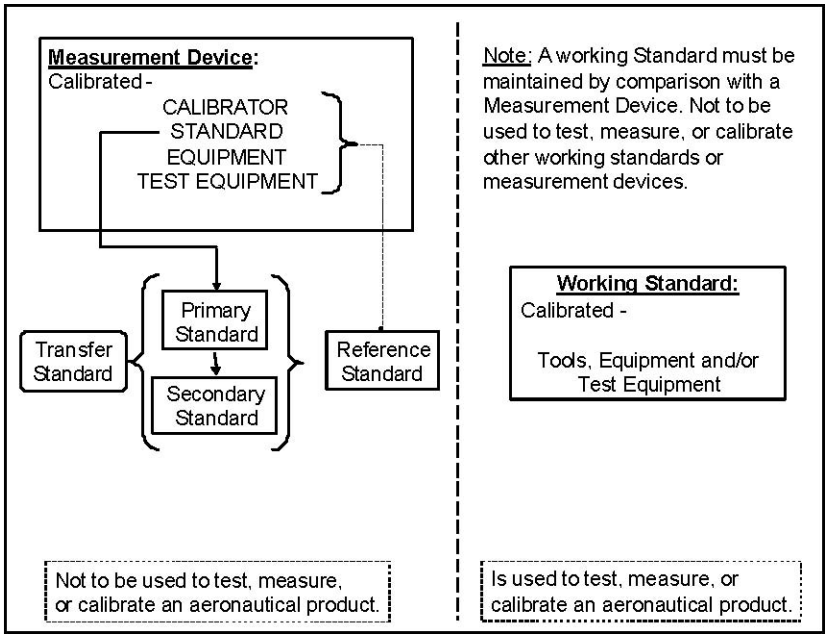

Figure1

V. BACKGROUND.

1. **Requirement**. CA(AMO)R Regulation 18 (3) requires that all AMOs ensure that all tools, equipment and test equipment (working standard) is tested and calibrated to a standard acceptable to the DCA.

Civil Aviation (Airworthiness) Regulations (CA(A)R) Regulation 28 (1) & (2) requires that each person performing maintenance, preventive maintenance, or modification on an aeronautical product shall use the methods, techniques and practices prescribed in the current manufacturer's maintenance manual or instructions for continued airworthiness prepared by the manufacturer; and additional methods, techniques and practices required by the DCA, or methods, techniques and practices designated by the DCA where he manufacturer's documents were not available.

CA(A)R Regulation 28 (3) & (4) requires that each person shall use the tools, equipment and test apparatus necessary to assure completion of the work in accordance with accepted industry practices. If the manufacturer involved recommends special equipment or test apparatus, the person performing maintenance shall use that equipment or apparatus or its equivalent acceptable to the DCA.

CA(A)R Regulation 28 (5) requires that each person performing maintenance, preventive maintenance, or modification on an aeronautical product shall do that work in such a manner and use materials of such a quality, that the condition of the aeronautical product worked on will be at least equal to its original or properly altered condition with regard to

aerodynamic function, structural strength, resistance to vibration and deterioration and other qualities affecting airworthiness.

2. **National Standards**. Every country either maintains a national laboratory housing the national standards for each quantity, or makes use of another country's national laboratory. Transfer standards may be physically transported to the national laboratory for comparison with the national standards. These national standards usually have year, even decades, of history associated with them. Their stability and uncertainty are therefore proved and accepted. The State Authority is usually the organisation that will establish, maintain and disseminate the primary standards of measurement for the country.

3. **International System of Units (Standards).** The international System of Units (SI) is the foundation of modern metrology. It is some times referred to as the "modern metric system" because the names of many of its units are carried forward from the original French metric system, which was established in 1960 by the General Conference of Weight and Measures. Like the United States most other nations subscribe to this conference and use the SI for most legal, scientific and technical purposes.

The SI units are used internationally and are the basis of all modern measurements. In the United States, the national system of measurement is the U.S. Customary System. However, all customary units, such as the inch, the foot, the yard and the pound, are defined in terms of the SI base units. For example, an inch is defined as being 2.54 centimeters in length.

The international use of the SI depends on scientific cooperation and legal agreements. Scientific cooperation is focused on improving the definition, realization, representation and dissemination of the basic units of measurement. Legal agreements ensure that scientific progress can be readily transferred across international borders to provide global support for advances in metrology and commerce.

4. **Traceability.** Traceability refers to the procedures and records that are used and kept to demonstrate that calibrations made in a calibration facility or laboratory accurately represent the quantities of interest. The scientific aspects of traceability involve principles of metrology used locally and independently by scientists, engineers and technicians. The legal aspects of traceability involve a governmentally established and maintained infrastructure within which the measurements are performed. The infrastructure that is in general use today has three major constituents:

a. World-wide legal adoption of the International System of Units (SI) as the basic system of units of weight and measure.

b. The establishment of national measurement laboratories that are chartered to maintain representations of the SI units (standards) and to disseminate their values to calibration laboratories.

c. Definition, implementation and use of methods and procedures that allow individual calibration facility or laboratories to compare their local standards with those of the national laboratories.

Traceability as known internationally is defined as "The property of the result of a measurement or value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons, all having stated uncertainties.

VI. POLICY.

For the purpose of clarification and standardization, tools, equipment and test equipment used by an AMO for product acceptance and/or for making a finding of airworthiness are otherwise known as working standards.

Calibrated calibrators, standards, tools, equipment and test equipment used to test, measure, or calibrate other calibrators, standards, tools, equipment and test equipment are otherwise known as measurement standards. A measurement device is not to be used to test, measure, or calibrate an aircraft or aeronautical product. Refer to Figure 1.

It is the responsibility of the AMO to ensure that the working standards are regularly calibrated to a standard acceptable to the Authority and traceable either directly or indirectly to a National or International Standard.

1. **Working Standards (Tools, Equipment, Test Equipment, Etc.)** An AMO may only use working standards that are regularly calibrated and traceable, as prescribed herein, when used for product acceptance and/or for making a finding of airworthiness.

An AMO shall establish:

a. A clear system of labeling all working standards to identify the next inspection or service or calibration is due and, if the item is unserviceable for any other reason or which may have limitations where it may not be obvious to the user.

b. A clear system of labeling all tools, equipment and test equipment not used for product acceptance and/or for making a finding of airworthiness.

c. Procedures in place that prohibit use of such non-calibrated working standards for product acceptance and/or for making a finding of airworthiness.

d. Procedures to inspect/service and where appropriate, calibrate working standards on a regular basis. This procedure must not be specific to any one ownership but should address tools, equipment and test equipment owned by the AMO or by a person employed or contracted by the AMO.

e. Procedures if it uses a measurement device for performing calibrations to another measurement device, that measurement device cannot be used to perform maintenance or calibrations on an aircraft or aeronautical product.

f. A program that ensures the recall or removal from service any working standard which has exceeded its calibration interval, has broken calibration seals, or is suspected to be malfunctioning because of mishandling, misuse, or unusual results or is otherwise judged to be unreliable.

g. A program that ensures that the AMO quality System addresses the traceability, calibration and system of a working standard performed by a calibration facility or laboratory.

h. A register of all working standards by make, model and serial number.

i. A record of calibrations for each working standard.

j. A program that ensures that working standards will not be used to test, measure, or calibrate other working standards or measurement devices.

k. Procedures in place to ensure that a calibration facility or laboratory shall comply with the record requirements.

2. **Measurement Devices**. This only applies if the AMO intends to perform its own testing, measuring, or calibrations to other measurement devices or working standards.

a. Same policy as the working standard above specific to Section VI, paragraphs 1(a), (d), (e), (f), (g), (h), (i), (j) and (k).

b. A program that ensures that the measurement device will not be used for product acceptance or for making a finding of airworthiness.

c. If the repair station offers a calibration service to other certificated repair stations, it must have a notification and recall procedure.

3. **Calibration Interval.** Working standards must be calibrated annually unless substantiation is provided over several calibration periods that reflect repeated accuracy. This is based on each specific working standard and its accessory. Calibration intervals are best established based on the performance on individual working standards including accessories with consideration given to their application and calibration history. The calibration intervals for working standards will also vary with the type of equipment, environment and use. Two similar working standards can be operated under very different conditions. One may be outside, exposed to the sun, damp air and dirt and used two shifts per day, while the other may be in a fixed location within a workshop under a controlled environment, only one shift uses it per day and maybe used only occasionally.

Evidence of a suitable calibration interval may be a calibration interval recommended by the manufacturer of the working standard or if the AMO can show by results that a different time period is appropriate in a particular case and acceptable to the DCA.

NOTE: ***A working standard must be calibrated at periodic intervals established and maintained to assure acceptable reliability, where reliability is defined as the probability that the working standard will remain in tolerance throughout the interval. Calibration intervals must be established for all working standards that are used in the performance of maintenance and/or calibrations in any work area for the purpose of forming the basis for product acceptance or for making a finding of airworthiness (approval for return to service) to an aircraft or aeronautical product regardless if the working standard is owned by the AMO or by a person employed or contracted by the AMO.***

a. In the case where an AMO is intending to extend the calibration interval for inspection, service, or calibrations of working standards the AMO must provide substantial documentation to support different calibration intervals beyond the annual interval or the one recommended by the working standard manufacturer. The AMO must have procedures to ensure that the working standards will continue to meet the extended calibration interval and a method of tracking such working standards to ensure that the equipment stays in proper calibration. Procedures in place for reducing working standard calibration intervals if the working standard can no longer withstand the extended time intervals.

NOTE: ***Two basic and interacting areas of policy and procedure that affect calibration quality are the assignment and adjustment of calibration intervals and the policy regarding the circumstances under which adjustments are made during the process of calibration. Both of these areas involve technical questions as well as philosophical and environmental considerations.***

b. Considerations for acceptance of calibration intervals include but are not limited to the following:

i. Manufacturer's recommendations for the type of equipment.
ii. Calibration facility or laboratory past calibration history, as applicable.
iii. AMO's intended use, appropriate training, environmental conditions, etc., and
iv. Adequate procedures developed by the AMO.

4. **Working Standard Manufacturer's Manual/Instructions.** In the case where the working standard manufacturer's manual/instructions does not describe a test and/or calibration procedure, the AMO must coordinate with the working standard manufacturer to develop the necessary procedures prior to any use of the working standard. In addition, the AMO must receive from the working standard manufacturer a written acceptance to the complete test and/or calibration procedure specific to the make, model, modification status and serial number or working standard manufacturer specific description, prior to any use of the working standard.

In the case where the working standard manufacturer is no longer in business and the working standard is beyond the calibration due date, an AMO shall not use such a working standard unless the DCA has validated and accepted the test procedure.

5. **Calibration Facility or Laboratory.** A calibration facility or laboratory can be any person or organisation that tests and/or calibrates measurement devices or working standards. Regardless if the AMO itself performs the test and/or calibrations or contracts out such work the AMO must retain and provide to the BCAD the documented evidence of traceability, standards used, procedure(s) used, data sheets (if applicable) and any other data requested by the BCAD.

A calibration facility or laboratory must perform the calibrations in accordance with the working standard manufacturer instructions and requirements using measurement devices traceable to a National or International Standard.

6. **Traceability.** An AMO must show that the working standard has been calibrated within an established calibration interval and that the calibration is traceable to a National or International Standard. To show traceability, the AMO must show documented evidence of an unbroken chain back to the National or International Standard. This traceability must be shown by calibration records identifying the measurement devices used in the calibration of the working standards have been calibrated to a standard that is in turn traceable a National or International Standard.

7. **Personnel.** An AMO shall ensure that it has appropriate personnel trained in metrology, as appropriate for the performance of reviewing calibration records or reports, for the auditing of calibration facilities or laboratories and determining equivalency of tools, equipment, or test equipment, as appropriate, to insure that the AMO is in compliance with the CARs.

8. **Calibration Record.** It is the responsibility of the AMO to demonstrate traceability by presenting documented evidence (Test Report, Calibration Report, Certificate of Calibration, etc.,) acceptable to the DCA. The documented evidence held by the AMO must show direct or indirect traceability to the National or International Standard, acceptable to the DCA. Documented evidence must identify at least the following:

- Name, address, report number, date of calibration, who performed and certified the calibration.
- Manufacturer, part number, model number, serial number, specific description specific to the working standard under test and/or calibration. If the working standard has one or more accessories which require calibration these also must be identified either on the same record or recorded as a separate record.
- A traceability statement, including the calibration procedure used, acceptable to the DCA.
- The measurement device(s) used for calibration. Including the measurement device identifier, manufacturer, model, serial number and/or description along with the calibration due date of each measurement device.
- Calibration details.
- Environmental conditions.

. • Any limited calibration(s) performed.
• Any placards installed by the calibration facility or laboratory or any placard required by the AMO.
. • Data sheets, identifying test data, if appropriate. Note: The individual record of any item whose accuracy must be reported via a calibration report or certificate will quote the report number on each sheet.
. • Accuracy statement or statement of uncertainty.

A record of calibration is a means by which an AMO determines that a working standard is traceable to a National or International Standard. It also determines that a working standard was tested and/or calibrated using the appropriate measurement device, procedure, system and conditions to determine if the working standard is the appropriate one for the specific job function.

9. **Accreditation**. The BCAD does not require that calibrations be performed by accredited laboratories or facilities. However, the AMO may find that the standards of quality and the available technical competence assured by accreditation warrant their use.

10. **Storage and Handling.** All tools, equipment and test equipment shall be handled, stored and transported in a manner which shall not adversely affect the calibration or condition of the tools, equipment and test equipment.

11. **Environmental Conditions and Controls**. The manufacturer of a measurement device or working standard provides a specification giving the ranges and maximum loads, together with the limited environmental conditions for the correct use of the measurement device or working standard. This information shall be used for establishing the conditions of use and to determine if any control is necessary to maintain these conditions. It is permissible to narrow the conditions of use but it is not to broaden them.

Measurement devices and working standards shall be calibrated and utilized in an environment controlled to the extent necessary to assure continued measurements of required accuracy giving due consideration to temperature, humidity, vibration, cleanliness and other controllable factors affecting the testing, measuring, or calibrations or measurement devices or working standards. When applicable, compensating corrections shall be applied to calibration results obtained in an environment, which departs from the manufacturer's specifications.