**Revision 0**

**Aircraft Software Configuration Management**

30-September 2010

**General**

Civil Aviation Authority advisory circulars (ACs) contain information about standards, practices, and procedures that the Director has found to be an **Acceptable Means of Compliance (AMC)** with the associated rule.

Consideration will be given to other methods of compliance that may be presented to the Director. When new standards, practices, or procedures are found to be acceptable they will be added to the appropriate AC.

**Purpose**

This AC describes an acceptable means of compliance with standards for the management of software in aircraft systems and provides means of meeting the software configuration aspects of aircraft configuration management inherent in rule 91.603(a)(1) and the associated definition of "airworthy condition" in CAR Part 1.

**Related Rules**

This AC relates specifically to Civil Aviation Rule Parts 43 and 91.

**Change Notice**

Initial issue.

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## Glossary of Terms

### Abbreviations

The following abbreviations are used in the AC:

| | |
|---|---|
| ADB | Aeronautical Databases |
| AMI | Airline / Operator Modifiable Information |
| AMS | Airline / Operator Modifiable Software |
| AOC | Airline Operational Control |
| CDB | Configuration Database |
| CMS | Cabin Management System |
| CRC | Cyclic Redundancy Check |
| FLS | Field Loadable Software |
| LRU | Line Replaceable Unit |
| LSAP | Loadable Software Aircraft Part |
| MEDB | Model/Engine Database |
| NDB | Navigation Database |
| OEM | Original Equipment Manufacturer |
| OMS | Operator Modifiable Software |
| OPC | Operational Programme Configuration |
| OPS | Operational Programme Software |
| ORT | Owner Requirement Tables |
| OSS | Option Selectable Software |
| SCS | Supplier Controlled Software |
| SCL | Software Control Library |
| SSA | System Safety Assessment |
| STC | Supplemental Type Certificate |
| TAWS DB | Terrain Awareness and Warning System Database |
| TC | Type Certificate |
| UCS | User Certified Software |
| UMS | User Modifiable Software |

### Explanation of Terms

The terms listed below are used in this AC and the context of their use is explained.

**Aeronautical Databases** (ADB): There are two significant types of databases, those which are aircraft parts (LSAP) and those which are Aeronautical Databases. The distinction between the two does not lie in the technologies and loading methods used, but in their regulatory status. This

together with practical considerations related to the frequency of updates does impact configuration management. ADBs are not classified as aircraft parts and are sometimes referred to as non-LSAPs. They may or may not be managed using methods developed for LSAP.

**Airline Modifiable Information**: (AMI) software is an example of UMS.

**Airline Operational Control**: (AOC) data communications software is an example of UMS.

**Configuration Database**: (CDB) software is an example of UCS.

**Field Loadable Software**: Field Loadable Software (FLS) is any software or data that can be loaded on the aircraft without removal of the target hardware from the aircraft

**Loadable Software Aircraft Part**: LSAPs are aircraft parts and are part of the aircraft type certificate.

**LSAP Databases**: Operators may elect to control some databases as LSAP. For example, some operators choose to manage Aeronautical Databases (ADBs) as LSAP. The practical considerations related to the frequency of ADB updates should be considered in the operator's configuration management program. Where this practice is followed, the operator's configuration management process should be flexible to allow for the frequency associated with ADB updates.

**Model/Engine Database**: The Model/Engine Database software defines a customized performance database for the navigation system. The performance database includes performance values such as fuel flow, drag factor, manoeuvre margin, minimum cruise time and minimum rate of climb.

**Operational Program Configuration**: (OPC) is an example of OSS and is the configuration data that determines the function of a system. The OPC is a special purpose database that enables or disables optional functions of features of OPS.

**Operational Program Software**: (OPS) is the program instructions for a LRU. Each version of OPS has a unique software part number.

**Operator Modifiable Software**: OMS consists of User Modifiable Software (UMS) and User Certifiable Software (UCS). In some cases operators desire to modify a system function, for example to suit preferred operational procedures, existing operational infrastructure, or local conditions. This can be achieved by providing a UMS partition within the executable software, with appropriate ground based tools to create the modified software for that partition. The resulting software can then be loaded onto the aircraft as a separate software part from the main executable software for the equipment concerned.

**Option Selectable Software**: The Type Certificate holder can define software selectable aircraft functions using Option Selectable Software (OSS). The system design should protect against inadvertent selections involving unsafe configurations for the target (host) computer.

**Owner Requirement Table**: (ORT) software is an example of UCS.

**Software Configuration**: The software configuration is a particular combination of software versions.

**Software Media**: Software media is the means of transporting and distributing software for installation in the user equipment and comes in many forms including disks (floppy and CD-ROM), memory cards, tapes (mostly obsolescent) but now includes the Internet. A single software media item may contain numerous Loadable Software Aircraft Parts or Aeronautical Databases.

**Software Version**: The software version is the specific software item at a designated revision status. Within software versions, it is common for there to be a major and a minor version designation. Minor version designations usually reflect only minor changes to the software.

Software version designation is often seen in the format A.BB where A is the major version designation and BB is the minor version designation.

**Supplier Controlled Software** (SCS): The supplier of this type of software is the Type Certificate/Supplemental Type Certificate holder or the developer of the software. Changes to Supplier Controlled Software require approval by the certification authority.

**User Certifiable Software**: UCS is software that an airline or its designated party chooses to modify, usually following the guidelines of RTCA DO-178 / EUROCAE ED-12 (latest version). RTCA DO-178B is a means, but not the only means, to secure regulatory approval of software. A change to UCS requires certification acceptable to the operator's regulatory authority.

**User Modifiable Software**: UMS is software intended for modification by the aircraft operator without review by the certification authority, the aircraft manufacturer, or the equipment manufacturer. Modifications by the user may include modifications to data or executable code, or both.

# Introduction

Many modern aircraft have systems that are operated or controlled by software. This software is developed and approved under the relevant certification processes. Since the operation and functionality of systems is controlled by software, that software is an integral part of the system and is covered by any approval the product or appliance may have.

A feature of aircraft system software is that it is usually quite easy to change the software loaded into a system. Changing the software loaded into a system does not make any visual change to the equipment and in many cases does not cause the hardware part number on the equipment to change.

The component parts of modern aircraft systems often require a specific software configuration to allow the system to function correctly. Thus it is important that the software installed in aircraft systems is maintained in a configuration relevant to that particular aircraft. In aircraft fleets, it is common for system changes to cut in at a particular aircraft or equipment serial number. This means that different software configurations are required for different aircraft in the fleet.

In modern aircraft, particularly the more complex types, software provides functions that are critical to the safe operation of the aircraft. With the ease with which software can be loaded into systems, it is essential that all operators with aircraft that utilise software manage the configuration. If the software configuration is not managed, it is quite possible for systems to not operate efficiently or to have significant malfunctions. Changing the software configuration in a system is a design change except when the change is to an aeronautical database.

Rule 91.603 requires the operator to maintain aircraft in an airworthy condition. This means that the aircraft must be maintained in a configuration compliant with its Type Certificate and applicable regulatory requirements; software is an integral part of an aircraft so it is essential that it is maintained. In many aircraft, the Type Certificated configuration provides for user modifiable configuration options and for operational data to be revised.

Implicit within the Part 1 definition of "airworthy condition" is the requirement for the aircraft operator to maintain a record of the aircraft configuration. Changes to the aircraft configuration are governed by the requirements of CAR Part 21 Subpart C. Incorporating a modification into an aircraft is a maintenance activity and so is governed by the requirements of CAR Part 43. Part 43.69 requires a record of maintenance carried out on an aircraft to be recorded in the aircraft maintenance logbook. Thus the software configuration is an inherent part of the overall configuration management of an aircraft.

Since software is often changed, the conventional means of configuration management using the Illustrated Parts Catalogue or other equivalent means become impracticable. This is certainly the case where the software installed in a system component can be revised without removing the component from the aircraft. Thus the need has arisen for the configuration of the software loaded into system components to be managed at the aircraft level rather than at the component level to ensure compatibility between systems and ensure continued compliance with airworthiness requirements.

This AC provides guidance and an acceptable means of addressing the management of aircraft software. This AC does not suggest any particular solution, but identifies the essential elements of a configuration management system that will meet the relevant requirements for overall aircraft configuration management. Operators may elect to follow an alternate method, provided the alternate method meets the overall aircraft configuration management requirements derived from CAR Part 91, Part 1, Part 21 and Part 43. However, if an operator uses the means described

in this AC, the operator must follow it in all important respects. Because the method of compliance presented in this AC is not mandatory, the term "must" used herein applies only to those who choose to follow this particular method without deviation.

Appendix A of this AC provides guidance for General Aviation operators (CAR Part 91 and small Part 119 operators) to meet the objectives of software configuration management specified herein.

## References

ARINC Report 667 Guidance For The Management Of Field Loadable Software.

## Types of Software

Within the systems in an aircraft that are software driven, there are various types of software, some of which can be changed in the normal operation of the aircraft and some can only be changed by the equipment manufacturer. The terms used by manufacturers vary but the basic types of software are described below in Figure 1.
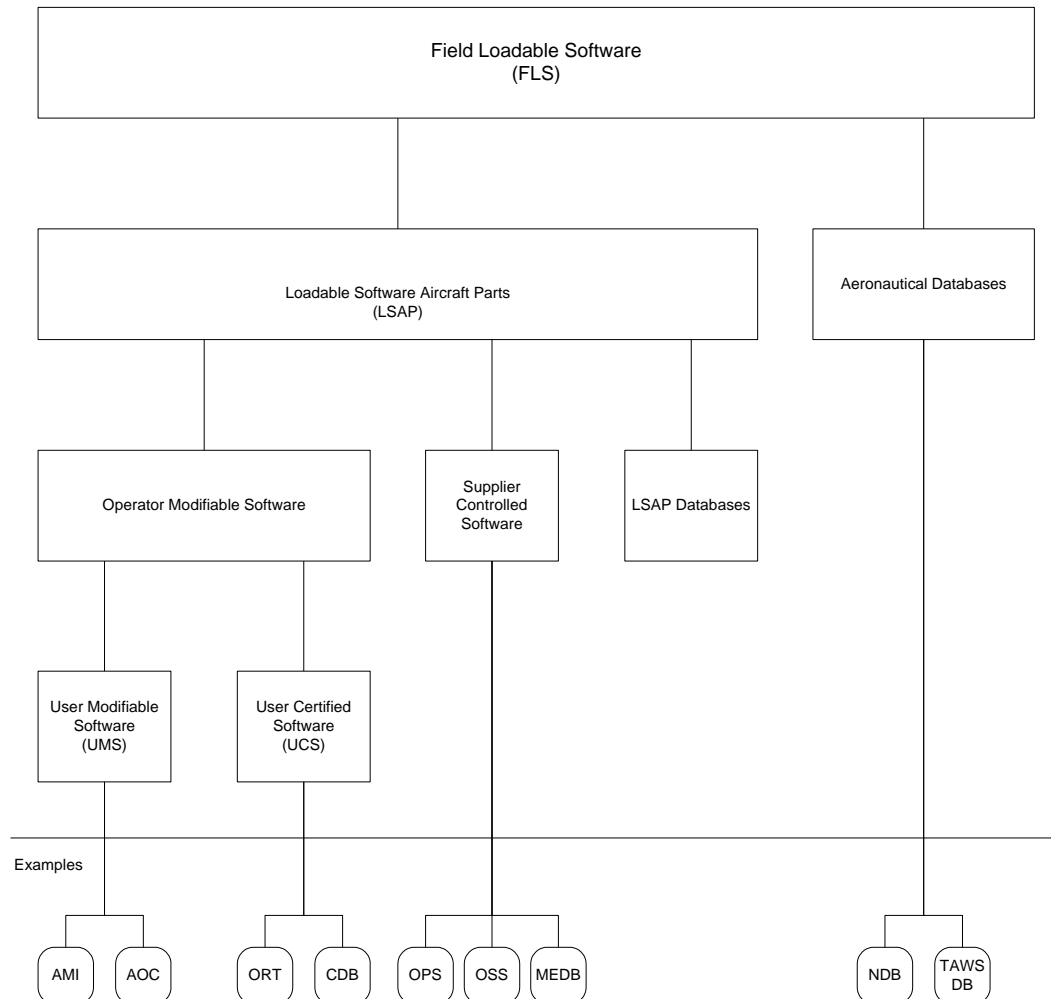
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                    ┌─────────────────────────────────────────┐
                    │      Field Loadable Software             │
                    │             (FLS)                        │
                    └─────────────────────────────────────────┘
                         │                         │
            ┌────────────────────────┐      ┌──────────────────┐
            │ Loadable Software      │      │ Aeronautical     │
            │ Aircraft Parts (LSAP)  │      │ Databases        │
            └────────────────────────┘      └──────────────────┘
              │         │         │                  │
     ┌───────────┐  ┌────────┐  ┌──────────┐
     │ Operator  │  │Supplier│  │ LSAP     │
     │ Modifiable│  │Controll│  │ Databases│
     │ Software  │  │ed Soft.│  │          │
     └───────────┘  └────────┘  └──────────┘
       │      │
  ┌────────┐ ┌────────┐
  │ User   │ │ User   │
  │ Modif. │ │ Certif.│
  │ (UMS)  │ │ (UCS)  │
  └────────┘ └────────┘
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Examples

AMI  AOC     ORT  CDB     OPS  OSS  MEDB          NDB  TAWS DB

**Figure 1: Types of Field Loadable Software.**

Generally, field loadable software refers only to software that can be loaded with the equipment installed in the aircraft. Software that is shop loaded is considered to be included in this AC for aircraft software configuration management purposes.

The criticality of the software determines the degree of rigour needed in its development, testing and certification; RTCA DO-178B describes the software development and certification process. The means by which software gets into a system is a function of the system design. Most modern systems have a capability for the field loading of software.

**Field Loadable Software** (FLS) is used specifically to describe the software part, rather than the medium containing it. Field Loadable Software (FLS) is any software or data that can be loaded on the aircraft without removal of the target hardware from the aircraft. For the purpose of this AC, FLS consists of 2 general types of software:  LSAP and non-LSAP or ADB.

Other characteristics of FLS are:

(a)  the part number is verifiable on aircraft by electronically accessing target hardware memory;

(b)  it does not change target hardware part number;

(c)  it has its own unique part number;

(d)  it may be an aircraft part; and

(e)  it can be uploaded regardless of current software state and will not prevent a previous version from over writing it.

**Loadable Software Aircraft Parts (LSAP) and non-LSAP parts (ADBs)**. LSAPs by definition are specified by the aircraft's drawings, so are included in the type certificate and any STCs or modifications applied to it. The certification methodology of RTCA DO-178/EUROCAE ED-12 applies to LSAPs.  LSAPs are aircraft parts, and therefore must be managed as such.

Field Loadable Software which is not part of the certified aircraft configuration is defined as an Aeronautical Database (ADB), or Non-LSAP part. These parts are commonly used for applications such as navigation, flight planning, and terrain awareness.  As they are not part of the aircraft Type Certificate, they may be routinely updated without a formal modification approval or STC being required. It is still critical, however, that they are subject to rigorous configuration control.

**Airline / Operator Modifiable Software** (A/OMS) consists of User Modifiable Software (UMS) and User Certifiable Software (UCS).

**User Modifiable Software** (UMS): UMS is software intended for modification by the aircraft operator without review by the certification authority, the aircraft manufacturer, or the equipment manufacturer. Modifications by the user may include modifications to data or executable code, or both.

As long as the modification remains within the bounds defined by the Original Equipment Manufacturer (generally enforced by a certified ground-based software tool), the content of the UMS does not require to be certified. However, as UMS is LSAP, processes for the production/distribution of media by an operator are applicable, and should follow internal operator practices and procedures. Part of these procedures should include conformity documentation.

UMS falls within the Level E criticality classification of RTCA DO-178B.

**User Certifiable Software** (UCS): There are some situations where the flexibility of Airline Modifiable Software is desired, but  it is not possible to avoid the need for certification authority review of the modifications. In these cases, the airline is obliged to follow appropriate certification rules. The term User Certifiable Software (UCS) is used in this AC for the purposes of describing this type of software. Examples of UCS are the Owner Requirement Tables (ORT) used with SATCOM and the Configuration Database (CDB) used in a Cabin Management System (CMS).

**Supplier Controlled Software** (SCS): The supplier of this type of software is the Type Certificate / Supplemental Type Certificate holder or the developer of the software. Changes to Supplier Controlled Software (SCS) require approval by the certification authority.

**Operational Program Software** (OPS) is the program instructions for a LRU. Each version of OPS has a unique software part number.

**Option Selectable Software** (OSS): The TC holder can define software selectable aircraft functions using Option Selectable Software. The system design should protect against inadvertent selections involving unsafe configurations for the target (host) computer.

**Operational Program Configuration** (OPC) is an example of OSS and is the configuration data that determines the function of a system. The OPC is a special purpose database that enables or disables optional functions or features of OPS. The OPC can replace the need for program pins, if the System Safety Assessment (SSA) allows, by providing software control, thus enhancing modification potential without the disadvantages of program pins.

## Software Status

The software configuration status of an aircraft has different states:

### Approved Aircraft Software Configuration

The approved aircraft software configuration defines the status of all software approved for installation in the aircraft. This software has a Regulatory Approval and is usually issued by the aircraft or equipment manufacturers or a STC holder. Not all approved software will be installed in every aircraft since software is often modified for a particular operator of an aircraft type. Most operational system software installed is approved but operational data is often supplied under a regulatory authorisation.

### Authorised Aircraft Software Configuration

The authorised aircraft software configuration defines the status of all software accepted by and authorised by the operator for the installation into the aircraft. Each operator is responsible for the configuration maintenance of the aircraft; this responsibility includes the software configuration. As with hardware modifications, particularly those from manufacturers, not all changes are applicable to all aircraft and then some are optional for the operator to determine whether or not the change is made.

For operators maintaining the software configuration of their aircraft, the authorised aircraft software configuration is the configuration that they have authorised for installation by accepting or rejecting modifications or Service Bulletins.

The authorised configuration does not necessarily reflect exactly the manufacturer's latest approved configuration but it must be an approved configuration. The authorised configuration will often allow several different versions of software to be installed into a system. With modification programmes, it is usual for the pre-modification and the post modification software to be authorised.  Once the programme is completed, the pre-modification software is removed from the authorised list.

### Actual Aircraft Software Configuration

The actual aircraft software configuration is as it says, the actual configuration. The actual aircraft configuration does not have to have the latest authorised software version installed but the actual configuration of the software installed must be authorised by the latest applicable authorised aircraft software configuration specification.

## Operator's Responsibilities

All operators are responsible for the configuration management of their aircraft, although this activity may be subcontracted to another organisation. Even though configuration management may be subcontracted, the responsibility remains with the operator.

The configuration management of their aircraft includes, but is not limited to, ensuring that any design changes are carried out using acceptable technical data as listed in CAR Part 21 Appendix D. The nature of software is such that it is often revised by manufacturers; the regular revision of software means that aircraft and equipment manufacturers are not able to revise the parts catalogues quickly enough to keep them current for specific aircraft.

Since the manufacturers' parts catalogues are unlikely to reflect the applicable current software, the operator needs to manage the software configuration of each aircraft using an alternative method. The methods used for this process can vary depending on the complexity of the aircraft and the size of the fleet to be managed. As an example, the operator may utilise an Aircraft Software Configuration List document, which may be updated as soon as the authorised or actual configuration is amended.

Operators need to have processes in place that reflect the contents of this AC to ensure that they are meeting their obligations in maintaining the defined configuration of their aircraft in accordance with existing CAR requirements derived from CAR Part 91, Part 1, Part 21 and Part 43.

## Data Review

With the exception of routine database updates, manufacturers usually issue a Service Bulletin to revise the software in a system. When the Service Bulletin is received, the operator needs to assess the contents and determine whether or not it is effective to aircraft in the fleet and whether or not it will be applied (unless it is a mandatory change). This assessment of bulletins should be formally recorded with the decision and the reasons for the decision.

When reviewing technical data, care should be taken to ensure that there are no inter-system compatibility conditions to be observed.

## Authorised Configuration

Having reviewed the technical data and decided to accept and apply the relevant design change, the operator must update the authorised configuration for each aircraft. The means of recording the configuration is up to the operator but the configuration data must be readily available to operational and maintenance personnel.

## Aircraft Documents

The authorised and actual aircraft software configurations need to be recorded and be available to maintenance and operational personnel; the configuration data recorded must be all the software components in each system. If equipment that contains software is replaced, the software configuration of the replacement equipment must be verified as an authorised configuration. If the software configuration of the replacement equipment is not listed as an authorised configuration, then either:

(a) the equipment must not be fitted;

(b) the software must be revised to a version that is authorised for installation in the particular aircraft; or

(c) the operator verifies that the configuration is acceptable and revises the authorised aircraft software configuration to include that of the replacement equipment.

When software is revised to a later version, it is recommended that it not be reverted to an earlier version even though this may still be a legitimate authorised version. Downgrading the software to an earlier version is modifying the aircraft in a way that makes the configuration management task more prone to error.

It is strongly recommended that a copy of the software configuration data that identifies the authorised and actual software configurations for the aircraft be carried in the aircraft so that it is readily available to personnel. When software is revised, an entry is required in the aircraft Maintenance Log. In addition to this Log entry, the software configuration listing should also be annotated to show that the software on the aircraft has been revised. The operator should then, in due course, update the software configuration listing to reflect the changes.

The software configuration document that is carried in the aircraft should contain the following information for each hardware component that contains software:

- ATA Chapter reference.

- Component nomenclature.

- Hardware part number.

- Software part number and version for all software components.

- Software media part number for all software components.

- Reference to the technical data that provides the instructions for installation of the software.

Organising the configuration listing is at the discretion of the operator but using the ATA chapter, system, hardware component and then the details of the software installed is a structure that is logical and has been implemented successfully.

## Aircraft Software Audits

As part of the review of airworthiness or maintenance review, it is recommended that operators carry out an audit of all software installed in the aircraft. This will ensure that the software actually installed and the aircraft records match and that there are no configuration discrepancies.

Operators should verify on a regular basis that they have all the manufacturers' current Service Bulletins for the equipment installed in their aircraft. It is recommended that operators carry out these checks periodically throughout the year, say at least every 6 months. It is recommended that one of the routine checks coincides with the review of airworthiness or the maintenance review.

## Multiple Systems

When an aircraft is fitted with multiple systems of the same type, the software configuration of the systems should be the same. If they cannot be the same, care must be exercised to ensure that there are no significant operational differences between the versions. A technical review is required to ensure the differing software configurations are acceptable.

## Repair of System Components

When operators send system components for repair, the repair documentation must define the software configuration the component must have on its return. Some repair shops automatically load the latest version; this is not an acceptable practice since it could result in an operator having an aircraft in an unacceptable configuration. It is the operator who is responsible for the aircraft configuration, so when equipment is sent for repair, the repair documentation must state the work to be accomplished.

Operators should ensure that the procedures of their organisations include the requirements for defining the required software configuration of components sent for repair and to verify the configuration on return from repair.

When system components are installed into an aircraft, the Aircraft Maintenance Manual task or operator work card should also include an instruction in the system functional checks to verify that an authorised software part for that aircraft has been installed.

### Operator Procedures

Part 119 certificated operators are expected to have organisational procedures and processes in place for the management of aircraft software configuration. Part 91 operators are individually responsible for the management of their aircraft software configuration.

Operators may subcontract the aircraft software configuration management task for their aircraft to another organisation that is competent to carry out the task. In subcontracting the task, the operator is still responsible for the task being carried out and meeting any applicable regulatory requirements. When aircraft software configuration management is subcontracted, the operator must have a written agreement between themselves and the subcontractor that details the work to be undertaken and the procedures to be used.

> Note:   *When an operator applies for an operational approval such as RVSM, RNP or GNSS under IFR, the operator needs to be able to demonstrate that they have the processes and procedures in place to manage the software configuration of the system. If an operator is not able to show that the software configuration of the system will be adequately managed, then the continuing compliance of the system with the relevant performance specifications and approval cannot be assured. Under these circumstances the approval will not issued until the necessary processes are in place.*

## Operator Modified Software

Where an operator modifies software for aircraft use, the operator must have process specifications that define the management process for the development and modification of that software. The software development process must define the configuration control and the validation processes to be used for the operator modifiable software. Refer to ARINC Report 667 for further details of the process required.

When a ground-based software tool is used to create UMS, the operator must have procedures and processes in place to ensure that the:

(a)   correct software version for the tool is used;

(b)   software tool operation manual is used in creating the UMS;

(c)   computer system requirements specified for the tool are met.

## Media Distribution

### Media Set Procurement

An operator is responsible for the purchasing and ordering of FLS parts. The operator is responsible for obtaining the appropriate documentation, including the appropriate licensing agreement for all intended installations. Service Bulletins (SBs) may be used by suppliers to provide software updates.

The Software Documentation section below refers to physical software media such as disks and memory cards. If software is downloaded from the Internet, adequate documentation should be available to verify that the software is that intended for the application. The basic principles applied to physical media should be applied to downloaded software.

## Software Documentation

Proper documentation should accompany FLS received from any supplier. Generally, an acceptable Authorised Release Certificate e.g. FAA Form 8130-3, EASA Form One, should accompany LSAP aircraft parts. If the FLS is received without adequate documentation, the operator must take all practicable steps to determine the airworthiness approval status of the software. The software supplier should provide appropriate conformity documents with the delivered FLS.

## Responsibilities for Receiving

It is widely recognised that the management of FLS requires a cooperative effort between the software supplier, component manufacturer, aircraft manufacturer, aircraft operator, and regulatory authority.

### Operator Responsibilities

The operator is responsible for the correct handling of software in accordance with supplier expectations, internal operator procedures, and regulatory authority requirements.

### Receiving Inspection of Media

Operators should have procedures and processes to inspect software media upon receiving it from both internal and external sources. As a minimum, the inspection should examine the media for correlation between the documentation accompanying the media and the information shown on the media label describing its contents.

The accompanying documentation for media delivered from an external source should be in the form of an acceptable Authorised Release Certificate. This documentation should be reviewed for completeness and the software part number should be correlated to the software part number on the media label.

### Designating a Master Media Set

When FLS is delivered, the operator is responsible for designating a master media set; the master media set may be physical media such as disks or memory cards or may be files stored on a computer network system file server. The provisions applying to a physical master media set are equally applicable to a master media set stored on a network. This master media set should be retained while that software part is a valid configuration for the operator's operation. The Authorised Release Certificate should also be retained. Operators should develop a process that correlates the media to the serviceability information. The serviceability information does not need to be kept with the media or the duplicate copies.

If a master media set is designated and stored on a computer network system file server, the network must be configured such that the media set cannot not be changed intentionally or unintentionally, or be otherwise destroyed. The folders / directories where the media set is stored should be limited to read access only and there should be archived versions that allow for recovery in the event of a system failure.

**Media**

Subject to the availability of suitable loading capability on the aircraft, software may be stored on various types of media, including but not limited to the following media types; Floppy Disc, CD-ROM, DVD, PC Card.

High density media sets are now being used for software to be stored and transferred. Multiple software programs or databases may be stored on one medium.

**FLS Handling**

In general, the procedures established for Loadable Software Aircraft Parts (LSAP) should be applied for all types of FLS.

**FLS Distribution**

FLS distribution will vary between organisations. This AC recognises the need for internal distribution within organisations and the need for external distribution between organisations. Organisations need to have procedures that define the processes to be used for the distribution of FLS.

**FLS Installation**

With the exception of pilot maintenance under rule 43.51(b) and Part 43 Appendix 1, installing operational data such as aeronautical navigation databases, the maintenance engineer is the primary handler of FLS. The FLS can be loaded in the target hardware as an aircraft line maintenance activity or loaded as a shop maintenance activity. Therefore, this makes the maintenance engineer responsible for ensuring that the FLS is installed in the aircraft and conforms to the engineering or configuration data requirements as written by the operator.

## Software Control Library (Physical or Electronic) Concept

A Software Control Library (SCL) can be developed as a physical location in which all master software versions are stored. The SCL may be used to maintain the configuration control of software. The SCL stores and categorises software on different media. The master media is used to create copies of software images for the purpose of loading software on the aircraft. The SCL should have management procedures in place to ensure the integrity of the master software. The SCL can be in the form of an electronic library on a file server which is the preferred method of control of software distribution. The file server should have the capability to maintain software configuration. FLS can be managed in an operator's inventory system without creation of a SCL.

## Media Packaging and Handling

**Labelling**

The media for internal operator use should be clearly labelled with sufficient information to identify the media content.

**Required Label Information**

An operator may choose to implement the full media label content recommended in ARINC Report 665. The labelling should identify, as a minimum, Media Content and Media Sequence Number.

Some operators feel the media they produce should contain a minimal amount of information on the label. They only want a maintenance engineer to have to match a software part number (or other identification such as a Service Bulletin number) from the media with the installation instructions to eliminate any confusion. For example, including the media set part number in

addition to the software part number can lead to confusion over which part numbers should match their instructions and what they are expected to do with the other part number.

Because the software part carried on the media is an aircraft part or an aeronautical database, there is an implicit requirement for software media to be received into the maintenance organisation through the approved parts receiving inspection processes. To facilitate this, it may be convenient to manage the media as if they were parts themselves.

The CAA considers that the media documentation should contain the media set part number and identify the software part number(s) of the media content.

### *Media Content*

The media content information describes the software contained on the media. The simplest and recommended content description is a software part number. Large capacity media may contain many software parts on one media set. Consequently, it may be difficult to list all the software part numbers on the media label. Therefore, other methods to identify the content may be required. Items such as a fleet or tail number (with versioning), Service Bulletin number, or work order number could act as the media content information linking a media to the service operation.

### *The Media Sequence Number*

The media sequence number should be used to indicate the order and type of media in use (e.g., "Disc 1 of 9" or "CD 1 of 3" or "PC Card 1 of 2").

### Recommended Label Information

The section below identifies the media label data fields and the content of those fields.

### *Proprietary Notice*

The label may contain a proprietary notice from the media producer or a supplier. If a supplier proprietary notice is applicable, the supplier text should be copied verbatim, unless written authorisation has been provided to alter the notice. It is acceptable for this notice to be in a physical form or electronic.

### *Company Name*

The company name field should contain  the name of the company that holds the copyright, claims proprietary rights, or is the spares source, as appropriate.

### *Media CRC*

The label may contain the media Cyclic Redundancy Check (CRC) or a check sum defined in ARINC Report 665. The media CRC or checksum can be used to verify the contents of the individual media set member.

### *Creation Date*

The label may contain the media creation date to assist in determining the age of the media. If used, the format should be DD MMM YY, where DD is the day, MMM is the month and YY is the year to ensure there is no ambiguity due to the date format. For example 14 APR 01.

### *Target Hardware*

The label may also optionally contain a fleet or tail number identifier for which the software is targeted.

**Label Format**

All information on labels should be typed, stamped, machine printed or neatly hand written in indelible ink. The font size and type should be selected as to be easily readable by an operator. For machine printed labels, it is recommended that either the Verdana or OCRB fonts be used as these fonts have unique characters.

**Label Characteristics**

The label should be constructed and permanently applied to the media in such a way that it will tear or be deformed to indicate an attempt to tamper with the label. If the media is physically too small to carry a label with all the details of the software contained, the media must be marked with the media part number and the other information included in the accompanying documentation.

**Storage and Handling**

Media handling practices should be developed based on recommendations from manufacturers of the media. Consideration should be given to avoid physical damage to the media due to factors such as temperature, humidity, vibration, electromagnetic radiation, dust, chemical and airborne contamination, moisture, and abusive handling.

**Transportation of Media**

Magnetic media that is transported from one location to another should be wrapped or bagged in a dust free, lint free, electrostatic discharge (ESD) protected material. In addition, media shipped to off-site locations should be packaged in a closed box or envelope. All media should be clearly and properly labelled for transport; all information on labels should be typed, stamped, machine printed or clearly hand-written. Media labelling is further defined in ARINC Report 665. Packaging should be clearly labelled as containing magnetic media, if applicable.

# Software Duplication

Operators expect to be authorised by the owner of the software intellectual property rights to use and copy the FLS parts that are required to maintain the authorised configuration of their aircraft. Therefore, the operator needs to respect the following needs:

- Protect the intellectual property rights contained in the software.

- The software will be used by the operator only in applications that are authorised by the intellectual property rights owner.

**Operator Responsibilities**

The operator is responsible for the copying procedure and the software tools used in the copying process. The operator should maintain a list of FLS for which permission to duplicate is authorised and use the designated master media set for duplication. When developing a duplication process, the operator should consider the following sections to ensure the integrity of the software image.

**Copy Tool**

The operator is responsible for using a software copying tool that will not alter the software image. The copy tool should provide a means to ensure that the copies created are identical to the software being copied. CRC checks or checksums and bit image comparisons may be used to ensure that the software image has not been altered during the duplication process. The quality assurance procedures should be defined and described in the operator's approved quality management program.

**Integrity**

The supplier should make the media CRC value available for any LSAP used by the operator. To ensure the integrity of the copy, the CRC or checksum should be used in compliance with ARINC Report 665.

When packaging software, the original input software is processed with the appropriate CRC or checksum algorithm to yield a check value. When the software is copied, the copy CRC or checksum is compared with the master LSAP check value. If the two check values do not agree, then an error has been made in the copy operation, and the software part is unserviceable.

The CRC or checksum value used for software loading is independent of the CRC or checksum used to duplicate software. Various software tools are available to calculate CRC or checksum value; agreement of the CRC or checksum calculated by the tool with the stored CRC or checksum ensures the integrity of the LSAP.

**Virus Detection and Protection**

Flight software is protected against viruses during normal operation by unique file formatting, including the CRC, which prevents loading a virus. The unique architecture of the flight systems prevents virus execution. Data-only interfaces also prevent a virus from spreading. During software development, the processes used ensure the software is built correctly and control configuration of that software ensures that a virus will not infect the software. In summary, the unique architecture, file structure, and CRCs protect flight systems from virus contamination and sabotage during operation.

## Appendix A: Guidance for General Aviation Operators

The contents of this AC are oriented to the larger CAR Part 119 certificated operators and those operating complex aircraft . For General Aviation operators operating under Part 91 or for Part 119 operators with a small fleet of relatively simple aircraft that have few software parts, the following provides a simplified means of meeting the objectives of this AC.

For Part 119 operators, the processes outlined below need to be included within the organisation's configuration and airworthiness management processes.

### Aircraft Software Configuration List

For each aircraft, there must be list of the software installed in each software controlled hardware item. Navigation databases may be omitted since they are updated every 28 days as defined by the AIRAC cycle. TAWS databases should be included since they are updated by the manufacturer at about four monthly intervals and are not on a regular update cycle. It is recommended that the details included in the software configuration list be that recommended in this AC Aircraft Documents section.

For aircraft with complex and highly integrated systems, such as the Garmin G1000 or other similar systems, each of the major components needs to be listed along with the software contained in each unit. While the manufacturers of these systems tend to provide a CD-ROM with all the software for a particular configuration, operators still need to be able to determine the software version installed in any component of the system.

### Aircraft Software Configuration Management

Each operator is responsible for the configuration management of their aircraft. For small fleets of relatively simple aircraft, the operator should register the equipment installed with the equipment manufacturer so that they are on the mailing list for service information. As a matter of practice, the operator should check the equipment manufacturer's web site at least every 6 months to verify that they have the up to date service information.

When a manufacturer issues a Service Bulletin revising the software in a piece of equipment, the operator needs to review the Bulletin, determine and document if it is applicable to their equipment, and if they need to incorporate the change.

For aircraft with multiple (dual) systems fitted, the software in both systems must be maintained in a configuration where there are no significant differences between the individual system functionality. Generally, this will mean that the major software version must be the same and the minor version within 1 or 2 versions. As a matter of practice, software should be maintained reasonably close to the latest applicable standard.

### Subcontracting of Software Configuration

It is acceptable for operators to subcontract the software configuration management of their aircraft to a competent organisation, such as an avionics maintenance provider. When the responsibility is subcontracted, the operator is still responsible for ensuring that the configuration management task is carried out.

It is strongly recommended that when software configuration management is subcontracted that a written agreement is put in place to define the responsibilities of the subcontractor and the processes to be followed.

**Navigation and TAWS Databases**

Navigation databases are updated every 28 days on the AIRAC cycle. In practice, many operators do not update their navigation system databases every cycle under rules 19.207 (5) and (6) and/or 19.209 (b)(3). If the database is fitted to a system that uses GNSS only, the provisions of Part 19 are acceptable, however, it is recommended that the database be updated every 6 months. In New Zealand, major changes are usually scheduled to be implemented at the beginning of November each year.

If the navigation database is fitted to a system that provides auto-tuning of radios, particularly for VOR / DME or DME / DME position determination, then the database should be updated each cycle. The need to update the database each cycle arises since it is not practicable for a pilot to verify the correct frequency and position data for all possible stations that may be used in a region.

TAWS databases should be updated at least every 6 months. Intermediate updates need not be installed if the changes to the database do not affect the area of operation.