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| <b>AEROSPACE<br/>RECOMMENDED PRACTICE</b>  | <b>ARP6028™</b>   | <b>REV. A</b> |
|  | Issued 2009-03<br>Revised 2015-08<br>Reaffirmed 2020-10 |               |
| (R) Configuration Control for Maintaining Correlation of Gas Turbine Engine Test Cells |   |               |
| Superseding ARP6028  |   |               |

RATIONALE

Revision A has been compiled to remove all dates and suffixes from reference documents to comply with SAE policy and to add a statement on the general "day to day" management of Configuration Control.

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## 1. SCOPE

### 1.1 Purpose

The FAA has issued Advisory Circular, AC43-207, that recommends re-correlation, trending or period checks. The FAA, AC43-207 bases their recommendation on ARP741.

This paper describes a recommended practice and procedure for the configuration control requirements to maintain test cell correlation status. This is necessary to maintain performance measurement integrity, particularly when correlation approval is achieved by statistical trending.

The configuration of a test facility that exists at the time when a correlation is being carried out should be "base lined" as a condition of correlation approval acceptance, and, be maintained during the time period that the respective correlation approval lasts. This defines test facility configuration control.

This is due to the fact that a change in configuration may have the potential to change the established correlation factors and measured engine performance. If such a change occurs then this should be judged by the respective OEMs or designated correlation approval authorities Subject Matter Expert (SME). In some cases, this may involve consultation with the engine project customer or airworthiness authorities.

The purpose of this paper is to recommend a means of identifying, recording, documenting and maintaining the configuration status of all correlations, including those where re-approval is achieved by using statistical trending methods rather than physical back-to-back type testing.

This paper can be considered applicable to all types and standards of test facilities in the aero, marine and industrial gas turbine engine businesses.

## 2. REFERENCES

### 2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

#### 2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

ARP741            Turbofan and Turbojet Gas Turbine Engine Test Cell Correlation

ARP4755        Turboshaft/Turboprop Gas Turbine Engine Test Cell Correlation

ARP5435        APU Gas Turbine Engine Test Cell Correlation

#### 2.1.2 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, [www.faa.gov](http://www.faa.gov).

Federal Aviation Administration Advisory Circular, AC43-207

## 2.2 Definitions

**CALIBRATION:** The comparison of a particular instrument or system with a standard of known accuracy.

**CORRELATION:** The comparison of engine performance parameters measured on a common engine tested in two test facilities, where one facility is the reference.

**CORRELATION FACTOR:** A multiplier used where appropriate to adjust for the difference in performance between the customer facility and a reference facility, also known as a "correction factor" or a "facility modifier."

**TEST FACILITY (TEST CELL):** An area in which a gas turbine engine is operated to determine its performance and other information as required by a given test. This description can also be known as the Test Bed, Test Plant, Test Stand, Test Bench, etc.

**TRENDING:** The statistical practice of recording and plotting parameters over time.

**FAA:** Federal Aviation Administration

**OEM:** Original Equipment Manufacturer of respective gas turbine engine.

**SME:** Subject Matter Expert(s) designated and qualified to make judgement on configuration control compliance issues.

**RFI:** Radio Frequency Interference

**EMI:** Electromagnetic Interference

**FOD:** Foreign Object Damage (to engine)

## 3. METHODS OF RECORDING, DOCUMENTING, AND MAINTAINING INFORMATION

It should be emphasized that configuration control can be split into three elements:

- a. Local basic visual check (as specified) of any fundamental requirements prior to all engine performance testing. This could include a simple check of any moveable/variable items such as exhaust systems, intakes, cranes, etc. Typically this could be a local check list posted on the test control room wall.
- b. The management of day-to-day change control that reviews any changes that will require judgement and sentencing by an SME and thus records any changes to the declared configuration, such that the main record can be updated periodically, as required. Typically this can be carried out on a local spread sheet.
- c. The full main overall declared configuration status to accompany any correlation approvals. This document should also reference any change control records above as an audit trail.

It is preferred that the main overall configuration status is contained in a single and separate report/document that is related and referenced to an associated correlation report, to aid clarity. Alternatively, the information could reside in a section of the correlation report or in a format that has been agreed with the respective OEMs or designated correlation approval authorities SME. This degree of flexibility is likely to increase successful implementation and compliance.

Separate reports/documentation should be compiled for differing engine types on the same test facility.

In the event of a correlation re-approval where there is no change to the configuration status, a simple statement of "no change" can be issued, either as an independent document, an issue update of the existing configuration report/document or a statement contained within the correlation report.

The following methods can be used to record, document, and maintain the required information and include:

- 3.1 Basic description with relevant dimensional information included.
- 3.2 Inclusion of various or sections of schemes and drawings in electronic pdf format.
- 3.3 Reference of all appropriate facility schemes, drawings, brochures, specifications, and records.
- 3.4 Inclusion of photographic evidence to highlight specific items (highly recommended).
- 3.5 The use of a painted "white box" on the floor to surround any items that are required to reside in the test cell, yet are capable of being moved (e.g., working platforms and ramps, ladders, mobile supplementary systems, etc.). This determines a fixed position for storage during all testing.
- 3.6 The use of white painted lines to check the axial alignment of any moveable equipment such as debris guards/FOD screens and telescopic exhaust collectors/detuners/augmentors.

#### 4. INFORMATION REQUIRED TO BE RECORDED

This section highlights the information that is deemed to have a potential effect on correlation factors and measured engine performance. This relates to the "base line" configuration status that is declared for a specific correlation approval and applies during engine testing only.

Some of this information relates to items that are deemed potentially variable with the ability to change during testing and/or over a period of time, and hence, likely to have a potential direct effect on test cell characteristics and engine performance. These items are considered critical to successful configuration control and are highlighted with a © at the beginning of the description.

Some of this information relates to items that are deemed to be fixed and unlikely to change unless major construction or modification is carried out to the test facility. However, it is strongly recommended that the basic fixed geometry is recorded as a baseline for the test facility during its initial correlation. This fundamental information will be of great help in making any SME judgements regarding configuration control maintenance validity, by enabling basic calculations or model predictions.

Also included is local ambient climatic and environmental conditions.

The following information is, therefore, to be recorded and is broken into various component sections of the test facility:

- 4.1 General Design Description and Local Environment Conditions (External)
  - 4.1.1 General description of design and dimensions.
  - 4.1.2 Altitude of test facility.
  - 4.1.3 Local average ambient climatic conditions for a typical year, including temperature, pressure, wind speeds/directions and humidity.
  - 4.1.4 Position relative to local prevailing wind directions.
  - 4.1.5 Position relative to other nearby test facilities, local buildings, taxi ways, helicopter landing pads, industrial features and natural features such as trees, that have the potential for aerodynamic intake instability or poor air quality (such as the ingestion of pollution, hot air, steam, and tree deposits).
  - 4.1.6 Position relative to any potential sources of radio frequency (RFI) or electromagnetic interference (EMI) from radar, communications or other fixed or mobile military or civil hardware.
  - 4.1.7 Fuel type being used.

## 4.2 Intake System Design Description

- 4.2.1 General description of design, including all flow conditioning, FOD protection, and acoustic components.
- 4.2.2 External inlet stack height (if applicable).
- 4.2.3 Position and dimensions of intake at test cell entry, with estimated geometric open area ratio flow area.
- 4.2.4 © Declared position, description and settings of any potential variable or moving components such as folding design systems and roller shutter doors.
- 4.2.5 © Duplicate information (of previous three items) in the event of the use of a secondary intake design.

## 4.3 Test Cell Design Description (Internal)

- 4.3.1 General description of design and dimensions of test cell, noting any unusual or intrusive features.
- 4.3.2 Position, dimensions and description of any turbulence control/FOD screens being used for test cell flow conditioning.
- 4.3.3 © Declared position, description and settings of any extractor fans being used for forced test cell ventilation and breathing (particularly on turbo-shafts).
- 4.3.4 Description of method to locate engine (floor or overhead mounted) with dimensions to test cell floor, ceiling and walls (from engine center line) and the distance from the engine intake leading edge to the trailing edge of the test cell intake splitters or turning vanes.
- 4.3.5 Description, position and integrity of any test cell sealing features such as wall ducts and holes or doors.

## 4.4 Test Cell Main Equipment Description

- 4.4.1 Position and description of any fixed major test cell equipment such as the engine stand, thrust stand, or dynamometer.
- 4.4.2 © Declared position, description, settings and means of positively securing any potential variable and moveable test cell equipment such as retractable work platforms, overhead cranes, mobile supplementary systems, and roller shutter doors.
- 4.4.3 © Declared position, description, and settings of any potential heat generating test cell equipment such as dynamometers, alternators, and heaters.

## 4.5 Test Cell "Slave" and Auxiliary Testing Equipment Description

- 4.5.1 Description and part/serial numbers of all engine related "slave" test equipment, such as intake/airmeters, nozzles, jet pipes and "C" ducts, ensuring correct identification and maintainability for each engine type (if applicable). These should also be recorded and referenced in the correlation report, with any declared factors, particularly when there may be more than one set. The part number/serial number of any component enables an independent trace on its life history, such as modification, repair, and overhaul.
- 4.5.2 © Declared position, description, and configuration of any working platforms, ramps, and ladders that are permitted to reside in the test cell.
- 4.5.3 Description and position of any significant instrumentation boxes, cabinets, or carriers.
- 4.5.4 Declared position, description, and configuration of any shielding or ducting from heat generating devices such as overboard bleeds, breathers and dynamometers, etc.

#### 4.6 Exhaust System Design Description

4.6.1 General description of design, including all flow conditioning and acoustic components.

4.6.2 External exhaust stack height.

4.6.3 Position and dimensions of exhaust duct at test cell exit with estimation of detuner/augmentor geometric control flow area.

4.6.4 © Declared position and axial dimension from the engine exhaust tail pipe trailing edge to the test facility exhaust duct leading edge at cell exit.

4.6.5 © Declared position, description settings, and method of positive location of any potential variable or moving components such as telescopic or swingaround exhausts and geometric flow area control devices (blockage plates, etc.).

4.6.6 © Position of any external blast deflectors (open air test facility).

#### 4.7 Measurement System Description

4.7.1 © Description of the measurement system being used with reference to the operating system application program and any settings optimized during the correlation/calibration, such as scanning rates and steady state "mean time averaging" values.

4.7.2 © Description of any measurement support equipment such as signal conditioning, amplifiers, thermocouple stabilization planes, and environmental control boxes that have the ability to change measured parameters.

#### 4.8 Instrumentation Description

4.8.1 © Description, position, quantity, and serial numbers (where possible) of all of the relevant instrumentation being used, such as load cells (thrust), torque-meter, alternator, fuel flow meters, spool speeds, pressure transducers, temperature thermocouples, resistance bulb thermometers (RBTs), and any specific production pass-off probes.

#### 4.9 Instrument Calibration Description and Record Retention

4.9.1 © Description, serial numbers (where possible), and traceability (to a national standard) of the calibration equipment and methods being used for all of the instrumentation highlighted in the previous section.

4.9.2 Statement of calibration period intent and reference to the library of previous results (record retention).

#### 4.10 Control System Influences

4.10.1 Description of any primary engine control system equipment that belongs to the test facility that can have an influence on measured performance. This particularly includes modern Electronic Control Systems (EECs) and the software version being used.

4.10.2 Description and recording of any specific settings or stabilization times/definitions required to achieve dynamometer or propeller control consistency on some Turbo-shaft engines.

#### 4.11 Performance Analysis and Pass-Off Program Software

4.11.1 © Description and version of the current performance analysis and pass-off software being used which should relate to that that was used or validated during the formal correlation/calibration.