



The European Organisation for Civil Aviation Equipment
L'Organisation Européenne pour l'Équipement de l'Aviation Civile

GUIDELINES FOR APPROVAL OF THE PROVISION AND USE OF AIR TRAFFIC SERVICES SUPPORTED BY DATA COMMUNICATIONS

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ED-78A

December 2000

102 rue Etienne Dolet
92240 MALAKOFF, France
Web Site: www.eurocae.net

Tel: 33 1 40 92 79 30
Fax: 33 1 46 55 62 65
Email: eurocae@eurocae.net

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FOREWORD

1. The development of these guidelines was jointly accomplished by (EUROCAE) WG-53 and RTCA SC-189 through a consensus process. It was accepted by the Council of EUROCAE and RTCA Program Management Committee on December 2000.
2. Eurocae is an international non-profit making organisation. Membership is open to European and manufacturers of equipment for aeronautics, trade associations, national civil aviation administrations and, under certain conditions, non-European organisations. Its work programme is principally directed to the preparation of performance specifications and guidance documents for civil aviation equipment, for adoption and use at European and world-wide levels.
3. The findings of EUROCAE are resolved after discussion among its members and in co-operation with RTCA Inc., Washington DC, USA and/or the Society of Automotive Engineers (SAE), Warrendale PA, USA through their appropriate committees.
4. This document is identical to RTCA DO-264.
5. This document supersedes EUROCAE ED-78 "Guidance Material for the establishment of Data Link supported ATS Services" (June 1997).

As compared with the ED-78 document, the main changes are :

- the consolidation of the various processes identified for the developpement of the data link applications
 - the evolution of the standard to be developped : DLASD (Data-Link Application System Document) is replaced by two standards Interop and SPR standards
 - the revision of the classification matrix.
6. The Guidelines are recommendations only. EUROCAE is not an official body of the European Governments therefore its recommendations are valid as statements of official policy any when adopted by a particular government or conference of governments. In particular, the inclusion of reference to standards published by Arinc or other standardisation bodies, or extract from those standards, in no way implies any safety or regulatory liability/
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EUROCAE
102 rue Etienne Dolet
92240 MALAKOFF
FRANCE

Tel: 33 1 40 92 79 30

Fax: 33 1 46 55 62 65

E-mail: eurocae@eurocae.net

Web site: www.eurocae.net

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CHAPTER 1

INTRODUCTION

The International Civil Aviation Organization (ICAO) has introduced the concept of the communication, navigation, and surveillance/air traffic management system (CNS/ATM). This concept will enable improvements in ATM worldwide through the application of modern technologies to provide air traffic services (ATS). These ATS include the use of data communications between the operators and the ATS providers and will require an allocation of operational, functional, technical, and performance requirements to the different elements that comprise the CNS/ATM system. The CNS/ATM system elements will need to be qualified, separately and when integrated, for approval to ensure that the system performs as intended and is acceptably safe. Figure 1-1 at the end of this sub-section shows the CNS/ATM system in its operating environment.

For classical technologies, ICAO has standards in order to ensure worldwide interoperability between any aircraft and any ATS provider under the responsibility of the contracting States. The use of data communications between ATS providers and aircraft increases system complexity. Because of this increased complexity, ATS supported by data communications require a high degree of coordination among the stakeholders and approval authorities to ensure compatibility between operator use and ATS provision. There is a need for State/industry-accepted guidance material on the processes for coordinating implementation requirements and qualifying for different types of approvals.

This guidance material was developed considering the provision and use of ATS supported by data communications. The term “ATS” is used throughout this document to refer to “ATS supported by data communications”. These include communication services such as communication management and clearances, navigation services such as flight planning, required navigation performance (RNP) monitoring and gross navigation error (GNE) prevention and detection, surveillance services such as position and intent reporting, and services that support ATM automation.

This guidance material is intended for stakeholders and approval authorities involved in the operational implementation of the provision and use of ATS supported by data communications. Stakeholders are those organizations that have a financial investment in the provision and use of ATS. Stakeholders include ATS providers, ATS equipment manufacturers, supporting service providers, such as those that provide communication and weather services, aircraft and equipment manufacturers, and operators. These stakeholders may be identified as applicants in the context of this document. Approval authorities are those organizations in control of or responsible for issuing approvals to any element of the CNS/ATM system.

This guidance material comprises criteria in clear and concise format to enable consistent results in its application throughout the world. The guidance material was developed jointly by RTCA, Inc. and the European Organisation for Civil Aviation Equipment (EUROCAE) in consideration of the International Civil Aviation Organization (ICAO) activities and in cooperation with States worldwide.

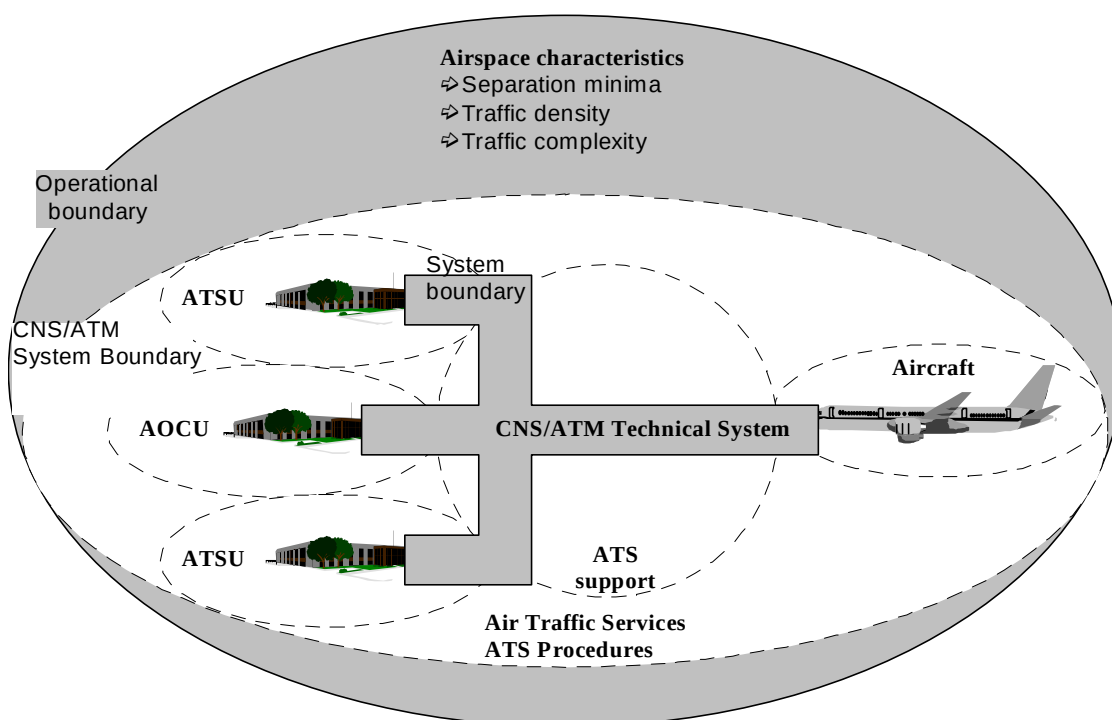


FIGURE 1-1: ATS SUPPORTED BY DATA COMMUNICATION OPERATIONAL ENVIRONMENT

1.1

PURPOSE

This guidance material recommends minimum acceptable criteria for approving the provision and use of an ATS supported by data communications when approvals are required to show compliance to civil regulations. The criteria are in the form of process objectives and guidance for evidence. As used throughout this document, evidence is data produced during the accomplishment of the process objectives. Applicants can use the evidence to show an approval authority that the objectives have been satisfied. For example, evidence may take the form of standards such as the SPR and INTEROP standards, or plans such as the approval plan, or results of verification activities such as test results. The formulation of related standards and the means to qualify related systems to those standards are discussed. "Approval" denotes those activities related to ATS provider operational approval, operator operational approval, and aircraft type design approval. These separate and distinct types of approvals collectively define the conceptual "CNS/ATM system approval." In cases for which there is no regulatory basis for approval of an element of the CNS/ATM system, "approval" denotes the activities that take place to establish implementation requirements and show compliance with the requirements allocated to that element. See Figure 1-2.

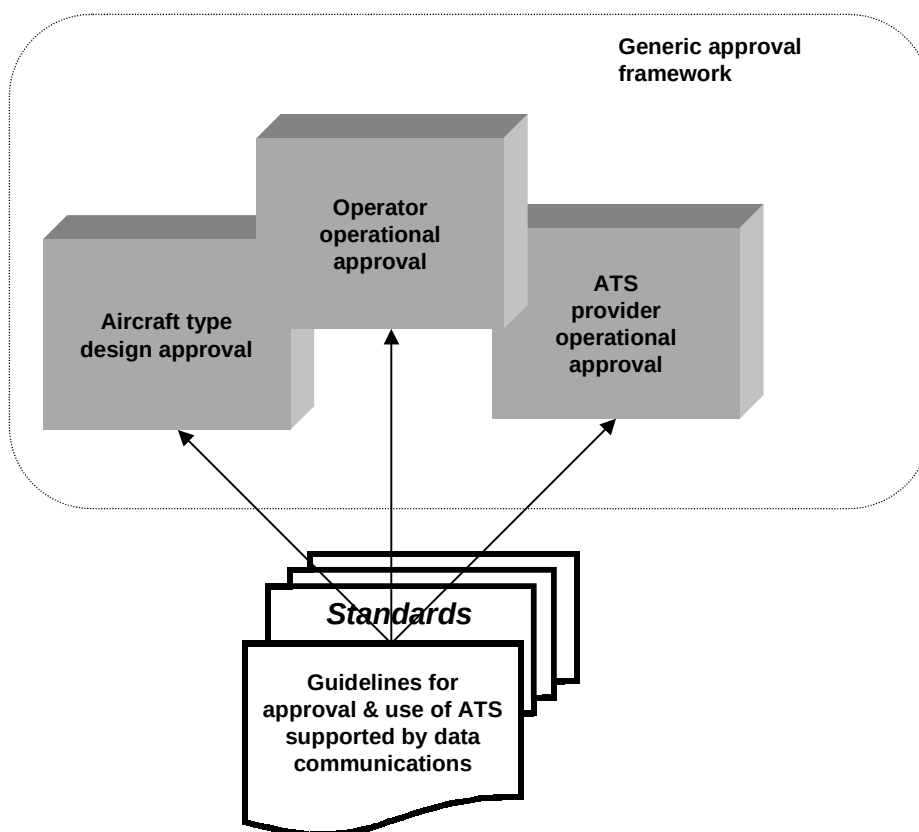


FIGURE 1-2: GENERIC REGULATORY FRAMEWORK FOR APPROVALS

- operator operational approval is the authorization granted to an operator to use the ATS, aircraft equipment, communication services procured by the operator, and related inter-networks with the ATS provider's communication services. It is supported by information provided by the aircraft type design approval and ATS provider operational approval;
- aircraft type design approval is the approval granted to an aircraft manufacturer or modifier to indicate that the type design of the aircraft equipment complies with applicable airworthiness requirements. It includes information to support operator operational approval; and
- ATS provider operational approval is granted to an ATS provider for the provision of ATS within an airspace and includes information to support the operator operational approval. It includes approval of the technical system and the communication services procured by the ATS provider.

1.2

SCOPE

This document provides means to establish the operational, safety, performance, and interoperability requirements for ATS supported by data communications, to assess their validity, and to qualify the related CNS/ATM system. It is a single source document that provides guidance for approval of the CNS/ATM system and its operation where coordination is necessary across organizations. The guidance material considers the allocations of the operational, safety, performance, and interoperability requirements to the elements of the CNS/ATM system. These include ground-based elements, operational procedures, including the human, and aircraft equipment.

Some ATS supported by data communications provide surveillance functions. The performance associated with these functions may be characterized by required surveillance performance (RSP). During the preparation of this document the definition of RSP and methods for asserting RSP were considered. The conclusion reached, however, was that the specification of RSP is not currently defined to the level required for this purpose. Hence, this document does not provide guidance for RSP.

Other RTCA special committees and EUROCAE working groups may provide guidance material related to human performance, development assurance, and security. This document is intended to support such future guidance material.

Assessments that are not within the scope of this document include the following examples:

- safety assessments related to the disposal of hazardous materials used in test and evaluation, or in technical system development;
- performance assessments related to establishing requirements for optimizing efficiency for ATM;
- interoperability assessments related to data communications between two ATS units (ATSU) or between ATSUs and aircraft operational control (AOC) units; and
- occupational health and safety assessments for ATS facility workers.

However, States and organizations that perform such assessments can conduct them in concert with the activities related to the operational assessments to which this guidance material relates.

1.3 OVERVIEW OF THE GUIDANCE MATERIAL AND DESCRIPTION OF RELATED STANDARDS

This sub-section provides an overview of the guidance material, and a description of standards and other evidence for approval of the provision and use of operational implementations of ATS and aircraft equipage. The guidance material and standards are intended for use by the aviation community when ATS providers, operators or aircraft manufacturers/modifiers intend to:

- provide or use new or modified ATS supported by data communications;
- use an existing ATS supported by data communications differently from its original intent; or
- add new functions or technologies, or modify existing functions or technologies to support an existing ATS.

1.3.1 Guidance Material

The guidance material minimizes references to specific national regulations and procedures; instead, generic terms are used. The guidance material is not mandated by law, but represents a consensus of the aviation community. It also recognizes that alternative means may be available to the applicant to obtain approval. To aid the use of alternative means, the guidance material uses the word “should”. However, if an applicant declares this guidance material as means of compliance for one of the approval types and the approval authority accepts it, then the “objectives” in sections 3 to 7 provide the basis for approval. Guidance on the applicability of the “objectives” to each of the approval types is provided in annex A. The guidance material may be revised as experience is gained in using the document.

1.3.1.1 Document Structure

Section 1 describes the purpose and scope of the document, and provides guidance on the use of this document and the standards and evidence resulting from its use.

Section 2 describes the processes for approval of the provision and use of ATS supported by data communications to which this guidance material applies. These processes are: approval planning, coordinated requirements determination, development and qualification of a system element, entry into service, and operations.

Section 3 provides objectives for approval planning. The evidence for approval planning is the approval plan and the acceptance of the plan by the approval authority.

Section 4 provides objectives for coordinated requirements determination. The evidence for coordinated requirements determination is a description of operational services and their intended operating environments in an operational services and environment description (OSD) and the operational, safety, and performance requirements (SPR) standard and interoperability requirements (INTEROP) standard.

Section 5 provides objectives for development and qualification of a system element. The evidence for development and qualification is data produced by the stakeholder in control of or responsible for a system element to show that it complies with the requirements allocated to it by the standards and is capable of operating within an operational CNS/ATM system.

Section 6 provides objectives for entry into service. The evidence for entry into service is coordinated data that shows one or more system elements integrated into an operational CNS/ATM system or a complete system will operate as intended.

Section 7 provides objectives for operations. The evidence for operations is the analysis and resolution of in-service problems to ensure that the standards requirements continue to be met. Evidence for operations also includes the analysis for follow-on modification for technical and operational changes that are made after entry into service to show that the standards requirements continue to be met or that the guidelines process needs to be repeated in part or in full.

In addition, sections that provide process objectives (sections 3 through 7) include guidance for the evidence that is required to show compliance to the objectives provided within each of the sections.

Annex A provides a summary of the process objectives and related evidence, and indicates applicability of each objective to the approval type.

Annex B provides a glossary of terms and acronyms.

Annex C provides guidance and templates for the operational services and environment definition (OSD).

Annex D provides guidance and templates for the operational safety and performance requirements (SPR) standard.

Annex E provides guidance and templates for the operational safety assessment (OSA).

Annex F provides guidance and templates for the operational performance assessment (OPA).

Annex G provides guidance and templates for the interoperability requirements (INTEROP) standard.

Figure 1-3: provides an overview of the structure of the guidance material

Narrative	Objectives and guidelines for evidence (Main body)				
Introduction & Description of Processes Sec. 1 & Sec. 2	Approval Planning Sec. 3	Coordinated Requirements Determination Sec. 4	Development & Qualification (Organizational) Sec. 5.1 & Sec. 5.2	Entry into service Sec. 6	Operations Sec. 7
		X.1 Details of objectives			
		X.2 Details of evidence			

Compliance matrix (Annex A)						
Section Reference for objective	Objective	Section Reference for evidence	Evidence	Approval type		
				Aircraft type design approval	ATS provider operational approval	Operator operational approval
	Reference to details of objectives & evidence with summary			Guidelines for applicability to approval types		

- Acronyms and glossary terms are contained in Annex B.
- Guidance and templates for coordinated requirements determination are provided in remaining annexes.

FIGURE 1-3: GUIDANCE MATERIAL STRUCTURE

1.3.1.2 Additional Considerations Using the Guidance Material

Note the following when using this guidance material:

- each process objective or guideline for evidence provided in this document is within a sub-section, paragraph, or sub-paragraph and assigned an alphanumeric character to facilitate traceability of compliance during approval. Annexes are normative parts of this document and include guidance material;
- explanatory text is included to aid the reader in understanding the topic under discussion. Sections 1 and 2, notes, and appendices provide explanatory text that does not contain guidance material;
- in cases where examples are used to indicate how the guidance material might be applied, either graphically or through narrative, the examples are not to be interpreted as the preferred method or best practice; and
- a list of items does not imply the list is all-inclusive.

1.3.2 Operational Services and Environment Definition (OSD) and Related Standards

Operational descriptions and standards facilitate coordination and allocation of requirements to stakeholders in control of or responsible for elements of the CNS/ATM system. The descriptions and standards are:

- operational services and environment definition (OSD);
- operational, safety, and performance requirements (SPR) standard;
- interoperability requirements (INTEROP) standard; and
- MOPS/MASPS.

1.3.2.1 Operational Services and Environment Definition (OSED)

The OSED is used as the basis for assessing and establishing operational, safety, performance, and interoperability requirements for the related CNS/ATM system. It is developed based on an operational services and environment information capture process (OSEIC) that coordinates the information among stakeholders. The OSEIC captures elements related to a defined CNS/ATM system, including aircraft equipage, ATS provider technical system, communication service provider systems, and procedural requirements. The OSED identifies the ATS supported by data communications and their intended operational environments and includes the operational performance expectations, functions, and selected technologies of the related CNS/ATM system. The OSED facilitates the formulation of technical and procedural requirements based on operational expectations and needs and is updated as necessary throughout the coordinated requirements determination process. The OSED captures requirements that have been derived and/or validated as being necessary for a particular operational service.

1.3.2.2 Operational, Safety, and Performance Requirements (SPR) Standard

An SPR standard is used to coordinate the operational, safety, and performance objectives and allocate requirements for the different approval types. It is developed using an operational safety assessment (OSA) and an operational performance assessment (OPA) of the functions, performance expectations, and characteristics of operational environments needed to support the ATS identified in the OSED. The SPR standard identifies the objectives and allocated requirements, including the substantiation, for a specific operation. The SPR provides traceability from each requirement to its source, the services, and operating environments described in the OSED, and captures the results of the OSA and OPA. An SPR standard can be tailored to meet the needs of a particular operational implementation.

1.3.2.3 Interoperability Requirements (INTEROP) Standard

An INTEROP standard is used to provide sufficient information to enable different stakeholders to develop system elements that are compatible for an operational implementation. It is developed using an interoperability assessment (IA) of selected functions and technologies needed to support the ATS identified in the OSED. An INTEROP standard identifies the technical, interface, and related functional requirements for a specific technology or a mix of technologies. The INTEROP provides traceability from each requirement to the functions it supports, the services, and the operating environments in the OSED. Similar to an SPR standard, an INTEROP standard can be tailored to meet the needs of a particular operational implementation.

1.3.2.4 MOPS and MASPS

In most cases, minimum operational performance standards (MOPS) and minimum aviation system performance standards (MASPS) provide performance requirements tailored to characteristics of a specific technology. These standards can be used to assess the feasibility of a specific technology to meet the minimum operational, safety, and performance requirements defined in an SPR. These standards normally do not provide an operational performance basis. The production of MOPS and MASPs is not part of this guidance material, whereas the SPR and INTEROP standards are included.

1.3.3 Relationships of Guidance Material to Standards and Evidence

The guidance material provides process objectives and guidelines for evidence as they relate to each of the approval types. It includes templates for the formulation of the OSED, the SPR standard, and the INTEROP standard. MASPS/MOPS that exist may facilitate the selection of technologies during the OSEIC process when information is captured in the OSED.

The OSED, the SPR standard, and the INTEROP standard are the products of coordinated requirements determination. They may be applicable to different operational implementations throughout the world provided the operational implementations are shown to meet the requirements provided by the standards in the context of the OSED under consideration. However, multiple OSEDs, SPR standards, and INTEROP standards may be developed over time. The OSED, SPR standard, and INTEROP standard can be tailored to an ATS provider's, an operator's, or an aircraft manufacturer's/modifier's specific requirements. They can:

- select from the OSED the ATS and operating environments appropriate for a particular operational implementation. Implementers need to qualify only to those requirements that trace to the ATS selected for the operational implementation;
- use the SPR and INTEROP source traceability to assess the impact in the event the ATS, aircraft equipage, and procedures selected for the operational implementation do not meet the operational, safety, performance, and interoperability requirements contained in the SPR and INTEROP standards;
- negotiate with approval authorities any deviations, additions, modifications, or clarifications of the SPR and INTEROP standards via the approval plan and operational data; and
- use the SPR standard to determine the basis for safety and performance monitoring during operations.

The SPR and INTEROP standards provide the basis for development, qualification, and entry into service of one or more elements of the CNS/ATM system, or a complete CNS/ATM system. Evidence is produced as part of development, qualification, and entry into service of a system element to support coordination and the approval of the system element and the CNS/ATM system. This evidence includes the approval plan, development and qualification data, including the accomplishment summary, and integration qualification data obtained from entry into service. The evidence is used to show compliance to the SPR and INTEROP standards prior to approval. Additional evidence is produced during operations and it is used to show that the operational CNS/ATM system continues to comply with the standards and to maintain operational approvals for the ATS provider and operator.

Figure 1-4 shows the relationships among the guidance material, the OSED, the SPR standard, the INTEROP standard, MOPS/MASPS, and other evidence under control of an applicant responsible for one of the approval types. The applicant starts with the approval planning process. The coordinated requirements determination and entry into service processes support development and qualification for each of the approval processes. Upon satisfactory completion of integration/qualification to support the approval, the approval process provides the approved system element for operations.

CHAPTER 2

DESCRIPTION OF PROCESSES

This section describes processes for approval planning, coordination of requirements determination across organizations, development and qualification of CNS/ATM systems at the organizational level, entry into service, and operations using ATS supported by data communications. The processes are shown in Figure 2-1, which also shows the relationships among the guidance material, the OSED, the SPR standard, the INTEROP standard, and other evidence under control of an applicant responsible for one of the approval types. The processes are shown in logical sequence. Recognizing that there may be considerable overlap of processes, the logical sequence is also the recommended sequence.

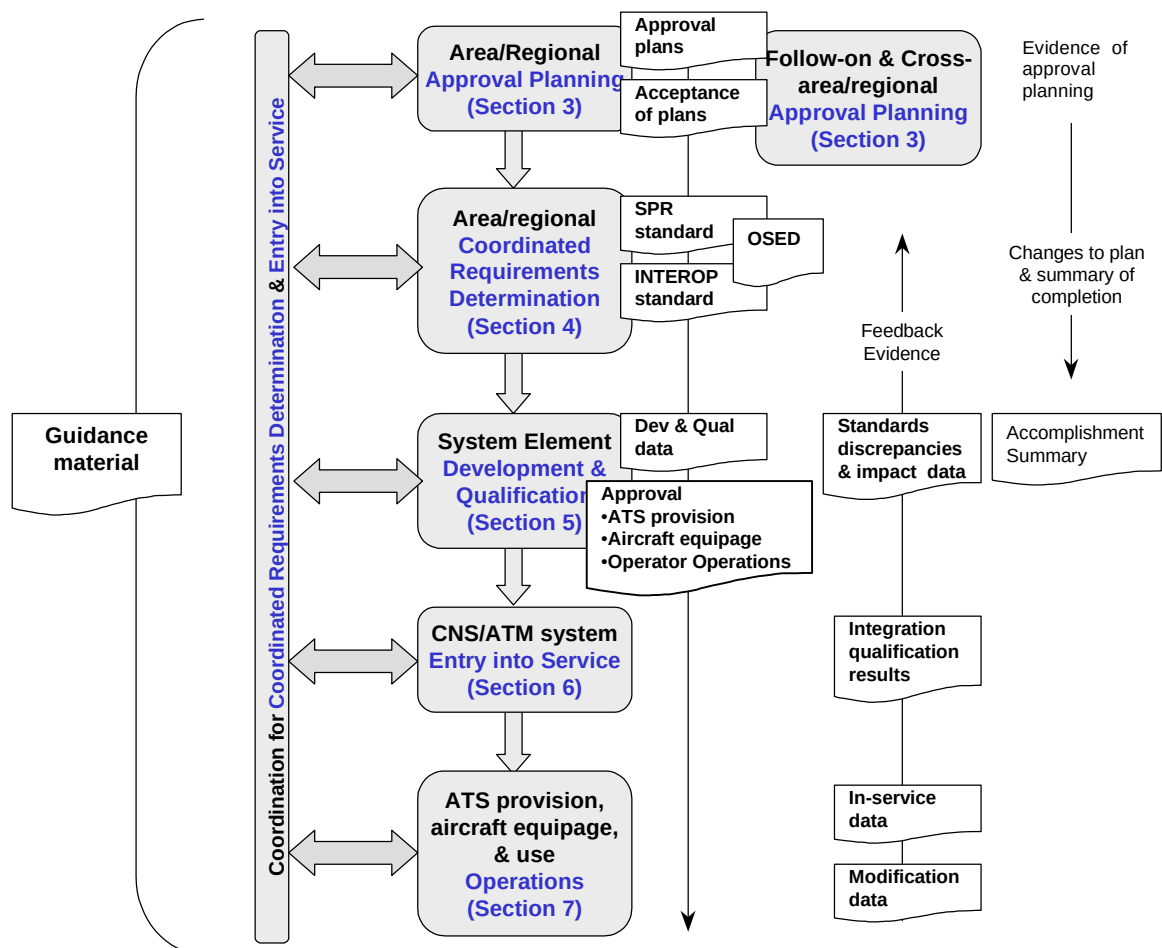


FIGURE 2-1: PROCESS FOR ATS SUPPORTED BY DATA COMMUNICATIONS

2.1

APPROVAL PLANNING

Approval planning is the process of describing the system, establishing the approval basis, proposing the means of compliance, and identifying tasks and schedules for the approval of a new or modified element of the CNS/ATM system related to ATS supported by data communications. Approval planning provides early involvement and commitment of the applicant and the approval authority for each of the approval types to agree on the approach for meeting the approval basis. It is intended to formalize the agreements among the ATS providers provisioning for the ATS, the operators who will use the ATS, the aircraft manufacturers and modifiers, and the approval authorities.

Follow-on implementations of the same or similar ATS in a different area or region of the world may consider the work that was previously done in order to reduce the planning, requirements determination, development, qualification, and approval effort. In these cases, the SPR and INTEROP standards, and the evidence for completion from previous implementations can provide the basis for approval of the follow-on implementations.

Evidence for approval planning includes an approval plan and acceptance of the plan from the approval authority. When accepted, the approval plan provides the agreed approach between the applicant and the approval authority.

Figure 2-2 depicts the approval planning process.

Refer to section 3 for objectives and guidance on evidence for approval planning.

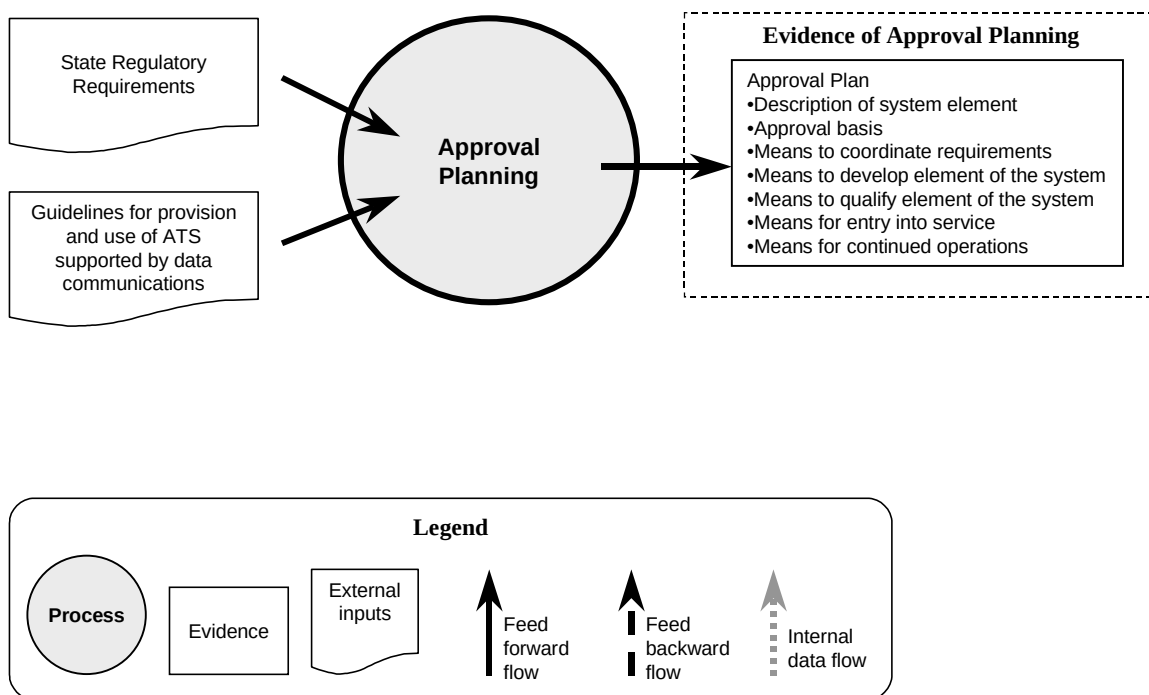


FIGURE 2-2: APPROVAL PLANNING

The legend in Figure 2-2 also applies to Figures 2-3, 2-4, 2-6 and 2-7.

2.2

COORDINATED REQUIREMENTS DETERMINATION

Coordinated requirements determination establishes requirements that require coordination among organizations involved in the development, qualification, operation, and approval of the CNS/ATM system. It consists of the OSEIC, OSA, OPA, and the IA. The OSEIC produces the OSED, which captures service descriptions, including operational communication processes, operational performance expectations, selected technologies, and characteristics of the intended operational environments. The OSA, OPA, and IA identify, coordinate, allocate, and validate the operational, safety, performance and interoperability requirements, and update the OSED, as necessary. The operational, safety, and performance requirements provide the operational basis for the operational implementation and are captured in the SPR standard. The interoperability requirements provide the technological and functional basis for the operational implementation and are captured in the INTEROP standard. The requirements in the standards are allocated to each of the stakeholders in control of or responsible for an element of the CNS/ATM system.

The OSA, OPA, and IA include the following generic activities in addition to the specific tasks identified in subsequent guidance.

- Identification of requirements. This activity involves the capture of requirements, which identify the operational, safety, performance, and interoperability attributes from the initial OSED;
- Coordination of requirements. This activity involves coordination among the stakeholders while they perform the appropriate assessments, in order to ensure that requirements affecting operational, safety, performance, and interoperability are addressed and correctly integrated into the OSED, SPR, and INTEROP. Coordination facilitates the validation of the operational, safety, performance, and interoperability requirements;
- Allocation of requirements. This activity allocates the operational, safety, performance, and interoperability requirements to the different stakeholders in control of or responsible for qualifying an element of the CNS/ATM system; and
- Validation of requirements. This activity ensures that requirements are necessary and sufficient for operational implementation. It may include analysis, simulation evaluations, prototype testing, and operational trials. The requirements provided in the SPR and INTEROP standards are validated prior to publication of the standards. The validation includes a consistency check between the requirements specified in the INTEROP standard and the SPR standard and consistency and completeness with the OSED. To support this validation, these standards are typically developed the first time an ATS or technology is implemented for operations, trials, or prototype development. The SPR and INTEROP standards are used to establish the basis for evaluating evidence produced during development and qualification in support of an operational implementation.

This document does not provide methods to allocate human performance to the human components of the system. However, it is necessary to qualify the human for approval, and criteria for allocation are negotiated with the approval authority during approval planning.

The outputs of the coordinated requirements determination process are an OSED, a SPR standard, and an INTEROP standard.

Coordinated requirements determination may be subject to external influences which are beyond the scope of this document, but which are indicated for completeness.

Figure 2-3 provides an overview of the overall coordinated requirements determination process.

Refer to section 4 for objectives and guidance on evidence for coordinated requirements determination.

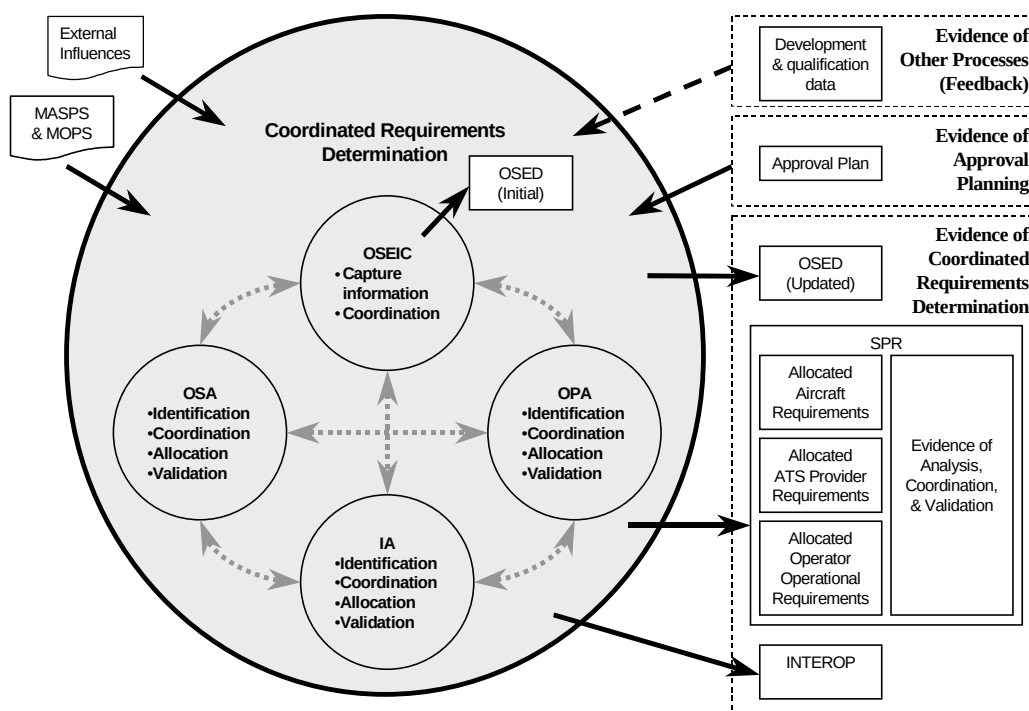


FIGURE 2-3: OVERVIEW OF COORDINATED REQUIREMENTS DETERMINATION

Each sub-process of coordinated requirements determination is described below.

2.2.1

Operational Services and Environment Information Capture (OSEIC)

The OSEIC captures, in a systematic and formal way, the operational objectives of the operators and the ATS providers, in terms of the implementation of ATS supported by data communications. All potential applicants including the operators, aircraft modifiers, system integrators, equipment designers, ATS providers, communication service providers and approval authorities are involved in the OSEIC process. Cost benefit analyses may influence the coordination process to decide what will be included in the OSED. The information captured during the OSEIC process is assessed and validated by the OSA, OPA and IA and may have to be modified as a result of those assessments to produce an updated OSED.

2.2.2 Operational Safety Assessment (OSA)

The OSA includes an operational hazard assessment (OHA) and an allocation of safety objectives and requirements (ASOR). The inputs to the OSA are derived from the OSED.

- Operational hazard assessment (OHA): The OHA is a qualitative assessment of the operational hazards associated with the OSED. For the OHA, services are examined to identify and classify hazards that could adversely effect those services. Hazards are classified according to a standardized classification scheme based on hazard severity, taking into account human factors. Overall safety objectives are assigned to the identified hazards.
- Allocation of safety objectives and requirements (ASOR): Based on the OHA results, the ASOR allocates safety objectives to organizations, develops and validates risk mitigation strategies that are shared by multiple organizations, and allocates safety requirements to those organizations. Requirements are allocated to the CNS/ATM system elements that provide the functional capability to perform the service and the stakeholders in control of or responsible for each of the elements. Understanding the interactions of the ATS, procedures, and airspace characteristics will assist in the identification of failures, errors, and/or combinations thereof that contribute significantly to the hazards identified in the OHA. The allocation may require updating based on feedback from other processes.
- Although the OHA is a qualitative assessment, agreement on quantitative goals may be set. This may take the form of agreement on the acceptable likelihood of occurrence for hazards of each severity level. This will enable safety objectives and requirements described in the ASOR to be given consistent and objective meaning.

2.2.3 Operational Performance Assessment (OPA)

The OPA provides methods to derive or validate required communication performance type (RCP type) from the OSED, based on the RCP concept.

The RCP concept is the operational framework to express the communication performance necessary for operation within a defined airspace or to perform a specified operation. When determining airspace requirements, an RCP is determined according to safety analysis and operational needs and is specified for ATS operational service for a given region that is deemed necessary for safe and efficient operation of the airspace. The RCP is independent of the technology used and applicable to voice and data communication.

The RCP type is specified in terms of a set of parameters needed to quantify the performance of the communications transaction. The denomination of RCP type is provided by one of its parameters: the transaction expiration time. The RCP type is further defined by a set of parameters listed in the following table.

Parameters	Value	Description
Transaction Expiration Time (ET_{RCP})	Time	Maximum time for completion of a transaction after which peer parties should revert to an alternative procedure. The rate at which a transaction expiration time can be exceeded is determined by the continuity parameter.
95% Transaction Time (TT_{95})	Time 95%	Time before which 95% of the transactions are completed. This is the time at which controllers and pilots can nominally accept the system performance and represents normal operating performance.
Continuity (C_{RCP})	Probability	That the transaction will be completed before the transaction expiration time, assuming that the communication system is available when the transaction is initiated
Availability (A_{RCP})	Probability	That the communication system between the two parties is in service when it is needed
Availability ($A_{Provision}$)	Probability	That communication with all aircraft in the area is in service.
Integrity (I_{RCP})	Acceptable Rate	Of transactions completed with undetected error.

TABLE 2-1: RCP SET OF PARAMETERS

The OPA allocates the performance requirements specified by the RCP type between the technical system and human, and further allocates the technical system performance to the organizations. The OPA includes the allocation of transaction performance between the aircraft and ATS provider combined with the controller/pilot performance to receive/transmit and process messages. The OPA includes the allocation of performance requirements between the ATS provider and aircraft, which are derived from the OSED.

- Required Communication Performance (RCP) type. RCP type is a statement of the communication performance necessary for operation within a defined airspace. RCP type is allocated between the human and the technical parts of the CNS/ATM system.
 - *Required Communication Technical Performance (RCTP).* The required communication technical performance (RCTP) is the framework to express the two-way technical performance of the communication path proposed to meet an RCP type. RCTP is used to separate the technical performance of the communication path from the human performances. The RCTP is expressed as a set of performance parameters, which reflects from a technical standpoint, the capability of the communication path required to satisfy an RCP type. The RCTP is defined for an entire transaction excluding the human factor with the same parameters as the RCP type. The RCTP will be allocated to the element of the CNS/ATM system.
 - *Human performance.* Human performance is a framework to express the human contribution to the required communication performance. Human performance is expressed as a set of parameters which reflects the capability of the human performance of the communication path to satisfy an RCP type. Human performance is defined for a entire transaction excluding the technical contribution with the same parameters as the RCP type.

2.2.4 Interoperability Assessment (IA)

The IA reviews the technical, functional, and interface requirements for the defined technologies and allocates the requirements to different stakeholders and subsequent approval processes. The allocation is based on the selected technologies and functions defined in the OSED. The IA is coordinated with the OSA and OPA, and safety and performance requirements that are necessary for interoperability are allocated in the IA. The definition of interoperability requirements in the scope of the IA is as follows:

Interoperability requirements are the minimum technical and functional requirements that provide the basis for ensuring compatibility among the various elements of the CNS/ATM system using specific technologies.

Some differences in implementations that can be accommodated by operational procedures may be acceptable and still be considered interoperable, however there may be limits in the number of such procedures due to operational or safety considerations.

2.2.5 Evidence for Coordinated Requirements Determination

Evidence for coordinated requirements determination includes the OSED, the SPR standard, and the INTEROP standard. The evidence for coordinated requirements determination provides the standards for development and qualification by stakeholders that are building the system elements that comprise the CNS/ATM system.

Refer to section 4 for guidance on evidence for coordinated requirements determination.

Refer to annex C for guidance and templates on developing an OSED.

Refer to annex D for guidance on developing an SPR standard.

Refer to annex E and F for guidance and templates on the OSA and OPA respectively.

Refer to annex G for guidance on developing an INTEROP standard.

2.3 DEVELOPMENT AND QUALIFICATION OF A SYSTEM ELEMENT

Development and qualification of a system element are processes that are performed by each stakeholder to ensure that their element of the CNS/ATM system is produced with assurance that operational, safety, performance, and interoperability objectives and requirements from the SPR and INTEROP standards are met. Considerations include the impact on schedule, effect of the result on safety, performance, or interoperability, and potential operating constraints.

Figure 2-4 provides an overview of development and qualification of a system element.

Refer to section 5 for objectives and guidance on evidence for development and qualification.

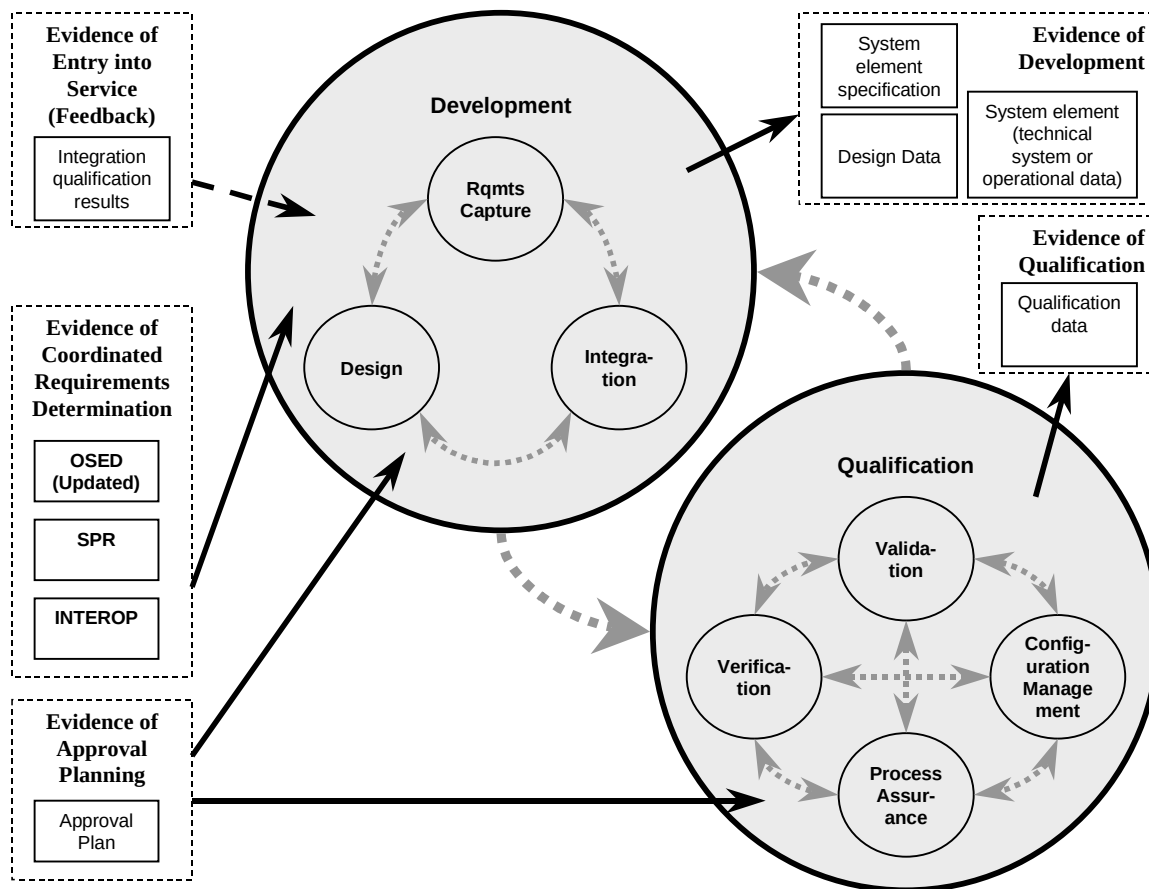


FIGURE 2-4: DEVELOPMENT AND QUALIFICATION OF A SYSTEM ELEMENT

The following paragraphs describe development and qualification of a system element.

2.3.1

Development

Development produces elements of the CNS/ATM system that meet the requirements of the coordinated requirements determination process. Elements may take the form of a technical system, which includes only the hardware and software components, or it may take the form of operational data, which provides the ATS provider and operator information needed to enter into service, provide, and use the ATS. Human factors considerations are involved in both the technical and operational elements of the CNS/ATM system.

Development also includes system integration of the CNS/ATM elements. Development can result in feedback to the appropriate coordination process (i.e., coordinated requirements determination or entry into service) of issues that are found to have a multi-organization impact. The acceptability of the element of the CNS/ATM system produced is based on the results of qualification.

Evidence for development includes system element specifications, design data, the technical system, and operational data.

Refer to sub-section 5.1 for objectives and guidance on evidence for development.

2.3.2

Qualification

Qualification ensures that the element of the CNS/ATM system meets the SPR and INTEROP standards, as officially recognized for use in an airspace by notification in the associated AIP/NOTAM. Qualification activities, which address validation, verification, configuration management, and process assurance, include:

- System Element Safety Assessment. This assessment ensures that the element of the CNS/ATM system, which a stakeholder is in control of or responsible for, satisfies the safety objectives identified and requirements that have been allocated by the OSA. The assessment takes human factors into consideration. The system element safety assessment allows applicants flexibility in allocating lower level requirements to satisfy the safety objectives identified and requirements allocated by the OSA. An applicant's safety assessment may address or define safety requirements that are beyond the scope of the OSA.
- System Element Performance Qualification. Qualification of performance takes into account the relationship between RCP, RCTP, Installed Communication Performance (ICP), Achieved Communication Performance (ACP), and human performance. Figure 2-5 graphically shows the RCP, ICP and ACP framework development phases.
 - Installed Communication Performance (ICP). ICP is a statement of performance for a given communication path which addresses the specific technology used. ICP identifies what the system is actually capable of performing at a 95% probability. The ICP excludes human performance and is used to qualify against a given RCTP. For operational approval a total ICP is qualified against a total RCTP. For qualification or approval of an element of the CNS/ATM system, the ICP component determined or measured for each functional domain is qualified against its respective allocated RCTP. The ICP is expressed in the same parameters as those of the RCTP. The total ICP that is achievable could vary, depending on the aircraft equipage and ATS provider technical system, including the network and selected technologies.
 - Achieved Communication Performance (ACP). ACP is the dynamic measure of the operational performance of the communication path, with human performance included in the measure. The ACP is expressed in the same terms and parameters as the RCP, but at any instant may vary, depending on environmental, communication, and CNS/ATM system failures, and human performance variability. The ACP is compared and evaluated against the RCP. The ACP is a transaction measurement and cannot be allocated.

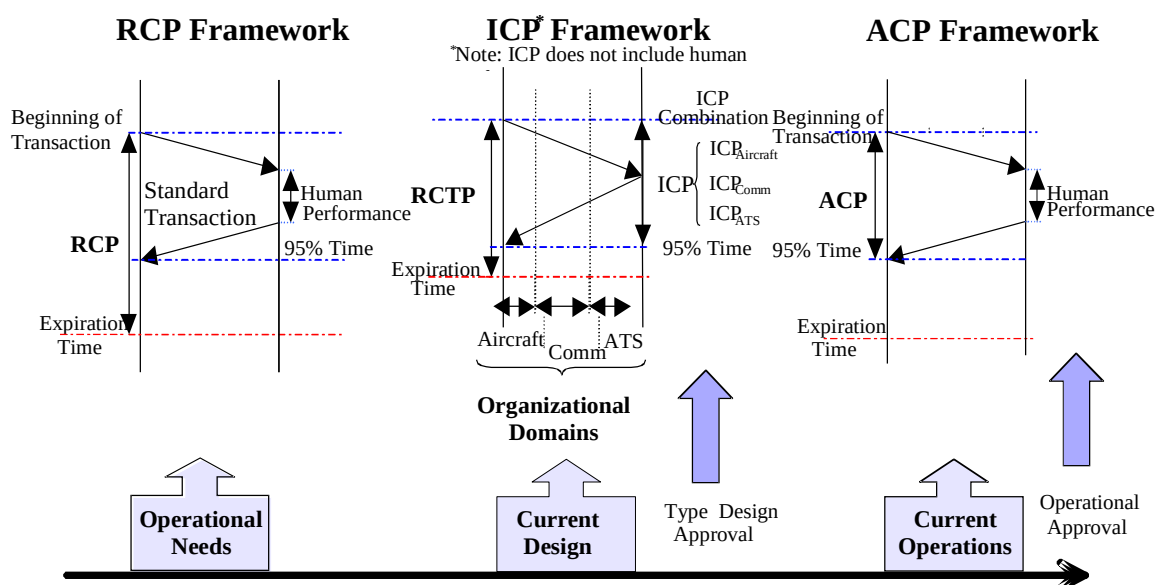


FIGURE 2-5: RCP/ICP/ACP DEVELOPMENT PHASES

- System Element Interoperability Qualification. Qualification for interoperability includes system element conformance to standards, interoperability testing at the functional level, interoperability testing between the aircraft equipage and ATS provider, and system integration and interface testing among the elements of the CNS/ATM system.

Evidence for qualification includes validation data, verification data at the system element and system integration levels, configuration management data, process and process assurance data.

Refer to sub-section 5.2 for objectives and guidance on evidence for qualification.

2.4

ENTRY INTO SERVICE

Entry into service is the process whereby a State responsible for an airspace coordinates with all appropriate stakeholders the results of the development and qualification activities performed at the organizational level for CNS/ATM system integration and preparation for operations.

Each ATS provider and operator provides the operational data to coordinate and prepare for operation of the CNS/ATM system including configuration management and in-service monitoring. The operational data includes operational qualification requirements that ensure the element of the CNS/ATM system functions as intended when integrated in a specified airspace. Operational qualification requirements are met during qualification of the operator and the ATS provider of that airspace to support their operational approvals.

Each operator is responsible for the integration of the aircraft equipage and its use with the ATS supported by data communications according to the criteria intended for the AIP/NOTAM and AFM. The operator provides assurance that, as a minimum, the requirements in the SPR and INTEROP standards are being met to allow for its integration in the CNS/ATM system.

The ATS provider is responsible for the provision of ATS supported by data communications to all aircraft flying into the specified airspace according with the criteria specified in the AIP/NOTAM.

Evidence for entry into service includes any integration qualification results that feedback to the coordinated requirements determination or development process.

Figure 2-6 depicts the entry into service process.

Refer to section 6 for objectives and guidance on evidence for coordinating entry into service.

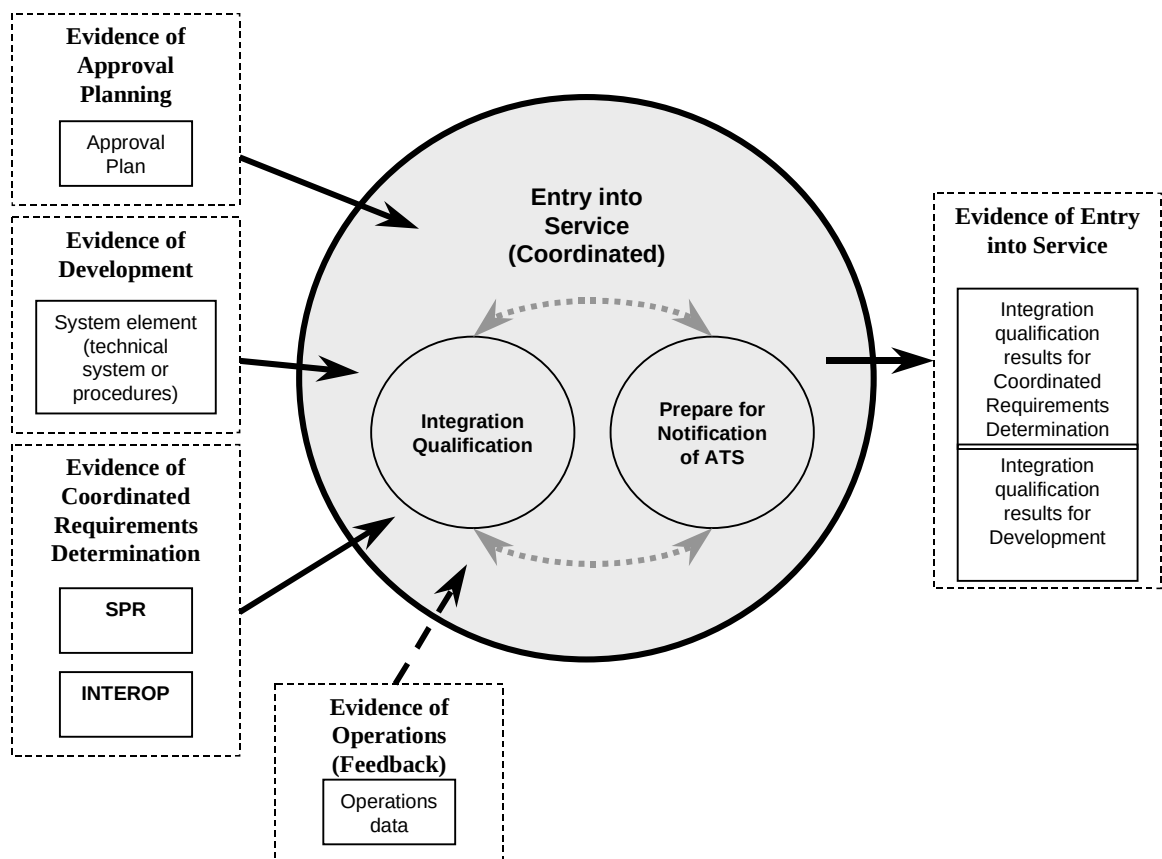


FIGURE 2-6: ENTRY INTO SERVICE

2.5

OPERATIONS

Operations include the process of ensuring that the operational, safety, performance, and interoperability objectives and requirements for the ATS and operating environment are maintained throughout operations. Operations include:

- continued operations, which include:
 - analysis and resolution of in-service operational issues reported by the ATS providers and operators. This item includes change management, continued verification, and configuration management. Where changes are proposed beyond the original operational approval, an impact analysis is conducted to determine the extent to which the processes described in this document will be applied.
 - addition of new organizations, ATS providers and operators, to the operational CNS/ATM system.
 - maintenance, which ensures that the CNS/ATM system is maintained in accordance with any maintenance requirements allocated by the SPR and INTEROP standards as negotiated prior to entry into service.
 - monitoring, which provides creditable operational data to determine that requirements for the CNS/ATM system and monitoring as defined in the SPR and INTEROP continue to be met. The ACP provides a means to monitor and measure the performance of the operational system to support operational approvals. The ACP is compared and evaluated against the RCP. The ACP is a transaction measurement and cannot be allocated. In the case where ACP does not meet a specified RCP level, an annunciation may be required. Monitoring includes data collection on a routine basis and as problems or abnormalities arise. System monitoring is performed by organizations which provide or use an ATS or are in control of or responsible for an element of the CNS/ATM system in operation and a data collection point resides within that element.
- development and qualification of follow-on modification, includes re-qualification when any of the operational, safety, performance, and interoperability requirements of the approved ATS are changed or system components are modified. Changes to the CNS/ATM system can include changes in procedures, changes to the operational environment, changes to elements of the CNS/ATM system, and removal from service. Follow-on modifications may take various forms, including introducing a new ATS (initial or different region). New ATS can be introduced into an airspace by modification of an existing CNS/ATM system previously installed or by installing a new system;
- replacing the system or procedures, or parts thereof, with another of similar or different technology or operation to perform the same ATS. The replacement system may be installed for a number of reasons including: replacement of obsolescent equipment, improvement of reliability or integrity, in compliance with a regulatory change, performance upgrade, or to correct problems or abnormalities encountered in operations or to enhance;

- *adapting an existing system or procedure to a different ATS; and*
- *modifying an existing ATS or element thereof. An alteration may result from a change in requirements or desired performance, correction of an implementation error, or an enhancement to equipment reliability.*
- *introducing organizational changes.*

Once the system has passed entry into service, approval of follow-on modification may be needed if the kinds of operation, services, and equipment have changed and the change affects the SPR or INTEROP standards. However, when a change in the operating environment, kind of operation, services, or communications equipment occurs, re-qualification and/or revalidation is performed only to the extent that the change impacts the analysis supporting the SPR and INTEROP standards.

Since most highly integrated or complex systems implement multiple functions, it is likely that a specific modification for such a system would involve more than one of these forms. Such modifications would imply a change to the OSED, which, in turn, implies revision or revalidation of the SPR and INTEROP standards. Each stakeholder ensures that it satisfies any new requirements. When it is necessary, the applicant submits new approval plans.

Evidence for continued operations includes the NOTAMs, monitoring data, configuration management data, and in-service problem analysis and resolution data. The purpose of evidence for continued operations is to provide information to the approval authority to substantiate that the objectives for continued operation are met.

Evidence for development and qualification of follow on modifications includes analysis to determine if any of the operational, safety, performance or interoperability requirements have been affected such that re-qualification is necessary. The purpose for evidence for follow-on modification is to show that the modification does not impact the operation, safety, performance, or interoperability of the initial implementation and that the modification performs as intended.

Figure 2-7 depicts the operations process.

Refer to section 7 for objectives and guidance on evidence for operations.

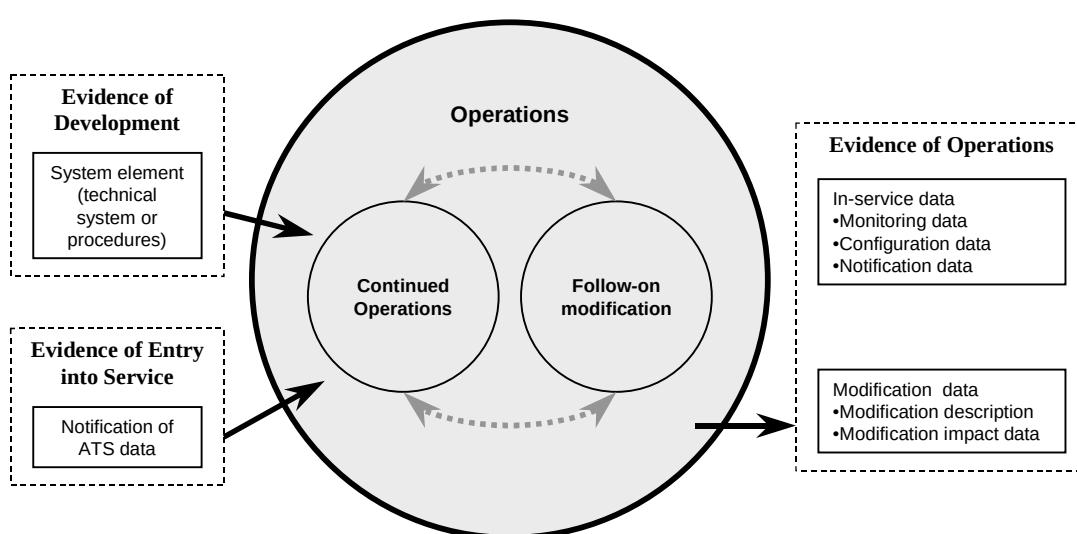


FIGURE 2-7: OPERATIONS

CHAPTER 3

APPROVAL PLANNING

This section provides objectives for approval planning and guidelines for related evidence. Approval planning enables applicants (i.e., ATS providers, operators, and aircraft and equipment manufacturers/modifiers) to resolve issues early rather than at entry into service and reach agreement on the approval approach with the approval authority.

3.1 OBJECTIVES FOR APPROVAL PLANNING

For approval planning, the following objectives should be met:

- a) Description of system element. The ATS, related CNS/ATM system, performance expectations, selected technologies, and intended operating environments are identified;
 - 1) The element of the CNS/ATM system and its operating environment are identified;
 - 2) The services, system architecture, human machine interface, including physical layout, and relevant operating assumptions are identified; and
 - 3) The interface and interactions with other systems are identified;
- b) Approval basis. Applicable approval processes and related regulatory requirements and means of compliance, including the approval basis, applicable regulatory requirements, other related regulatory material, industry guidelines, standards, or other documents, are identified;

NOTE: *In cases where there is no regulatory basis for a particular element of the CNS/ATM system, the regulatory requirements refer to those requirements established by the stakeholder responsible for development and qualification of the element.*
- c) Related approval plans and their relationship to this approval are identified;
- d) Planning for coordinated requirements determination. The means to identify, coordinate, allocate, and validate the operational, safety, performance, and interoperability requirements are described. Refer to section 4 for guidance on completing the SPR, INTEROP and related OSED;
- e) Planning for development. The means to develop the implementation are described. Refer to sub-section 5.1 for guidance on developing an element of the CNS/ATM system and operational integration and transition;

- f) Planning for qualification. The means to qualify the implementation to the requirements are described. Refer to sub-section 5.2 and section 6 for guidance on qualifying an element of the CNS/ATM system for operational integration and transition;
- g) Planning for continued operations. The means of monitoring for operational, safety, and performance considerations, interoperability, and managing the configuration of the system during operations are described. Refer to section 7 for guidance on criteria for establishing and maintaining a monitoring system for the provision and use of the ATS;
- h) Schedule. The schedule for operational implementation is identified and indicates the interaction between the applicant and the approval authority, including milestones for reviews, evaluations, and data submittals; and
- i) Proposal acceptance. Agreements with the approval authorities on the approval plans are obtained:
 - 1) The means for providing evidence showing that the element of the CNS/ATM system complies with approval requirements are defined, including how approval data will be packaged, in what form, and how approval data are made available to the approval authority. (e.g., manual for ATS (MATS) supplements, airplane flight manual (AFM), minimum equipment list (MEL), and operator's operational specifications); and
 - 2) The involvement of the approval authority is defined, including proposals for delegated authority.

3.2

EVIDENCE FOR APPROVAL PLANNING

The evidence for the approval planning process is the:

- a) Approval plan. The approval plan provides information to show that the objectives for approval planning are satisfied; and
- b) Acceptance of the plan from the approval authority.

CHAPTER 4

COORDINATED REQUIREMENTS DETERMINATION

This section provides objectives for approval coordinated requirements determination and guidelines for related evidence. The coordinated requirements determination process includes the inter-related processes that are coordinated by the stakeholders. These are:

- the OSEIC;
- the OSA, including the OHA and ASOR;
- the OPA, including RCP type determination or evaluation (when directly provided in the OSED), RCTP and human performance determination, and RCTP system elements allocation; and
- the IA.

4.1 OBJECTIVES FOR COORDINATED REQUIREMENTS DETERMINATION

For coordinated requirements determination, which includes the OSEIC, OSA, OPA, and IA, the objectives in the paragraphs in this sub-section should be met.

4.1.1 Operational Services and Environment Information Capture (OSEIC)

For the OSEIC, the following objectives should be met:

- a) Stakeholder identification. Applicants, approval authorities, and stakeholders needed to establish and show compliance to requirements for the ATS provision, its use, and related CNS/ATM system are identified;
- b) Operational objectives, intentions, and capabilities. The operator's operational objectives are defined, ATS providers intentions are defined, and intended operational capabilities are defined;
- c) Air Traffic Services description. The air traffic services and related operational communication processes provided by the CNS/ATM system are defined.
 - 1) The performance expectations of the service are defined;
 - 2) The technologies providing the CNS/ATM system are defined, including technical choices and functional characteristics;
 - 3) Dependencies on aircraft equipment are identified;
 - 4) Dependencies on ATS provider technical system automation are identified;
 - 5) Accommodation criteria for legacy systems are identified;
 - 6) ATS descriptions and related operational communication processes are defined, including operational scenarios, procedural requirements, and human factors requirements;

- d) Operational environment description. The operational environment for which the services are intended is described. This description includes environmental characteristics that are relied on for risk mitigation, performance, and interoperability. Some examples of environmental descriptors may include:

- 1) separation minima;
- 2) route configuration and complexity;
- 3) ATM services (including automation support tools);
- 4) airspace class;
- 5) traffic characteristic description;
- 6) traffic rates;
- 7) aircraft mix by functionality and performance;
- 8) navigation capability and performance (e.g., RNP, RNAV);
- 9) surveillance capability and performance (e.g., primary radar, ADS, SSR)
- 10) FIR and sector performance;
- 11) special use airspace restrictions;
- 12) general environmental conditions (e.g., weather, volcanic ash); and voice and data communication sub-networks.

OSD updates. The OSD is updated from information input from the OSA, OPA, and IA.

4.1.2 Operational Safety Assessment (OSA)

The OSA includes the OHA and ASOR. Objectives for the OSA are provided in terms of objectives for the OHA and ASOR respectively.

4.1.2.1 Operational Hazard Assessment (OHA)

For the OHA, the following objectives should be met:

- a) Stakeholder identification. Applicants, approval authorities, and stakeholders needed to establish and show compliance to requirements for the ATS provision, its use, and related CNS/ATM system are identified;
- b) Operational Air Traffic Services identification. Air traffic services as provided in the OSD are copied into the OHA to serve as its basis;
- c) Operational hazard identification. The operational hazards are identified as the loss or malfunction of the service, including misleading or delayed information.

NOTE: *The loss of service (LOS), loss of operational communication process (LOCP) between the controller and the pilot, unexpected interruption of the transaction (UIT), and undetected corruption of the transaction (UCT) are considered in order to determine and/or validate RCP parameter values (see annex F.4.2).*

- d) Operational hazard effects identification. The effects of each operational hazard are identified by evaluating the services in the environment, including legacy system considerations, for the intended operational capabilities as defined in the OSED. (see Table 4-1);
- e) Operational hazard classification. Each operational hazard is classified according to the severity of its identified effects using a hazard classification matrix, Table 4-1. To determine hazard severity:
 - 1) assess the effects of the hazard on operations considering the effects on the aircrew, air traffic services, and the aircraft occupants;
 - 2) if the hazard is identified at the service level, then environmental mitigation can be used to lower the hazard class. The requirements that define the environmental mitigation strategy should be defined in the SPR; and
 - 3) shared mitigation strategies within the CNS/ATM system being introduced and assessed should not be used to lower the hazard class at the service level.
- f) Traceability of operational hazards and effects. The operational hazards and their effects are traceable to services and environment as defined in the OSED;
- g) Safety objectives identification. Overall safety objectives (either qualitative or quantitative) based on the operational hazard classifications are established, Figure 4-1;

NOTE: *This document does not provide guidance on determining the quantitative values for the qualitative safety objectives illustrated in Figure 4-1. However, in cases where numerical analysis is required for approval, the quantitative and other objective criteria is negotiated with the approval authority during approval planning.*
- h) Candidate safety requirements identification. Candidate requirements established from environmental mitigation strategies are identified. Candidate requirements include procedural requirements, as well as aircraft and ATS provider technical system requirements not related to the new or modified CNS/ATM system.

Hazard Class	1 (most severe)	2	3	4	5 (least severe)
Effect on Operations	Normally with hull loss. Total loss of flight control, mid-air collision, flight into terrain or high speed surface movement collision.	Large reduction in safety margins or aircraft functional capabilities.	Significant reduction in safety margins or aircraft functional capabilities.	Slight reduction in safety margins or aircraft functional capabilities.	No effect on operational capabilities or safety
Effect on Occupants	Multiple fatalities.	Serious or fatal injury to a small number of passengers or cabin crew.	Physical distress, possibly including injuries.	Physical discomfort.	Inconvenience.
Effect on Air crew	Fatalities or incapacitation.	Physical distress or excessive workload impairs ability to perform tasks.	Physical discomfort, possibly including injuries or significant increase in workload.	Slight increase in workload.	No effect on flight crew.
Effect on Air Traffic Service	Total loss of separation.	Large reduction in separation or a total loss of air traffic control for a significant period of time.	Significant reduction in separation or significant reduction in air traffic control capability.	Slight reduction in separation or slight reduction in air traffic control capability. Significant increase in air traffic controller workload.	Slight increase in air traffic controller workload.

**TABLE 4-1: OPERATIONAL SAFETY ASSESSMENT
HAZARD CLASSIFICATION MATRIX**

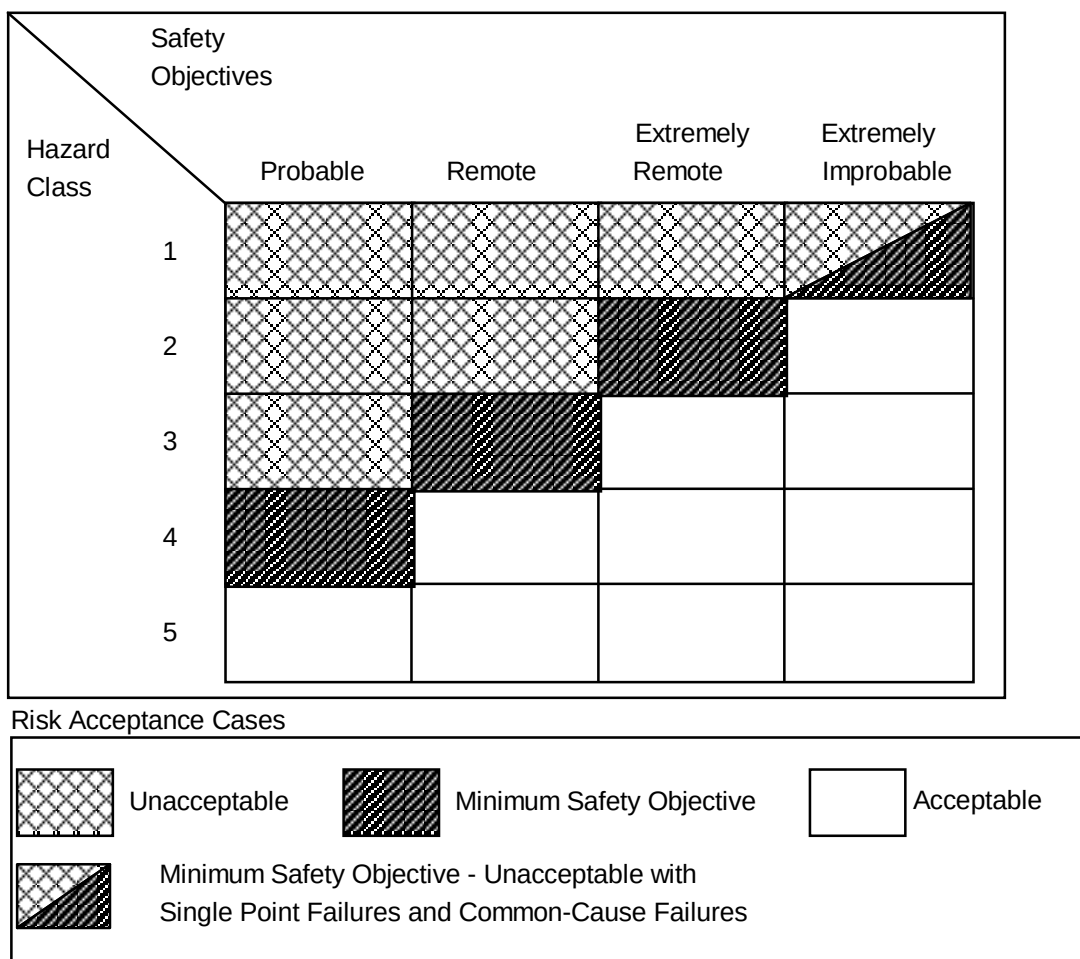


FIGURE 4-1: HAZARD CLASSIFICATION AND SAFETY OBJECTIVES RELATIONSHIP

4.1.2.2

Allocating Safety Objectives and Requirements (ASOR)

For the ASOR, the following objectives should be met:

- Stakeholder identification. Applicants, approval authorities, and stakeholders needed to establish and show compliance to requirements for the ATS provision, its use, and related CNS/ATM system are identified;
- Identification of system failure relationships. Identify the relationships of CNS/ATM system failures, procedural errors, and the effects on air traffic services to the hazard. Include identification of common cause failures or errors occurring among elements of the system.
- Identification of shared risk mitigation strategy. Identify risk mitigation strategies that are shared by multiple elements of the CNS/ATM system, including mitigation from effects of common cause failures or errors occurring across system elements. CNS/ATM system mitigation includes architectural and procedural aspects of the system and environmental mitigation and related candidate safety requirements identified in the OHA.

- d) Identification of safety requirements. Determine safety requirements from the shared risk mitigation strategies that satisfy the safety objectives.
- e) Allocation of safety objectives and requirements. Allocate the safety objectives and requirements, including requirements from environmental mitigation, to elements of the CNS/ATM system.
- f) Traceability of ASOR results to OHA. Trace the ASOR results to each safety objective identified in the OHA.
- g) Shared safety objective and requirement coordination. Coordinate the ASOR results:
 - 1) The impact of the ASOR on the OSEIC and other operational assessments are identified and reported to the appropriate process.
 - 2) The impact of the ASOR on development and qualification of system elements are identified and reported to the appropriate organizations. This impact includes criteria for quantifying safety objectives and for determining development assurance requirements, considering architecture including design features, for reducing the effects of generic design and implementation errors. Criteria for validating the effectiveness of procedural requirements are also provided.
- h) Validation of OSA results. Ensure the correctness and completeness of the safety objectives and requirements, including candidate safety requirements identified during the OHA.

4.1.3 Operational Performance Assessment (OPA)

The OPA includes determination of required communication performance (RCP) type, allocation of RCP type to human (human performance) and technical elements of the system (RCTP), and allocation of RCTP to technical elements of the CNS/ATM system.

NOTE: *The OPA does not provide methods to allocate human performance to the human elements of the system. The criteria for allocation are negotiated with the approval authority during approval planning.*

4.1.3.1 Determination of RCP Type

To determine RCP type, the following objectives should be met:

- a) Stakeholder identification. Applicants, approval authorities, and stakeholders needed to establish and show compliance to requirements for the ATS provision, its use, and related CNS/ATM system are identified;
- b) Selection of operational scenarios. Select from the OSED operational communication transactions for determining the RCP type for the intended application.
- c) RCP type determination. If not defined in the OSED, RCP type is specified according to the following parameters:

- 1) Transaction expiration time. The maximum time to complete a transaction, after which peer parties revert to an alternative procedure (Note: When the expiration time is exceeded, an alert is necessary to invoke the alternative procedures). The rate at which a transaction expiration time can be exceeded is determined by the continuity parameter;
 - 2) 95% transaction time. The time before which 95% of the transactions is completed. This is the time at which controllers and pilots can nominally accept the system performance and represents normal operating performance;
 - 3) Continuity. The probability that the transaction will be completed before the transaction expiration time, assuming that the communication system is available when the transaction is initiated;
 - 4) Availability. The probability that the communication system between the two parties is in service when it is needed; and
 - 5) Integrity. The risk of non-detection of message corruption, or the probability that the transaction is completed with an undetected error;
- d) RCP type evaluation. RCP type is evaluated for the air traffic services in the environments, including legacy systems, as defined in the OSED.

4.1.3.2

Allocation of RCP Type

To allocate RCP type between human and technical elements of the system, the following objectives should be met:

- a) Stakeholder identification. Applicants, approval authorities, and stakeholders needed to establish and show compliance to requirements for the ATS provision, its use, and related CNS/ATM system are identified;
- b) Allocation of RCP type to human and technical elements. RCP type parameters are allocated between technical and human performance. The RCTP determines the performance requirement in order to qualify the technical system elements. Human performance requirements determine the performance requirement in order to qualify the human element (including performance related to human machine interaction and human response).
- c) Allocation of RCTP to technical elements. RCTP is allocated to the aircraft and ATS provider technical system.

NOTE: *Allocation of RCTP to technical elements supports the different approval types for the elements. Further allocations may be necessary for the network, when provided by a different stakeholder than the applicant, and would be qualified for operator operational approval or ATS provider operational approval, as appropriate.*

- d) Evaluation of RCP type allocations. Ensure the correctness and completeness of the performance allocations based on the RCP type.
- e) Traceability of RCP type to operational services. The allocations of RCP type are traceable to the operational services defined in the OSED.

- f) Coordination of RCP type allocations. The allocated performance parameters are coordinated.
 - 1) The impact of the OPA on the OSEIC and other operational assessments are identified and reported to the appropriate process.
 - 2) The impact of the OPA on development and qualification of system elements are identified and reported to the appropriate organizations. This impact includes criteria for qualification and monitoring and configuration management for performance of system element and the CNS/ATM system.

4.1.4 Interoperability Assessment (IA)

The IA defines the interoperability requirements and their allocation across organizational boundaries.

For the IA, the following objectives should be met:

- a) Stakeholder identification. Applicants, approval authorities, and stakeholders needed to establish and show compliance to requirements for the ATS provision, its use, and related CNS/ATM system are identified;
- b) Requirements, rules, constraints. The requirements, basic rules and constraints that are necessary for interoperability are identified. For new ATS implementations, it should be determined whether one or more existing INTEROP standard(s) should be used as a baseline.
- c) Compatibility/interface technical requirements. The technical requirements for CNS/ATM system compatibility and organization interfaces are identified, including legacy system considerations;
- d) Standards references and additional requirements. International and industry standards are referenced whenever available, and any additional requirements are defined, including:
 - 1) message subsets;
 - 2) changes or deviations from existing standards;
 - 3) selected options;
 - 4) dynamic behavior and timing, and;
 - 5) limitations necessary to achieve interoperability of the system in the operational environment defined in the OSED;
- e) Requirements coordination/allocation. The interoperability requirements are coordinated and allocated to the applicable applicant or stakeholder; and
- f) Requirements validation and documentation. The interoperability requirements are validated and documented in INTEROPs (the interoperability requirements template in annex G provides an example format).
- g) Traceability of interoperability to operational services. The interoperability requirements are traceable to the operational services defined in the OSED.

- h) Coordination of interoperability requirements. The interoperability requirements are coordinated.
- 1) The impact of the IA on the OSEIC and other operational assessments are identified and reported to the appropriate process.
 - 2) The impact of the IA on development and qualification of system elements are identified and reported to the appropriate organizations. This impact includes criteria for qualification and monitoring and configuration management for interoperability of system element and the CNS/ATM system.

4.2

EVIDENCE FOR COORDINATED REQUIREMENTS DETERMINATION

The output of the coordinated requirements determination process consists of three data items:

- a) OSED;
- b) SPR; and
- c) INTEROP.

The OSED, the SPR, and the INTEROP provide the evidence that the objectives of the coordinated requirements process have been met

CHAPTER 5

DEVELOPMENT AND QUALIFICATION OF A SYSTEM ELEMENT

This section provides guidance on how to meet objectives and provide the related evidence required for the development and qualification processes at the organizational level. Development and qualification of a system element indicates that an applicant is developing or qualifying their own particular element of the CNS/ATM system.

5.1 DEVELOPMENT

Development is the process used to produce an element of a CNS/ATM system that meets the requirements of the coordinated requirements determination process. The inputs to the development process are the OSED, SPR, and INTEROP. Development includes the following:

- requirements capture;
- design; and
- integration.

5.1.1 Objectives for Development

For development at the organizational level, the following objectives should be met:

- a) System element requirements. System element requirements are captured from the SPR and INTEROP in accordance with the following criteria:
 - 1) requirements allocated to the organizations by the coordinated requirements determination process;
 - 2) safety requirements are highlighted;
 - 3) human machine interface requirements;
 - 4) human qualification requirements (e.g., flight crew, maintenance crew, and air traffic controllers); and
 - 5) operational requirements issues, including:
 - i) the aircraft flight manual and flight manual supplements;
 - ii) training and maintenance programs;
 - iii) identification of procedures, highlighting those that are safety related, and normal/abnormal/emergency checklists;
 - iv) a means to monitor ACP and compare to RCP and the associated procedures for corrective action if ACP does not meet RCP; and
 - v) configuration management of the operational CNS/ATM system;
- b) Requirements consistency. Requirements are modified to eliminate ambiguities, inconsistencies, and undefined conditions;

- c) Requirements discrepancies. Inadequate or discrepant coordinated requirements, or deviations from the coordinated requirements, together with their impact on the operational safety, performance, and interoperability of the CNS/ATM system are reported back to the appropriate coordination body;
- d) Development assurance. Development assurance level assignments for isolated components are determined and assigned.
- e) Development environment. The development environment is defined, including development standards and tools;
- f) Design. Design data are determined from the requirements, and consider:
 - 1) operational, performance, interoperability, and safety-related design;
 - 2) definition of the interface to the CNS/ATM system for which it is intended; and
 - 3) human machine interface design, including controls, displays, alerts/annunciation, and other human factors design data related to system functionality, performance, and workstation/flight deck integration, training, maintenance;
 - 4) monitoring provisions; and
 - 5) procedures;
- g) Traceability of requirements and design. Requirements and design data are:
 - 1) produced in accordance with development standards and plans;
 - 2) traceable, verifiable, and consistent; and
 - 3) provided as input to the appropriate qualification process;
- h) Component Integration. The components of the system element are integrated and the system element is produced;
- i) Training and maintenance. The training and maintenance programs are developed;
- j) Transition criteria identification. Transition criteria are defined, including procedures, airspace requirements, and NOTAM;
- k) Specification of SPR and INTEROP standards in operational data. RCP types and RCTP for the system element, including references to guidance material, SPR, and INTEROP standards, are specified in operational data; and
- l) Operations. The activities and their interrelationships with other activities within the approval process are defined.

5.1.2

Evidence for Development

Evidence for development should include the following.

- a) the system element specification, which provides the results of requirements capture, including development plans, procedures, and standards;
- b) the design data, including plans, procedures, and standards;
- c) the technical system; and
- d) the operational data, including training, operating, and maintenance procedures and manuals.

5.2 QUALIFICATION

Qualification is the process that provides an acceptable level of confidence that the development process has produced an element of the CNS/ATM system that meets the requirements of the coordinated requirements determination process.

5.2.1 Objectives for Qualification

For qualification of a system element, the following general objectives should be met:

- a) Qualification plans and procedures. Qualification plans and procedures are produced, and qualification is carried out in accordance with the plans and procedures;
- b) Approval. Approval is obtained for each element of the CNS/ATM system; and
- c) Standards recognition. The applicable SPR and INTEROP standards are officially recognized for use in an airspace by notification in the associated AIP/NOTAM.

In addition, the following sections provide qualification objectives related to validation, verification, process assurance, and configuration management.

5.2.1.1 Validation Objectives

For qualification of a system element, the following validation objectives should be met:

- a) Requirements validation. The requirements produced at the organizational level are validated;
- b) Risk mitigation strategy validation. Risk mitigation strategies which are not shared, and related architecture and design for the element of the CNS/ATM system are validated; and
- c) Human machine interface requirements validation. Human machine interface requirements are validated. Issues to be considered include:
 - 1) ease of operation;
 - 2) mode confusion;
 - 3) task sharing and distribution of workload within an ATSU or flight deck;
 - 4) adequacy of feedback;
 - 5) the methods used for consideration of realistic human performance, including the effect of error, are defined; and
- 3) system integration to ensure that the human machine interface is consistent with the interface and design of the particular aircraft or ATS provider system in which the element of the CNS/ATM system is installed.

5.2.1.2 Verification Objectives

For qualification of a system element, the following verification objectives should be met:

- a) Verification flight and ground tests. Verification flight and ground tests are performed, including verification of aircraft flight deck interface acceptability;
- b) Element verification. The results of the development process are verified against the objectives and requirements allocated by the coordinated requirements determination process, including the following:
 - 1) the objectives and requirements for the intended operation;
 - 2) the safety objectives and requirements that support shared risk mitigation strategies;
 - 3) operational and technical interoperability requirements for the selected technologies and intended operation are verified;
 - 4) the CNS/ATM system element is verified to have no adverse affect on the operation, safety, and performance aspects of the existing ATS or existing aircraft equipage in which it is integrated;
 - 5) development assurance aspects are verified;
 - 6) implementation of monitoring requirements is verified;
 - 7) It is verified that ICP has no adverse effect on the operation, safety, and performance aspects of the existing ATS or existing aircraft equipage in which it is integrated; and
 - 8) ICP meets its requirements;
- c) System element safety assessment. The safety assessment activities and their interrelationships with other activities within the approval process are defined; this includes the means to verify allocated requirements and risk mitigation strategies specific to the system element, and considers the following:
 - 1) operational hazards being addressed by the applicant, with associated safety objectives and requirements;
 - 2) verification that these safety objectives and requirements have been met (with reference to appropriate standards or codes of practices if appropriate);
 - 3) objectives within the system element safety assessment that cannot be met by that applicant;
 - 4) assumptions made in the OSA, about the system elements;
 - 5) the list of system element safety assessment specific hazards with associated safety objectives and requirements, which have been identified by the applicant, and verification that these safety requirements have been met; and
 - 6) deviations from standards;
- d) Installed communication performance (ICP). The performance assessment activities and their interrelationships with other activities within the approval process are defined;

- e) Verification of operational, performance, and interoperability implementation. The means to verify operation, performance, interoperability implementation of the element of the CNS/ATM system at system integration and its interrelationships with other activities within the approval process are defined. The element is verified, considering the following:
- 1) test organizations (i.e., which participants participate with personnel, test equipment, development systems, or operational systems);
 - 2) test tools (e.g., operationally equivalent, independently developed tools);
 - 3) test schedules;
 - 4) test plans and procedures, including success criteria;
 - 5) objectives within the SPR and INTEROP that cannot be met by those organizations;
 - 6) assumptions made in the SPR and INTEROP about elements of those organizations that have been identified as being incorrect;
 - 7) operating conditions within elements of those organizations that can change and affect the assumptions made in the SPR and INTEROP about the achievement of the operational, performance, and interoperability objectives;
 - 8) new assumptions which are made about the other organizations;
 - 9) identified functions allocated to the wrong organizations;
 - 10) identification of OSED, SPR, or INTEROP characteristics and information, or requirements that need to be monitored before and/or at entry into service;
 - 11) results of monitoring exercises;
 - 12) capability of interoperating with a characteristic ATS provider technical system;
 - 13) capability of ICP to meet applicable RCP and capability that the operator can satisfactorily operate the technical system in the intended environment; and
 - 14) interoperability is demonstrated through exhaustive, multi-leveled interoperability testing at the component, organizational interface, and CNS/ATM system levels; and
- f) Element Integration and transition tests. The objectives and acceptance criteria for flight, ATS provider technical system, and laboratory tests are defined. These tests include means to validate the element of the CNS/ATM system in the context of the operational, safety, performance and interoperability requirements and to check for adverse effects on other system elements and operations;

NOTE: Refer to section 6 for qualification objectives for integrating a system element into the overall CNS/ATM system.

5.2.1.3 Process Assurance Objectives

For qualification of a system element, the following process assurance objectives should be met:

- a) Adherence to plans. Qualification is performed in accordance with plans and procedures;
- b) Feedback from entry into service. The results fed back from the entry into service process are accounted for; and
- c) Discrepancies. Organizational requirements and design are assessed to ensure that they satisfy the operational, safety, performance, and interoperability aspects of the CNS/ATM system, and discrepancies are indicated to the development process;

5.2.1.4 Configuration Management Objectives

For qualification of a system element, the following configuration management objectives should be met:

Configuration management. The configuration of the system element is managed throughout the development and qualification process.

5.2.2 Evidence for Qualification

Evidence provides proof that the compliance objectives for qualification have been met and that the system is suitable for its intended use. This section provides guidance on how to produce evidence to show compliance and to ensure the objectives for development and qualification have been met.

Evidence for qualification should include the following.

- a) validation plans, procedures, and results;
- b) verification plans, procedures, and results;
- c) process assurance plans, procedures, and results;
- d) configuration management plans, procedures, and results;
- e) accomplishment summary;
- f) approval; and
- g) AIP and/or NOTAM.

CHAPTER 6

ENTRY INTO SERVICE

This section provides objectives and related evidence for entry into service. Entry into service is a coordinated process that:

- Accepts the development and qualification data produced by the stakeholders; and
- Ensures that the elements of the CNS/ATM system have been implemented in accordance with approved plans, except in cases where deviations, clarifications, or additions have been identified and accepted in each of the approvals.

6.1 OBJECTIVES FOR ENTRY INTO SERVICE

The ATS provider operational approval authorizes the provision of ATS supported by data communication in a specified airspace in accordance with the provisions of the AIP/NOTAM. The operator's operational approval authorizes the use of the CNS/ATM system based on compliance with the criteria prescribed in the AIP/NOTAM and the AFM. The operational approval requires the applicant, approval authority and other stakeholders to work collaboratively. For entry into service, the following objectives should be met:

- a) System element demonstration. It is demonstrated that the system element performs as intended and meets the requirements allocated by the SPR and INTEROP, including demonstration that ACP meets the RCP type and ICP meets RCTP, when operated in the CNS/ATM system environment. Table 6-1 provides an acceptable set of qualification measures. Qualification measures should include factors, such as capacity, network loading, coverage, and workload;

Qualification Parameters	Requirement (Ref Annex F)	Qualification means
Expiration Time	$\text{Min}\{\text{ET}_x\}$	$\text{ET}\{\# \text{ of transactions to continuity level}\}$ see Note 1 & 2
Transaction Time	$\text{Min}\{\text{TT}_x\}$	$\text{TT}\{\# \text{ of transactions to 95\% level}\}$ see Note 2
Availability of Use	More Stringent: $\{(1-\text{QSPL}_{\text{LOCP}}), (1-\text{QOPL}_{\text{LOCP}})\}$	$1-[\text{total outage duration time}/\text{total exposure time}]$
Availability of Provision	More Stringent: $\{(1-\text{QSPL}_{\text{LOS}}), (1-\text{QOPL}_{\text{LOS}})\}$	$1-[\text{total outage duration time}/\text{total exposure time}]$
Integrity	More Stringent: $\{(1-\text{QSPL}_{\text{UCT}}), (1-\text{QOPL}_{\text{UCT}})\}$	Qualification by analysis
Continuity	More Stringent: $\{(1-\text{QSPL}_{\text{UIT}}), (1-\text{QOPL}_{\text{UIT}})\}$	$1-[\text{NET}/\text{TNT}]$ see Note 2
NET – number of transactions exceeding expiration time QOPL – quantitative operational performance level QSPL – quantitative safety performance level TNT – total number of transactions initiated Note 1 - Expiration time is used as a timer threshold for an indication to perform alternative procedure if this timer threshold is exceeded. Note 2 - The qualification of these parameters is based on analysis of the distribution determined from a sufficient sample of data collected from the CNS/ATM system.		

TABLE 6-1: QUALIFICATION MEASURES

- b) Issues/deficiencies. Issues or deficiencies, which manifest at operational integration, are identified;
- c) Corrective actions. Corrective action(s) for each issue or deficiency are agreed upon and implemented; and
- d) Operational verification. The operational CNS/ATM system operates in accordance with operational data.

6.2

EVIDENCE FOR ENTRY INTO SERVICE

For entry into service, the following evidence should be produced:

- a) Element integration verification plans, procedures, and results, including configuration data; and
- b) Corrective actions agreed upon for issues/deficiencies identified during entry into service.

CHAPTER 7

OPERATIONS

This section provides objectives and guidance on evidence required for operations. The operations process ensures that system operations continue to satisfy operational, safety, performance, and interoperability requirements while in service. For each applicant, this process consists of:

- continued operations, including system monitoring and iterative operational safety, performance, and interoperability assessments as internal or external changes are made for adjustments and problem resolution; and
- the development and qualification of follow-on modifications.

7.1 OBJECTIVES FOR OPERATIONS

This section provides guidance on the objectives for operations.

7.1.1 Continued Operations

Organizations continually monitor to detect any deviations beyond the granted operational approval and coordinate timely and effective corrective action. Where changes are proposed beyond the original operational approval, an impact analysis is conducted to determine the extent to which the processes described in this document should be applied.

For continued operations, the following monitoring objectives should be met:

- a) Evaluation. Operations and procedures are continually evaluated;
- b) Problem identification. Potential problems are identified early;
- c) Problem management. Information concerning identified problems is disseminated to operators and ATS providers to raise awareness and facilitate problem resolution;
 - 1) status reports are generated on a periodic basis by each applicant; and
 - 2) status reports and problem reports are based on data collected and analyzed, including the reason problems or abnormal events occurred.
- d) Problem resolution tracking. Problem resolution is tracked;
 - 1) problem resolution is identified, including interim operational procedures and operating constraints, which mitigate the effects of problems until such time a longer term solution is implemented;
 - 2) problem resolution is monitored to assure implementation;
 - 3) problem resolution are traceable to the point at which the problem was encountered, their operational implications, and their resolution and are identified and traceable;
 - 4) system performance is assessed; and
 - 5) system testing is authorized and coordinated.

- e) Problem resolution. Problems affecting safety or flight operations are resolved in a timeframe acceptable to the approval authority. Problem resolution may require:
 - 1) re-training of system operators, revision of training procedures to ensure compliance with existing procedures, or operational constraints;
 - 2) changes to operational data (including operator's operations specifications); and
 - 3) changes to systems including design, performance and interoperability.
- f) ACP. ACP is monitored and the data is analyzed in regard to the RCP.
- g) Configuration changes. Changes to the configuration of the system that impact the SPR and INTEROP requirements are managed per the configuration management procedures defined in operational data.

7.1.2 Development and Qualification of Follow-on Modification

For follow-on modification, the following objectives should be met:

- a) Assessment. The modification is assessed as to its impact on the SPR and INTEROP standards, development and qualification, and the integration into the operational environment;
- b) Standards revision. SPR and/or INTEROP standards are revised in accordance with section 4;
- c) Development and qualification. The modification is developed and qualified in accordance with section 5; and
- d) Integration qualification. The modification is integrated into the operational environment in accordance with section 6.

7.2 EVIDENCE DURING OPERATIONS

This section provides guidance for evidence produced during operations to support the operator's and ATS provider's operational approvals.

7.2.1 Continued Operations

For continued operations, the following evidence should be produced:

- a) AIP and/or NOTAM;
- b) Monitoring data; and
- c) Configuration management data.

7.2.2 Follow-on Modification

For follow-on modification, the following evidence should be produced:

- a) Modification impact assessment, including applicable service data;
- b) Data from the development process;
- c) Data from the qualification process that shows the change has been implemented correctly and does not affect existing elements of the CNS/ATM system; and
- d) Notification to operators and ATS providers that the modification is operational.

ANNEX A

COMPLIANCE MATRIX

Objective Reference	Objective	Evidence Reference	Evidence	Approval types		
				Aircraft type design approval	ATS provider operational approval	Operator operational approval
Section 3, Approval Planning						
3.1.a)	Description of system element	3.2.a	Approval plan	The system element is the aircraft equipage and includes interactions with the ATS provision and intended use.	The system element is ATS provision and includes relevant third party communication services and internet working capability.	The system element is the ATS use and includes relevant third party communication services and internetworking capability.
3.1.b)	Approval basis	3.2.a	Approval plan	Aircraft use	ATS provision	ATS use
3.1.c)	Related approval plans	3.2.a	Approval plan	Not applicable	Not applicable	Related to ATS provision and aircraft equipage
3.1.d)	Planning for coordinated requirements determination	3.2.a	Approval plan	ATS provision, aircraft equipage, ATS use.	ATS provision, aircraft equipage, ATS use.	ATS provision, aircraft equipage, ATS use.
3.1.e)	Planning for development	3.2.a	Approval plan	Aircraft equipage and operational data (e.g., airplane flight manual and supporting references)	ATS provision includes technical system and operational data (e.g., manual of ATS supplement)	Operational data and supporting material (e.g., training material, operator's operations specifications)
3.1.f)	Planning for qualification	3.2.a	Approval plan	Aircraft equipage	ATS provision	ATS provision / aircraft equipage integration and ATS use
3.1.g)	Planning for continued operations	3.2.a)	Approval plan	Aircraft equipage provisions and operational data to support operational monitoring and configuration management	ATS provision, operational data	ATS use, operational data
3.1.h)	Schedule	3.2.a)	Approval plan	Aircraft equipage	ATS provision	ATS use