Australian Government
Civil Aviation Safety Authority

CAAP 30-2(1)

Calibration of test equipment for maintenance purposes

Civil Aviation Advisory Publication
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This publication is advisory only. It consolidates information on the relevant regulatory requirements relating to the subject for ease of reference. It is intended to aid in the understanding of and compliance with regulatory requirements.

Always read this advice in conjunction with the appropriate regulations.

Contents...

References

- Regulation 30 of CAR – Certificates of Approval
- ATA Common Support Data Dictionary (CSDD)
- Standards Association of Australia (SAA) HB18.25 - 1991 Guide 25 General Requirements for the Competence of Calibration and Testing Laboratories
- SAA HB86.1:1996 - The Selection Care Calibration and Checking of Measuring Instruments in Industry
- AS 3900.4-1994 Quality management and quality assurance Standards - Guide to dependability program management
- ISO / IEC 17025:1999 General requirements for the competence of testing and calibration laboratories.
- ISO 10012-1:1992 §4.3 Quality assurance requirements for Measuring Equipment

Who this CAAP applies to

- Approved Maintenance Organisations
- Maintenance Personnel

Why this CAAP was written

The purpose of this CAAP is to provide guidance to maintenance organisations and maintenance personnel regarding the calibration of "test equipment". This CAAP does not provide instructions for carrying out calibration or who may provide the calibration service.

Note: For the purpose of this CAAP, test equipment means any inspection equipment, test equipment, tooling or jig that, to function properly, must be calibrated

Status of this CAAP

This is the first revision of this CAAP.

For further information

Contact the CASA Area Office closest to you.

1. Background

1.1 The responsibility of an Approved Maintenance Organisation (AMO) is to provide within its Maintenance Organisation Manual (Policy and Procedures Manual (or equivalent document) a list of all test equipment that must be calibrated and the process to track the calibration as required by CAR 30.

2. Recommended practices

2.1 Traceability to recognised national, international physical standards or recognised industry standard is only possible if in the calibration chain all calibrations have been performed using a suitable method.

2.2 The phrase "all inspection and test equipment" has, in the past, had various explanations. The phrase has been interpreted literally and required all inspection and test equipment to be calibrated against a recognised standard. As a consequence of this ambiguity, industry and CASA have had varying views as to the applicable criteria of the regulation. **An evolving philosophy now requires that only test equipment used to establish the calibration and conformance of components to manufacturer's instructions for continuing airworthiness be periodically calibrated to a recognised standard**.

Note: This CAAP is information on calibration of equipment for compliance with aviation regulatory requirements only.

2.3 It has been a long standing practice by various industrial, aerospace, and defence organisations to permit the use of workshop equipment that is not subjected to periodic calibration when no test data is recorded. For example, for null indication, waveform monitoring, continuity checking, troubleshooting or the determination or assessing the feasibility of repairing versus scrapping an item, etc. In these cases the equipment must be clearly identified as "UNCALIBRATED", "NO CALIBRATION REQUIRED" or "UNCONTROLLED" or similar. Equipment so identified cannot be utilised for conformance acceptance or during return to service or heading directly to a return to service.

Note: A suitable method of marking may be using a sticker with the appropriate calibration details recorded, date and signature or stamp.

2.4 Where a process or sequence of processes require calibrated equipment to determine a return to service conformance then at each step in the process the equipment used must be calibrated.

3. Calibration

3.1 WHY CALIBRATE?

3.1.1 We calibrate to control measurement errors and uncertainties to acceptable levels. For calibration of test equipment, acceptable levels of uncertainty are defined by the tolerance limits of the equipment's parameters established by the manufacturers. The outcome is the maintenance of the equipment within the defined accuracy of the manufacturers' design tolerances.

3.2 WHAT IS CALIBRATION?

3.2.1 Calibration is as defined in the CSDD as:

> *"The application of specifically known and accurately measured input to ensure that an item will produce a specifically known output which is accurately measured or indicated. Calibration includes adjustment or recording of corrections as appropriate".*

3.3 ACCEPTABLE PROCESSES AND EQUIPMENT

3.3.1 An acceptable process is one that has been stipulated by the equipment manufacturer. The manufacturer may consider that only certain test equipment is considered as being acceptable to determine the calibration of their equipment. If this is the case and alternate test equipment is required to be used then either the manufacturer or an appropriate person, qualified in metrology may accept the use of alternate test equipment.

3.4 TRACEABILITY

3.4.1 All test equipment used to establish the conformance of an aeronautical product or an aircraft system should be tested using test equipment that has been calibrated such that values indicated or represented by the equipment are traceable back to the national standard. The purpose of the traceability of measurement is to ensure that the measurements are accurate and credible by referencing them to a recognised national or international physical standard. If measurements are not traceable, it will not be known how results obtained today will be compared to results obtained in the future.

3.4.2 Many pieces of modern test equipment have automatic or self-calibration features designed within the instrument itself. This type of equipment generally has a reference standard built into the instrument and, at regular or predefined times, performs a calibration of the instrument. The manufacturer may specify any further calibration requirements.

3.4.3 Other instruments, such as electronic scales, have an auto zero feature. Auto zeroing instruments only remove the drift inherent in the design of an instrument to reset the zero point each time the instrument is used. This type of instrument generally requires some regular calibration check.

Note 1: Partial calibration of test equipment is acceptable as long as the ranges that are calibrated should be clearly identified in accordance with SAA HB86.1:1996. (CASA require that a Maintenance Organisation provide a system that supports the use of that tool and limits the use of that tool to processes that require only the calibrated range.)

Note 2: The reference or transfer standard should be 3 to 10 times more accurate than the instrument being tested. See ISO 10012-1:1992 §4.3.

4. Calibration Interval and labelling

4.1 The equipment manufacturer usually stipulates the calibration interval.

4.2 Where an equipment manufacturer does not specify a calibration interval then an initial maximum interval of twelve months should be applied. To take advantage of this initial maximum interval then an evaluation utilising the following dot points would be required and substantiation to support any decision taken:

- Quality of the tool
- Operating environment (usage level, where used, storage etc)
- Interval for other similar equipment
- The accuracy of measurement required

4.3 The resultant reduced interval is then established as the initial calibration interval and may be increased or reduced based on the process outlined in section 8.

4.4 The calibration interval may be varied based on the reliability of the equipment in maintaining its accuracy as determined from the equipment history. Any interval should be appropriate to the accuracy of measurement to be performed.

4.5 Some torque wrench manufacturers have established an "aviation calibration standard". These are significantly reduced intervals, some as low as 3 months.

Note: Reference to "masters" means equipment that is usually calibrated against a reference standard and is routinely used to calibrate or check test equipment. The "master" is usually specifically identified as such within the organisation's system of calibration hierarchy.

4.6 Where a tool is marked "Calibrate Before Use" the transfer standard against which that tool is checked prior to use should have a log book where each calibration prior to use is recorded. This activity ensures that there is an auditable trail relating to the use of that tool. The policy regarding the use of such tools and "masters" should be highlighted within the appropriate section the Policy and Procedures Manual (or equivalent document).

4.7 Calibration of equipment should be performed at certain periods of the equipment life. Generally calibration should be performed at the following events:

- Initial purchase
- Repair
- Periodic recalibration
- When accuracy is in doubt

4.8 There may be some instances where the aircraft or equipment manufacturer specifies more stringent calibration requirements for a particular piece of test equipment than the test equipment manufacturer requires. This additional requirement must be considered when setting calibration intervals.

5. Procedures for variation of intervals

5.1 The following outline of the process is purely as a minimal guideline to allow an escalation of the interval where no manufacturer's recommendation is given. Where there is a manufacturers specified interval this process may be acceptable to correlate data to support an application to the equipment manufacturer to allow a variation based on an organisation's experience or equipment usage.

5.2 The determination of an escalated calibration interval involves the analysis of data arranged as an observed percent intolerance versus time since calibration or test. Such data is assembled from recorded results of calibration or testing, organised into calibration histories.

A calibration history consists of an unbroken sequence of calibration or testing results accompanied by the date of service for each service action. An ideal calibration history would be one that is maintained for each parameter of interest. Until automated or real-time desktop calibration procedures become more widely used, it is not economically feasible to maintain histories by parameter. At present, the best that can be expected is the maintenance of calibration histories at the equipment serial number level.

5.3 The most common method of analysis, the maximum likelihood method, will pool histories for individual serial numbered items into homogeneous groupings, usually at the manufacturer / model level. The pooled data are then organised into successive windows of time. In each time window the number of observed in-tolerances is divided by the number calibrated to arrive at the observed percent intolerance. Each observed percent intolerance for each time window is arranged chronologically in a time series. Maximum likelihood methods are then applied to the time series to select the appropriate reliability model and to calculate the optimal calibration interval for the homogeneous grouping. The following data management requirements must be met to ensure that this process produces a correct interval.

5.4 DESCRIPTION OF DATA MANAGEMENT REQUIREMENT

5.4.1 Continuity — Calibration histories should be free of missing service actions. If missing service actions are present, they should be detectable.

5.4.2 Completeness — Each record should provide all information necessary for analysis. This information includes as a minimum:

(a) identification of the item serviced;

(b) any special usage classification or designation;

(c) date of service;

(d) condition received prior to adjustment or other corrective service;

(e) service action taken;

(f) condition released; and

(g) condition received into calibration facility (pre calibration check).

Note: the term "condition released" refers to whether the item was in tolerance when returned to service.

5.4.3 Consistency — Each record in a serial numbered item's calibration history should reflect uniformity with respect to parameters calibrated, tolerances used, procedures used, etc. If this is not the case, then the observed time series is contaminated and the resulting interval will be sub optimal.

5.4.4 Environment (storage and usage) — This factor has a direct relationship to the assessment program. If the location or usage of the test equipment changes this is required to be taken into consideration. For example, a torque wrench used daily that has a transit container and is stored on a tool board may have a 12 month calibration interval. When it is transferred for use on the tarmac with neither a transit container or correct storage facility consideration should be given to reducing its calibration interval.

6. Personal equipment

6.1 Personal equipment must be appropriately marked whether it is calibrated or not. The AMO may elect to control the calibration of employees' personal equipment (this includes hand held tools such as crimping tools, multimeters, torque wrenches etc). Where the maintenance organisation elects to control the calibration of that equipment then details of the process must be included in the Policy and Procedures Manual (or equivalent document). Where the maintenance organisation elects not to control this equipment then all that equipment must be suitably marked.

6.2 The AMO should detail its policy relating to the use of uncalibrated personal tools within its Policy and Procedures Manual (or equivalent document).

7. Out of tolerance action

7.1 Out of Tolerance Action (OTA) occurs when a piece of test equipment is found to be out of tolerance. This may occur as a result of a pre-calibration check or if there is a suspicion of an out of tolerance situation when crosschecking a suspect result of some process.

7.2 An OTA provides a degree of uncertainty that all components, aircraft systems, etc whose determination of being either servicable or conforming was dependant upon that test equipment were actually within tolerance. If test equipment is found to be out of calibration it must be assumed that all measurements, since the last calibration was performed, are suspect of being non conforming..

7.3 The AMO should, within its quality system, detail procedures that will be adopted as a result an OTA. These procedures include:

- A risk assessment of the affect of the OTA;
- The procedures used to assess the risk;
- An audit trail to determine what equipment, systems, etc the tool was used in determining the return to service criteria (hence a good practice would be to detail test equipment used as part of a work package);
- Procedures for any recall that may be determined necessary; and
- Documentation to support the above process.

8. Policy and Procedures Manual

8.1 The calibration processes within the Policy And Procedures Manual (or equivalent document) should contain as a minimum the following:

(a) a list of all test equipment that require calibration;

(b) a list of calibration service providers, per equipment;

(c) a method of tracking when calibration is due and a notification procedure;

(d) a method of retention of calibration reports current and historic;

(e) a process to control publications issued to calibration service providers;

(f) the audit requirements and processes for calibration service providers;

(g) a process for control of personal equipment that the company takes responsibility for, including a list of equipment and serial numbers;

(h) procedures for a calibration interval variation (if used);

(i) procedures for OTA's; and

(j) details of any contract for total tool calibration management.

9. Non-Destructive Testing

9.1 To avoid confusion, NDT equipment, test samples and standards are not subject to calibration as described is the preceding paragraphs. NDT is primarily a sensitivity based inspection system using known reference samples to verify and set test equipment prior to performing an inspection. These samples are based on the item being inspected and are used to "null" the equipment, not to produce an exact result.

9.2 However, equipment such as the following (note this list is not exhaustive, the manufacturers manuals will provide appropriate guidance):

- blacklight emitting, (UV) and UV measuring equipment,
- white light measuring devices,
- magnetic particle (MPI) bench ammeters and timers,
- radiography (X-ray) film densitometer,

are subject to a calibration regime to a known reference standard and should be calibrated by a suitable accredited and competent organisation.

Bill McIntyre
Executive Manager
Aviation Safety Standards Division

Appendix 1

1. Guidance to determining the suitability of a calibration facility

1.1 As Calibration Facilities have no requirement to be approved by CASA the facility that an AMO selects may not have the appropriate procedures in place to provide auditable processes. As a guide, an AMO may wish to consider preparing a checklist with the following or similar questions. The assessment of the answers will assist in the determination. The selected facility should be able to answer "Yes" to the majority of these questions. An AMO may need to be more specific or detailed in its requirements .

1.2 Is the organisation certified to a national standard? If not then consider these points.

- Quality Management System.
  - Is there a Quality Assurance / Quality Control QA / QC program / manual?
  - Are there internal / external audit programs?
  - Does the audit program have appropriate corrective actions processes for findings?
  - Are audit findings available to the customer?
  - Are there audit procedures for your sub contractors?
- Inspection
  - Is there a documented receipt inspection procedure?
- Data Control
  - Is there a procedure to ensure that your technical data is current?
  - Is there a process to maintain a revision process and record of document status?
  - Is there a process to have approved procedures to control manual revisions that are on loan or borrowed?
  - Is there a process that records deviations from OEM specifications?
- Tool Calibration
  - Is there a calibration program for equipment / tooling?
  - Are all calibrated tools listed?
  - Are the standards used to calibrate equipment and tooling traceable back to a National Standard?
  - Are there procedures in place to prevent the use of uncalibrated equipment / tooling?
- Training
  - Is there a documented training program?
  - Are the technicians / inspectors included in that training program?
  - Does that training program include any refresher training?
- Facilities
  - Are storage areas separate from your work area?
  - Is there storage area environmentally controlled?
  - Is there an Electrostatic Discharge Sensitive Equipment policy and is that policy supported by training (where appropriate)?

- Work Processing
  - Is there a process to validate tooling or equipment used in the calibration process that differs from the manufacturers requirements?
- Has the organisation been certified as an equivalent and how was it substantiated?
  - is there a copy of its operating and maintenance manuals?
  - Is there a process to identify and track customer's equipment?
- Does the work records contain:
  - A description of work performed
  - pre calibration check details
  - date of completion
  - work package reference number to allow full traceability?
- Are there procedures relating to out of tolerance actions and discrepancies noted during calibration?
- Certification
  - The organisation should be able to provide a copy of any certification held.
- Calibration Certificates should be required to record:
  - name and address of facility;
  - unique identification of report;
  - description of item being calibrated(tested);
  - identification of specific method;
  - results of measurement including correction charts and tables;
  - a statement of measurement uncertainties achieved and any limitations of detection that apply;
  - an indication of any tests (if applicable) that have been subcontracted out to other facilities;
  - Printed details, signature and title of an authorised member of the facility that accepts responsibility for the report and the testing work upon which it was based;
  - Means of traceability of the measurement results to the National Standard including identification of the test equipment; and
  - Environmental conditions under which the calibration was performed.