

COCKPIT AVIONICS INTEGRATION OF NON-REQUIRED SAFETY ENHANCING SYSTEM INSTALLATIONS

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Abstract

The airworthiness regulations applicable to systems and installations, not specifically addressed in CS27/29 or FAR27/29, require equipment general installation features e.g. appropriate design, manufacture and installation enabling intended function implementation, avoidance of unacceptable hazard to helicopter due to malfunction or failure.

This paper deals with such equipment items, which are not previously ETSO authorized or TSO approved, developed by AH/AHD or AHD suppliers to enhance operational safety.

It provides several directions to be followed when new, “non-required” design solutions are proposed to be integrated into the helicopter cockpit design.

The discussion is done without addressing a specific system installation; it sums up activities of the applicant’s airworthiness office to support presentation of the design to certification authorities and to propose acceptable means to achieve installation airworthiness approval.

The objectives of this paper are to identify features of such “non-required” installation classes to be considered for acceptable cockpit integration. The paper provides overall considerations on certification liaison activities and proposes investigation methods with general applicability. It is not written for a given system architecture and is intended to be a complement for “non-required” system development and integration in helicopter. Its establishment is based on experience gained in the past on AHD experimental projects in which new helicopter functions have been proposed and implemented. Aim of the paper is to discuss airworthiness investigation of installations expected to provide an overall safety benefit, assessing system function development assurance level in combination with integration and compatibility principles. To achieve a large applicability, the paper does not discuss compliance methods which apply to type certification but is reduced to type design changes only.

1. INTRODUCTION

The aim of this paper is to highlight further interpretation of published guidance material [1] for avionics systems not specifically addressed in airworthiness or operational regulations. The guidance material indicates that aviation electronics presented for installation approval, when not qualified by TSO or other approval means, should be accompanied by sufficient data to substantiate their design acceptability. Such acceptability criteria are proposed in the paper, providing an overview of the main system features to be evaluated and the proof of compliance methods that may be used. The discussion is an industry affixation to the FAA policy no: PS-ASW-27, 29-10.

1.1 Background

Airworthiness certification projects, covering mainly type design changes, investigate new avionics systems installations acceptability with respect to the certification basis established for a given helicopter type design. New design solutions are proposed for equipment, systems and installations required by the airworthiness and operational regulations. Well known proof of compliance methods substantiate the airworthiness of such installations; they are established and implemented in approved design organizations following Authorities specific rules.

1.2 Purpose

In addition to the project categories mentioned above, airworthiness needs to be demonstrated for systems not foreseen by regulations. New design solutions, intended to provide safety benefits, are presented as part of new avionics installations. Proof of compliance for such “non-required” systems can be shown with “general applicable” airworthiness requirements, written before the system design proposal has been raised. This paper indicates several activities and methods

that may be used during such airworthiness investigation projects.

1.3 Area of applicability

Helicopters avionics system installations provide functional capabilities beyond the minimum given in ICAO standards and recommended practices for airworthiness [3] and operations [2]. Helicopter aerial work capabilities are not covered by [2] and new designed avionics systems may support such specialised types of operations.

A second group of “non-required” systems implement new functional capabilities and provisions introduced for military commercial derivative in the initial helicopter type design.

The discussion is kept general enough to cover also future “non-required” system developments, not presented yet for airworthiness investigation.

2. AIRWORTHINESS CODE

There are no specific airworthiness rules written for “non-required” equipment, systems or installations. Rules to be complied with in such cases are the ones using the wording “each”, in [4] and [5] section F, making them applicable to the entire equipment items population installed in the helicopter. As an example, EASA regulations [4] and [5] contain in 2X.1301 and 2X.1309 mandatory general rules to be demonstrated by the applicant.

2.1 “Non-required” attribute

The main contribution of the airworthiness specialist is to support his design organization when assessing optional equipment and required equipment attributes in airworthiness and operational regulations context. Required equipment is not further discussed in this paper; such investigation is usually performed based on Authorities interpretative guidance materials and policies.

The “non-required” or optional equipment may be introduced as a helicopter type design component excluding it from the airworthiness and operational required equipment population.

Note: separation between the “required” and “non-required” areas is not easily identifiable. Continuous rules improvement move elements from “non-required” into “required” domain [8].

2.2 Safety benefit

The main objective in this paper is to propose concepts that enable applicants to capture new system design solutions from the “non-required” group and build acceptable life cycle data for their installations airworthiness approval. Such a multi-dimensional process takes into account the new introduced system features, the way they complement existing airworthiness and operational rules, the crew additional indication or alerting needs in specific flight phases, compatibility with approved cockpit configuration for approved flight rules, cockpit lighting and electromagnetic compatibility aspects, expected installation limitations and other objectives to be achieved considering general applicable standards.

2.3 Non safety related equipment

Equipment items, whose functional aspects have no safety effect at helicopter level, are not discussed in this paper.

3. SYSTEM FEATURES

3.1 Identification

The prerequisite for a systematic certification oriented installation investigation is a clear system narrative description. It needs to contain, as a minimum, information on: system overview, boundary and interfaces identification, operational concept, environmental assumptions, functional

architecture, intended performance and functionality, complexity, indicating and alerting capabilities.

Such information enable establishment of a type design change project draft to address the main installation features to be demonstrated.

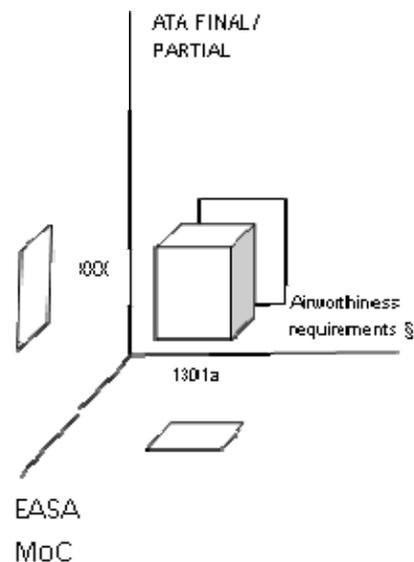


Figure 1: item decomposition

For proof of compliance purposes, system features can be assigned to “ATA codes” to identify specific areas of investigation. The figure above indicates a multidimensional approach to build proof of compliance with a general airworthiness requirement i.e. 2X.1301a, for a specific affected area XXX using a recommended EASA method.

3.2 Development assurance level

Different integration strategies indicate currently either federated system architectures or integrated modular avionics installations solutions. Both implementations address the system development assurance level concept necessary to determine software level and airborne electronic hardware design assurance of the components. For “non-required” systems, failure conditions

classification estimate system C or D DAL assignment. This estimation is based on the fact that required systems are mostly assigned to at least DAL C, being specifically addressed by regulations.

3.3 Kinds of operation

Helicopter specific kinds of operation, beyond VFR and IFR capabilities, may include aided night operations or non-commercial aerial work. New “non-required” systems may support such operational capabilities and their contribution needs to be clearly formulated and captured in functional requirements. This information enables evaluation of safety benefits and provides clear input data to development assurance level assignment via functional failure conditions classification.

3.4 Crew information

Integration of means used by “non-required” systems to provide information to the crew is also to be described with sufficient level of details to enable later capture in system requirements. New symbols, colours and graphical features introduced in the display scheme must be clearly described together with their full or part time display needs.

3.5 Aural and visual alerting

Aural alerting prioritization scheme is an important issue to be considered when “non-required” systems provide aural alerting capabilities. Possible aural alerting inhibition may be addressed for kinds of operations where the “non-required” system usage does not provide a safety benefit.

Visual alerting features of the “non-required” system should not conflict with the helicopter type design alerting concept and lighting components compatibility.

3.6 Intended performance

All “non-required” systems are not addressed in ETSO or TSO related Minimum Operational Performance Standards. It may be useful to formulate specific system performance requirements, test procedures and installation performance requirements to indicate operational expectations for the “non-required” system. Such data support the integration process enabling forward and backward traceability for requirements validation purposes.

3.7 Intended function

This information is the key element in “non-required” system / function development assurance level establishment. Functional requirements should not be limited to general features; they may be detailed at sub-functions levels to enable later traceability to lower level requirements and provide efficient inputs to the safety assessment process.

3.8 Complexity

This attribute of the “non-required” system may indicate the rigor of the development process used to achieve installation approval.

FAA Advisory Circulars and EASA memoranda applicable to helicopter installations contain guidance information and recommendations on methods to be used when such an attribute is identified for a given system.

3.9 System Integrity

Where applicable, information on system intended availability, accuracy and integrity are to be addressed as features to be considered in the proof of compliance activity.

3.10 Immunity and environmental qualification

The “non-required” systems immunity to specific threats e.g. lightning indirect effects, high intensity radiated fields are to be correlated with the helicopter type certification

basis requirements, special conditions, equivalent safety findings or IM/MoC agreed with the Certification Authority. Environmental qualification features are also to be addressed in the system specification, to enable future compatibility evaluation.

4 INVESTIGATION METHODS

This section is addressing proof of compliance methods for each system feature mentioned above. This criterion to attach to each system feature an investigation method ensures demonstration completeness to the applicable extent. Several methods may group system features together e.g. validation of all systems functional, performance, immunity requirements may be reported in one validation report, system requirements verification planning may be shared with other installed systems.

These activities provide systems integration life cycle data answering to the topic formulated in INTRODUCTION, i.e. systems should be accompanied by sufficient data to substantiate their design acceptability.

“Non-required” systems installations may contain a single line replaceable unit, several LRUs interconnected in a federated architecture or high level integration in modular avionics platforms. The further subsections address the latest integration solution, considering the increasing level of integration between the helicopter functions and the system that implements them as a representative example.

4.1 Development Assurance

This concept introduced initially with [6] in 1996 has been refined in the revision A to introduce several updates e.g. standardization of the term Development Assurance Level, enlargement of applicability to [4] and [5], correlation with integrated modular avionics guidance contained in [7].

The methods given in [6] have a wide international recognition and are recommended by the European Aviation Safety Agency (mostly in project interpretative materials and means of compliance certification review items). It is not yet applied by AHD for integrated modular avionics systems installed in civil helicopters.

Activities correlated between [6], system engineering requirements process, safety assessment, software assurance and airborne electronic hardware are not further addressed in this paper.

This paper has identified in section 1.3, according to ICAO [2] standards, differences between civil helicopters (authorized for commercial air transport) and helicopters with aerial work capabilities (non-commercial specialised operations).

New, highly integrated systems may include several “non-required” functions, whose development is performed in a similar way like the “required” ones. The rigor of processes recommended in [6] enables a clear identification of the additional system installation requirements allocated to helicopters with aerial work / specialised operations capabilities. Backward traceability from system level to “specialised operational requirements” [8] provides means to validate “non-required” system requirements introduced beyond the “required” systems mentioned in the type-certification basis.

Reports on new functions requirements validation, verification, process assurance, together with safety assessment outcomes produce life cycle data useable for the new installation approval.

4.2 Environmental qualification

Integrated Modular Avionics guidance material ED124 / DO-297 [7] Task 5 (Changes) may be also applied for additional integration of “non-required” functions and LRUs, provided that

requirements determination, validation, verification, quality assurance and configuration management processes are applied consistent with the first time installation approval. Environmental qualification achieved during first time installation of IMA may ensure the additional “non-required” functionality in foreseeable operating conditions of the airborne environment.

As far as no new LRUs are installed, the IMA platforms acceptance accomplishment summaries may report all data for environmental qualification. High Intensity Radiated Fields immunity reporting data may not be affected compared with the first time installation, as long as the “non-required” function DAL is C or D.

4.3 Indication / controls integration

Considering the “non-required” functionality introduced with a type design change in an already approved IMA installation, ([7] task 5), the means used to provide “non-required” information to the crew need are to be captured in system requirements. Validation and verification of these new requirements can ensure adequate integration in the global helicopter display concept. Human Factors compliance plan used for the first time installation may be updated to include the new indicating / controls elements added to the system installation. Evaluation outcomes can be recorded in bench, ground and flight test reports.

4.4 Alerting integration

IMA installations enable additional alerting capabilities to be added and approved during follow on type design change projects. The main issue on visual alerting design is the crew understanding and expected reaction to “non-required” system alarms in specific operational context. These elements are to be captured as system requirements, validated

and verified as guided in [6] and evaluated using human factors analysis.

The “non-required” system aural alerting sub-functions specification needs to consider the existing IMA aural alerting prioritization scheme. In the IMA system specification, “non-required” functions aural alerting inhibition can be considered, during helicopter operations in which the function is not needed.

5 CONCLUSIONS

The area of “non-required” systems installations or functional implementations is not specifically addressed in airworthiness or operational regulations. The proof of compliance activities with general airworthiness requirements 2X.1301 and 2X.1309 described in this paper contributes to build Authorities confidence that the rule interpretation is based on clearly stated criteria. Investigation methods attached to each system feature ensure evidence that investigation omissions are avoided and that new “non-required” system installations are accompanied by well-established life cycle data.

The paper has kept the discussion at a general level, highlighting the principles to be used in such projects. Even if additional “non-required” systems features may be identified in specific projects, the methods discussed above can be applied to achieve EASA agreement on the airworthiness investigation.

6 ABBREVIATIONS

AH	AIRBUS HELICOPTERS
AHD	AIRBUS HELICOPTERS DEUTSCHLAND
DAL	Development Assurance Level

EASA European Aviation Safety Agency
ETSO European Technical Standard Order
IMA Integrated Modular Avionics
IM/MoC Interpretative Material / Means of Compliance
LRU Line Replaceable Unit
SPO Specialized Operations
TSO Technical Standard Order

7 REFERENCES

- [1] AC 29-2C MG 1 "CERTIFICATION PROCEDURE FOR ROTORCRAFT AVIONICS" section (a)(3).
- [2] ICAO ANNEX 6 Operation of Aircraft Part III
- [3] ICAO ANNEX 8 Airworthiness of Aircraft Part IV
- [4] EASA Certification Specifications for Small Rotorcraft CS-27 Subpart F
- [5] EASA Certification Specifications for Large Rotorcraft CS-29 Subpart F
- [6] EUROCAE ED-79A / SAE ARP 4754A GUIDELINES FOR DEVELOPMENT OF CIVIL AIRCRAFT AND SYSTEMS
- [7] EUROCAE ED-124 / RTCA DO-297 IMA DEVELOPMENT GUIDANCE AND CERTIFICATION CONSIDERATIONS
- [8] COMMISSION REGULATION (EU) No 379/2014 of 7 April 2014 amending Commission Regulation (EU) No 965/2012 laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council

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