# FAS Topic Paper (FTP)

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| FTP1000 Parameter Data Items Clarifications | 9 | 06-Jan-2020 |

**ABSTRACT/PURPOSE:**

This FTP discusses the intent of the definition and scope of parameter data items (PDI) in DO-178C/ED-12C, to indicate which types and aspects of PDI are reviewed for DO-178C/ED-12C compliance as part of the certification or TSOA/ETSOA process, and which aspects are reviewed for compliance during the manufacturing process.

**RELATED DO/ED DOCUMENTS:**

**_X_** DO-178C/ED-12C: SW Airborne Sys & Equip
____ DO-278A/ED-109A:SW (CNS/ATM) Systems
**_X_** DO-248C/ED-94C: Supporting Information
____ DO-330/ED-215: Software Tool Qualification Considerations
____ DO-331/ED-218: Model Based Development & Verification Supplement
____ DO-332/ED-217: OO Technology and Related Techniques Supplement
____ DO-333/ED-216: Formal Methods Supplement
____ Other

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## FAS Team Definition and Goals:

The FAS user group monitors and exchanges information on the application of the following "software document suite" that was developed by joint RTCA/EUROCAE committee SC-205/WG-71:

- DO-178C/ED-12C - Software Considerations in Airborne Systems and Equipment Certification
- DO-278A/ED-109A - Software Integrity Assurance Considerations for Communication, Navigation, Surveillance and Air Traffic Management (CNS/ATM) Systems
- DO-248C/ED-94C - Supporting Information
- DO-330/ED-215 - Software Tool Qualification Considerations
- DO-331/ ED-218 - Model Based Development & Verification Supplement
- DO-332/ED-217 - Object Oriented Technology and Related Techniques Supplement
- DO-333/ ED-216 - Formal Methods Supplement

The goals of the FAS user group are as follows:

1. To share lessons learned in the use of the RTCA/EUROCAE "software document suite" and to encourage good practices and promote the effective use of RTCA's and EUROCAE's publications.
2. To develop FAS Topics Papers (FTPs) relative to RTCA's and EUROCAE's publications or other related aeronautical software industry topics. These FTPs may include clarification to the "software document suite" or a discussion on a new topic.
3. To identify and record any issues or errata showing the need for clarifications or the need for modifications to the "software document suite".

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**Abstract / Purpose of the FAS Topic Paper:**

This FTP discusses the intent of the definition and scope of parameter data items (PDI) in DO-178C/ED-12C, to indicate which types and aspects of PDI are reviewed for DO-178C/ED-12C compliance as part of the certification or TSOA/ETSOA process, and which aspects are reviewed for compliance during the manufacturing process.

**FTP Discussion:**

DO-178C/ED-12C is recognized under the aircraft certification process (for example, AC 20-115D and AMC 20-115D). DO-178C/ED-12C compliance is determined as part of that certification process. DO-178C/ED-12C provides guidance related to PDI Files. In some cases, however the contents of the PDI File are populated after certification (and after DO-178C/ED-12C compliance is determined), during the manufacturing process or maintenance process (referred to in the remainder of this paper only as "manufacturing process"). The problem statement is: "How can compliance with DO-178C/ED-12C Annex A Table A-5 objective 8 "Parameter Data Item File is correct and complete" and Table A-5 objective 9 "Verification of Parameter Data Item File is achieved" be determined if the PDI File is not yet populated at time of certification?"

This FTP provides answers to 3 industry questions related to these aspects of PDI.

**Question #1 from Industry:**

When might an instance of PDI be populated?

**Response from FAS:**

In some cases, the contents of the PDI File are populated as part of the software development process that results in a certification or Technical Standard Order Authorization (TSOA)/European Technical Standard Order Authorization (ETSOA). In other cases, the contents of the PDI File are populated after certification or TSOA/ETSOA is completed.

In any case, the activities linked to the creation and verification of a PDI File should be planned according to DO-178C/ED-12C subsection 4.2. The requirements, integration, verification, configuration management and quality assurance processes should follow respectively sections 5.1, 5.4, 6.6, 7 and 8 of DO-178C/ED-12C.

**Examples**

The following examples highlight various processes to develop, implement and verify PDI. They are real life examples gathered from the industry; some examples are very detailed and others give only an overview of the process used.

All of them are given only for information and are not intended to provide any guidance or direction on how to develop and verify PDIs.

- **Case 1 PDI File populated prior to certification**

  The PDI Files that define the data parameters transmitted and received by components communicating over a data bus are typically populated during the software development process, and therefore compliance to the requirements for the data content can be verified prior to certification. The verification of the contents would be captured in Software Verification Results and summarized in the Software Accomplishment Summary (SAS). In this case, a change to the contents of the PDI File would require a change impact analysis, re-verification and a re-certification.

- **Case 2 PDI File populated after certification**

  PDI Files are used to calibrate equipment or to adapt equipment to a specific system installation, such as to:

  - Define input/output routing
  - Identify types of sensors connected
  - Identify types of optional equipment installed
  - Select options to enable/disable software functions

  In this case, only the PDI structure is defined prior to the certification or TSOA/ETSOA. In this second group of examples, the contents of the file might be populated during product manufacture, during aircraft manufacture, or even by the aircraft operator after they receive the aircraft.

  A few examples of this case, among others, are:

  **Case 2, Example 1 - PDI File populated during product manufacture**

  An example is the configuration files that capture calibration data for products during their manufacture. The contents of the file are potentially different for each product serial number manufactured. The structure of the file is captured during the certification or TSOA/ETSOA process, and software requirements are defined and executable code implemented to interface with the PDI File. However, the contents of the PDI File might be developed after the SAS is released for the initial certification or TSOA/ETSOA has been generated and approved. Therefore, the generation and verification of the contents of these files need to be approved as part of the manufacturing process. Typically this data, if incorrect, can have a safety

effect, so it cannot be classified as user modifiable software or data. Examples of this scenario are provided below:

Example 1.1
An example is an engine control system that is designed with a strain gauge pressure sensor to measure ambient pressure for accurate engine fuel flow calculations. The software is Level A and errors in the sensor can cause an engine flame-out. The pressure sensor is temperature and pressure calibrated during manufacturing of the full authority digital engine control (FADEC). The software was designed to have a temperature/pressure lookup map loaded into flash memory to provide the required accuracy to meet the product specification. The software requirements specify the map size and value ranges for verification of the design robustness. The hardware design specification and software design are coordinated so the software meets the expected adjustment range. The certification process is based on these flexible map criteria, but no actual PDI File could be assessed at certification time (however one or several PDI File(s) is(are) populated at certification time, to allow verification of the operational software). Since there could be hundreds or thousands of possible different trim files, it would not be feasible to create all of them in advance. Therefore they are not part of the Software Configuration Index (SCI) and are not listed in the SAS. The data is loaded as part of the FADEC manufacturing process and checked as part of the product acceptance test. The actual values of the PDI File are not part of the design data but are instead treated as manufacturing data.

Example 1.2
An example is a hydro mechanical fuel control that has specific accuracies with respect to fuel valve command versus actual fuel flow delivered. This relationship is also a function of ambient pressure and fuel temperature. The fuel control hardware contains a flash chip that holds the lookup maps. The chip is read by the FADEC. Like the data in example 1.1, this data is manufacturing data that is verified and stored with the other production data.

**Case 2, Example 2 - PDI File populated during aircraft manufacture**

An example is the configuration files that capture rigging data or the aircraft configuration during the manufacture of an aircraft. As with the examples above, the contents of the file are potentially different for each aircraft serial number. The generation and verification of the contents of these files are outside the scope of the aircraft certification. There are cases where this data, if incorrect, can have a safety effect, so it cannot be classified as user modifiable software or data. An example of this scenario is provided below:

A flight control system has rigging data in a PDI File that is calculated and loaded during the aircraft manufacturing process. Although the executable object code of the flight control system typically has validity checks for the data, an error in the data within the valid ranges could have safety effects. Typically, the flight control

system manufacturer would execute the process for generating the file, but the aircraft manufacturer would be responsible for the verification, configuration management and quality assurance processes for the file.

**Case 2, Example 3 - Engine Maintenance Implementation**

The PDI File is loaded into an engine configuration plug. This type of data can be utilized by an engine control, and is loaded into the control or a memory device that is directly used by the control. This engine configuration plug is a memory device that remains with the engine even if the controls are replaced. When maintenance activities are performed on the engine, the PDI Files may be updated to reflect normalized thrust settings, thrust ratings, or other parameters. When the PDI File generation and load process is performed in service use, the process is controlled via an approved configuration method such as a service bulletin.

PDI Files generated during maintenance and loaded to engine configuration plugs contain data such as:

- Thrust ratings
- Engine configuration selections
- Engine serial number
- N1 rotor speed or engine pressure ratio thrust trims

**Case 2, Example 4 - Aircraft Manufacture Implementation**

This example has been successfully used by an aircraft manufacturer during their manufacturing process. It is provided here as one means of managing PDI Files populated during the manufacturing process. As the manufacturing process is outside the scope of DO-178C/ED-12C, it is not intended to prescribe a process or data items contents.

a. The PDI File is specified, developed and verified and is established following a planning document describing:
   i. The allocated software level of the file.
   ii. The means and rules applied to identify the PDI File.
   iii. The architecture of the system/equipment that receives the PDI File.
   iv. The list and description of the configurable functions/parameters.
   v. The means used to ensure compatibility between the PDI File and the application using it.
   vi. The means used to control the integrity of the PDI File.
   vii. The sharing of responsibility between the aircraft manufacturer and the equipment supplier.
   viii. The PDI life cycle for each PDI File (specification, design, and verification for the first instance of the PDI File and each subsequent instance).
   ix. The reuse of any already approved PDI Files.

x. The process applied to load a new PDI File.

b. The activities described in the planning document are tailored according to the allocated software level of the file. The impact on the following is substantiated:
   i. Integrity check, such as checksum or cyclic redundancy check (CRC) of the file loaded into the system.
   ii. Level of verification and related independency constraint.
c. This planning document constitutes a compliance document agreed with the certification authorities.
d. A unique specification is established for each PDI File. This specification is manually verified against the requirements (for the aircraft configuration ordered by the customer) and against the parameter data structure and rules/attributes (e.g. parameter data range, possible incompatible combination of parameters).
e. The PDI File is developed with tools for generating a loadable file. Depending on the project, tools are qualified in compliance with the applicable DO-330/ED-215 tool qualification level.
f. The PDI File is verified during the system tests of the new installation.
g. The verification activities are recorded in a document containing:
   i. The customized PDI File specification
   ii. The compatibility matrix between the PDI File and the hardware/software equipment configuration
   iii. The PDI File verification procedure and results
   iv. The identification of the PDI File
h. This document containing verification activities, is a compliance record retained in the manufacturing quality system.

**Clarifications**

Clarification 1

In the case where a PDI File that has a potential safety impact if incorrect, is populated after certification, the Plan for Software Aspects of Certification (PSAC) and SAS should identify the aspects of the PDI that will be managed by the software process, and those which will be handled by another process, such as the manufacturing process. The structure and attributes of the PDI should be defined during the software development, while the values of the PDI elements will be defined during the manufacturing process. The software plans should define the processes for compliance to DO-178C/ED-12C Annex A Table A-5 objectives 8 and 9 that will be used during manufacturing, and describe how these processes will be communicated to the manufacturer. As the processes communicated to the manufacturing process are part of the software plans, they will be subjected to review (see subsection 4.1f) and be part of the certification process (see section 9b). The Software Accomplishment Summary should indicate compliance to Annex A Table A-5 objectives 8 and 9 for the instances(s) of the PDI Files that were generated and verified during development, describe how the processes will be communicated to the manufacturing process, and state that the manufacturer will need an equivalent and approved manufacturing process to populate and verify the contents of instances of the PDI Files generated during manufacturing. This equivalent and approved manufacturing process is not further

approved in this document as it is outside the scope of DO-178C/ED-12C compliance, aircraft/engine certification and TSOA/ETSOA.

Clarification 2

If the processes and/or tools used to verify the PDI Files during manufacturing were approved under DO-178C/ED-12C, then any proposed changes to these processes and tools would need to be evaluated under DO-178C/ED-12C processes and re-approved. This could include re-qualification of the tools. Refer to DO-330/ED-12C paragraph 11.2.3 for guidance on changes to previously qualified tools.

**Question #2 from Industry:**

Is user modifiable software guidance applicable to PDI when populated during product manufacture, during aircraft manufacture, or even by the aircraft operator?

**Response from FAS:**

The PDI Files may be populated by the product manufacturer, aircraft manufacturer or operator. This data may be classified as user modifiable software or data, only if it is established that it has no adverse effect on: safety, operational capabilities, flight crew workload, any non-modifiable software components, or any software protection mechanism used.

**Question #3 from Industry:**

When tools are used to populate and/or verify a PDI instance, do they need qualification?

**Response from FAS:**

If a tool is used to populate the PDI File, and verification of compliance to DO-178C/ED-12C Annex A Table A-5 objectives 8 and 9 is not performed, then the tool should be qualified per DO-178C/ED-12C subsection 12.2.2 Criteria 1. If a tool is used to automate the verification of compliance to DO-178C/ED-12C Annex A Table A-5 objectives 8 and 9, then the tool should be qualified per DO-178C/ED-12C paragraph 12.2.2 Criteria 3.