WAM Generic Guidance Process - Volume 1
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EXECUTIVE SUMMARY

This document is designed to support Air Navigation Service Providers in achieving operational approval for a Wide Area Multilateration (WAM) system. The document is presented in two volumes.

This volume contains an introduction to the approvals process, followed by a six step outline of the tasks ANSPs will need to undertake to achieve operational approval for WAM. WAM specific elements are highlighted throughout, with particular attention paid to differences from traditional radar surveillance.

This volume is complemented by a second volume, containing **guidance notes** intended to highlight best practice in each of the following areas:

A. Operational approvals within the SES

B. How to decide which technology to procure

C. Procurement options for ANSPs

D. Operational considerations when deploying WAM

E. Performance and interoperability requirements

F. Coverage and receiver site planning

G. How to plan for future system expansion

H. Assessing the WAM communications links

I. Guidance on the re-use of the EUROCONTROL example WAM safety assessment

J. Failure mode scenarios: potential mitigations and practices

K. How to conduct a performance assessment of WAM systems

L. Integration of WAM systems – the effect on the ATC system

The first formal release of the document was written by Helios under contract TRS T07/11131CG. The Eurocontrol Agency will, on behalf of MLTF members, update the document within the context of MLTF activities to reflect lessons learnt and refinements to guidance notes etc. Latest versions will be posted on www.eurocontrol.int/surveillance and also on the MLTF One Sky team site.

Any feedback on the document is encouraged, and should be sent to the contact points at www.eurocontrol.int/surveillance

1 Introduction

1.1 Purpose

This document provides guidance for Air Navigation Service Providers (ANSPs) seeking to gain operational approval for the use of a Wide Area Multilateration (WAM) system.

The overall aim of the document is to ensure that the process followed by European ANSPs, when they seek approval for a WAM system, takes account of the experience gained from early adopters of WAM and reflects existing European regulatory requirements as established by the Single European Sky (SES).

The approvals process is conducted as part of the overall system **procurement process** – that is the process followed to procure and commission a new system. This document therefore uses the main steps of the procurement process to describe the actions required to obtain operational approval.

The information contained in this document will assist the ANSP in preparing submissions to their National Supervisory Authority (NSA). For NSAs, the information presented should prove useful when responding to requests for approval for applications of a WAM service.

This document does not intend to set out a rigorous or formal approach; instead, it sets out the best practice established so far for the processes and tasks that need to be followed, identifies common issues that have arisen from them and proposes potential solutions.

In doing this, the document puts the approval of WAM in its context. Although some elements are common to the approval of any surveillance system, the WAM-specific elements are highlighted throughout this document.

1.2 Reading this document

The document is structured to help the reader understand the context and overall structure of the approvals process, before detailing specific WAM elements to each step. It contains two main elements:

- In this volume, a **six step description of the approvals process**, with a detailed description of how WAM differs from “traditional” surveillance approvals; and
- In volume 2, a **series of twelve guidance notes** are presented, each focusing on a specific area of WAM approvals and giving guidance on the process based on other ANSPs experience and previous research.

The document focuses on the European approvals process as applicable to European ANSPs subject to the provisions of the Single European Sky legislation. For non-European States wishing to adapt this approach, relevant reference should be made to local certification and approval requirements.

The intended readership within ANSPs is principally those persons concerned with:

- the procurement, installation and transition to new (WAM) surveillance systems;
- supporting surveillance systems throughout their operational lifetime from procurement to disposal.

This includes:

- Managers concerned with planning the deployment of people, procedures or equipment in support of surveillance systems.
- Engineers who provide technical support to both new and existing (legacy) surveillance systems throughout their lifecycle (including provision, through life support and disposal).

From a regulators (NSA) perspective, this document provides ‘best practice’ guidelines that they can expect their ANSP to follow in the course of gaining approval.

Elements of this document will also be of interest to a wider audience including surveillance officials (particularly in relation to the approval steps specific to a WAM surveillance system [as opposed to other surveillance techniques e.g. a Primary and Secondary Surveillance Radars]) and WAM system manufacturers.

1.3 Terms and definitions

This document uses a number of commonly used definitions to refer to services and systems. This section defines those terms, and clarifies the boundaries of the system or service.

A **system** is a combination of physical components, procedures and human resources organised to perform a function.

Note that this is in line with the Interoperability Regulation [ref 21] definition which states that the ATM **system** is the “ground and airborne constituents and the space equipment to support air navigation services during all phases of flight”.

Constituents: tangible items, such as equipment, and intangible items, such as the software on which the interoperability of the European air traffic management network depends (from Interoperability of the European ATM Network: Regulation 552/2004) [ref 21]. Note that the terms components and constituents are used interchangeably within this document.

The **WAM system** is the combination of components, procedures and human resources of Wide Area Multilateration, including the specific hardware and software of the Wide Area Multilateration function.

The **WAM infrastructure** is the deployed [physical] WAM system, including power, communications and integration elements.

It should be noted that the ANSP’s procurement does not consist solely of any of these elements, but includes contractual elements, secondary elements such as training and maintenance, along with the physical WAM components themselves.

Several different types of service exist, and can be explained in the following diagram:

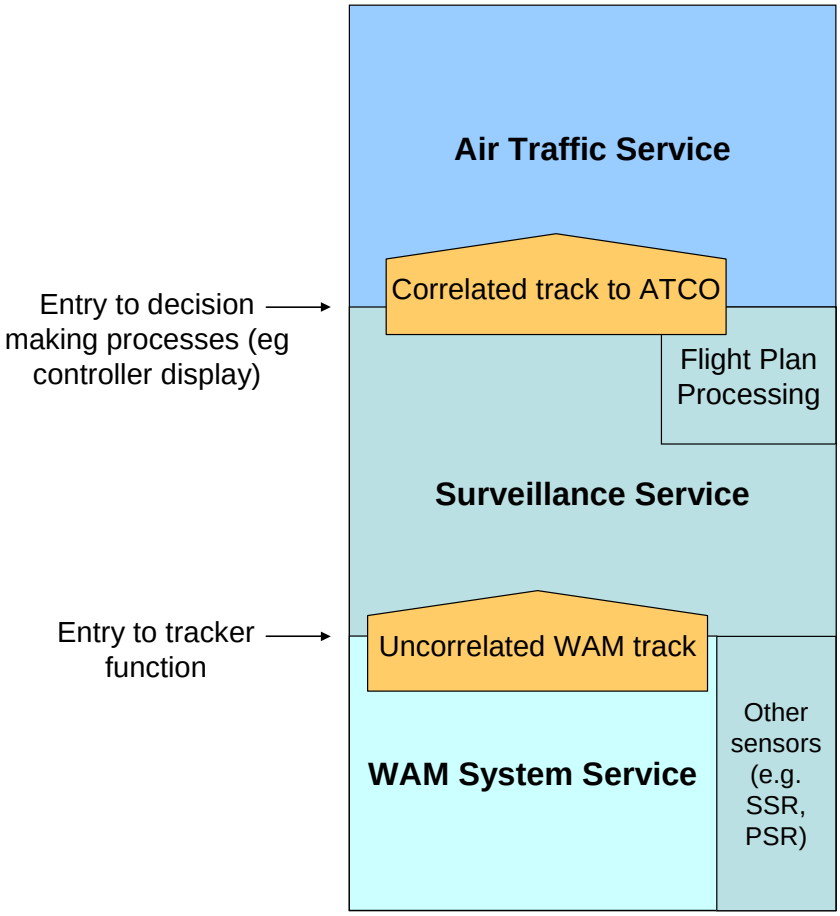

Figure 1 - Levels of service in the surveillance domain

WAM System Service = the provision of the uncorrelated WAM track to the tracker functionality of the ANSP (many WAM systems have a Central Processing Function that outputs a track rather than a series of plots). The WAM system service ends at the entry to the tracker functionality of the service provider (e.g. the flight data processing system for track correlation) or other agreed interface point.

Surveillance Service = the provision of correlated surveillance data to the controller or controller tools. The WAM track is correlated with other sensors position reports, and the flight plan processing function, to give a correlated track including operational identity. The surveillance service ends at the entry to the decision making processes, namely the controller working position or controller tools utilised by the service provider.

The Air Traffic Service (ATS) is the end-service provided to the user by the service provider, for example the provision of Air Traffic Control separation services.

1.4 Structure of the document

The process for achieving the operational approval of a WAM system needs to reflect the strengths and weaknesses of WAM as a surveillance technique. It therefore differs substantially from that used for traditional surveillance methods such as PSR and SSR. In response to this EUROCONTROL issued a contract to develop best practice guidelines for operational approval of WAM systems.

The first formal release of the document was written by Helios under contract TRS T07/11131CG. The Eurocontrol Agency will, on behalf of MLTF members, update the document within the context of MLTF activities to reflect lessons learnt and refinements to guidance notes etc. Latest versions will be posted on www.eurocontrol.int/surveillance and also on the MLTF One Sky team site.

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The document is organised as follows:

- Section 2 gives an overview of the approvals process.
- Section 3 contains a high level description of the steps involved in collating evidence for approvals, and discussion of several WAM specific elements in actors' roles, contracts and procurement options.
- Section 4 contains a detailed explanation of each step, including the key WAM-specific tasks at each stage.
- Section 5 contains a list of abbreviations used in this document.
- Section 6 contains the list of references used in the document.
- Section 7 explains in greater detail the use of the principal references used in this document in an annotated bibliography.

This volume is complemented by a second volume containing the following **guidance notes**:

A. Operational approvals within the SES

B. How to decide which technology to procure

C. Procurement options for ANSPs

D. Operational considerations when deploying WAM

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2 The Approvals Process

2.1 Purpose

Prior to commencing operational use of the data from a WAM system, the ANSP must obtain operational approval from the relevant regulatory authority (within Europe, the NSA).

Approval for the WAM system may form part of the wider approval for the overall Air Navigation Service (ANS). The ANSP must gather evidence to present to the NSA that the proposed WAM system is fit for purpose. This section provides a brief overview of the main bodies and standards involved in gathering the required evidence. It is designed to aid understanding of the following sections and the guidance notes. Section 0 then applies the material to surveillance systems, with particular attention paid to the specifics of WAM systems infrastructure and their interface with the hardware of other CNS systems, and the surrounding infrastructure, with section 4 adding the detail.

2.2 Approvals and certification

It is important to first understand the difference between system approval and equipment certification. The approvals process is the series of activities performed to gain formal recognition from an authorised body that a product, process or service conforms to applicable safety regulatory requirements whilst operating within a real-life environment.

By contrast certification is system-specific, and is usually carried out by the equipment manufacturer prior to deployment. The certification process refers to the confirmation that the system has certain characteristics (safety, functionality etc.). Formal recognition, within an appropriate legislative framework, is still required for certification.

The key difference between most definitions of certification and approval is the applicability of the local environment of interest (approval examines a service within a given environment whereas certification deals with the conformity of a product to an industry standard or factory specification).

Example 1: If a fire extinguisher was certified as being acceptably safe by one authorised body, it would not be approved for use in a particular building until the local building inspector (or local fire prevention officer) had authorised it for operational use in that building.

Example 2: If a Wide Area Multilateration system was certified by the equipment manufacturer and appropriate regulatory authority (the authorised body acting under a legislative framework), it would not be approved for use in a particular airspace until the local National Supervisory Authority had authorised it for operational use (by giving operational and technical approval).

In order to achieve approval, a full description of the system and the nature of its local implementation are needed by the ANSP, and subsequently the NSA, including aspects surrounding the:

- Safety of the WAM system (and the quality and performance standards to which it adheres; both in terms of coverage volume and service reliability)
- Management, engineering and overall capability standards assurance.

There are many different European bodies responsible for certifying, authorising and approving new ATM products, processes and services. The next section provides a simplified view of the overall process.

2.3 Organisations and documents involved

The following organisations play a role in the approvals process:

NSA – Responsible for granting approval of the system, in terms of the Air Traffic Service which it will provide. This is done by reviewing the evidence presented by the ANSP. The evidence is normally presented in the form of a **Safety Case** which defines the ATS service to be provided, the performance requirements, the technical and procedural means of the providing the Air Traffic Service and the mitigations against identified hazards[1]. Note that as part of determining what is necessary for the Air Traffic Service, many NSAs may decide to look in detail at the surveillance service also (and the WAM system service as part of that). The NSA legislation is outlined in the SES Service Provision regulation (550/2004) [ref 19], which separates the regulatory function from the service provision function.

ANSP – Responsible for providing the agreed Air Traffic Service, implementing appropriate surveillance services to support this, and developing the Safety Case to demonstrate that the proposed solution is fit for purpose. The safety case is a way of ordering the required evidence in a coherent manner based around a '**safety argument**' as to why the system is safe. The safety case addresses operational, technical and lifecycle issues. The ANSP is also required to make a Declaration of Verification **(DOV)** to the NSA under the SES legislation (see section 2.4).

Equipment Manufacturer – Responsible for demonstrating compliance of system components to relevant standards as requested by the purchaser – typically the relevant ICAO and EUROCAE documents and local requirements defined in the **Functional and Technical Specification (FTS).** The equipment manufacturer is also responsible for completing a Declaration of Conformity or Suitability of Use **(DSU)** under the SES legislation (see section 2.4).

ICAO develops Annexes to the Chicago Convention, outlining the Procedures and Standards necessary to ensure global interoperability. In particular, ICAO develops **SARPs** (Standards and Recommend Practices) which define the high level technical requirements of some aviation technologies – for example the Mode S signal interoperability is defined in SARPS. It also develops PANS (Procedures for Air Navigation Services), setting out how the various enablers will be used operationally. ICAO is now concentrating on producing performance standards which will define the level of technical service (e.g. CNS) required to provide certain Air Traffic Services. The most mature example is the Manual on Performance Based Navigation. A similar document on Surveillance would provide guidance to states on the Quality of Service required from the surveillance system to provide pre-defined operations such as 5nm Separation minima. In the absence of this performance-based surveillance, it is recommended that service providers use **EUROCONTROL's Surveillance Standard** [ref 6] to define performance requirements.

Note that the EUROCONTROL Surveillance Standard is currently undergoing revision to ensure it is based on Required Surveillance Performance, rather than any particular technology. This is line with ICAO PANS-ATM Doc 4444 Section 8 [ref 15], which now refers to ATS Surveillance Systems and Surveillance Services (rather than Radar Services).

[1] The Safety Case is recommended to be developed using the EUROCONTROL Safety Case Development Manual [ref 24].

EUROCAE develop a series of documents that define the requirements for systems and constituent elements:

- **MASPS** – Minimum Aviation System Performance Specifications which define the operational and/or functional requirements of a complete end-to-end system (where the system includes people, procedures and equipment).
- **OSED** – Operational Services and Environment Definition (OSED) defines the operational concept, proposed service and associated environment.
- **SPR** – Safety and Performance Requirements define the minimum operational, safety and performance requirements for the implementation of a particular system (focusing on the equipment).
- **INTEROP** – Interoperability Requirements are defined between the different domains in a system (e.g. airborne, ground); for each of them, it identifies the technical interface and related functional requirements.

Note that the OSED, SPR and INTEROP can be combined to form a MASPS-type specification. All the above documents look at the application-level, and apply top-down requirements.

- **MOPS** – Minimum Operational Performance Specifications (MOPS) define how systems should be tested. They contain more detailed testable requirements for individual systems and sub-systems, and can be based on the MASPS or OSED/SPR/INTEROP requirements.

There are also documents termed “Technical Specifications” – for example, for **Wide Area Multilateration (ED-142)** (not yet published). The draft ED-142 document states: “*Compliance with this technical specification by manufacturers, installers and users is recommended as a means of assuring that the equipment will satisfactorily perform its intended function(s) under all conditions normally encountered in Air Traffic Control surveillance operations*.”

EUROCAE documents have no formal standing in their own right, but are referenced by certification authorities as an acceptable means of compliance.

ESOs (CEN, CENELEC and ETSI) develop European Norms (ENs)) which define technical requirements for constituent systems. ENs have a similar content to EUROCAE MOPS. No ENs have been produced for surveillance equipment – but the ESOs have a growing role within the SES Interoperability Regulation (see section 2.4).

In summary, approvals is about demonstrating to the regulator that the proposed service is fit for purpose. This is aided by the adherence to various standards.

However, the system is still open to significant interpretation by the national regulator and the ANSP must work closely with the regulator to ensure that the regulator understands and accepts the evidence presented when asking for approval. The level of detail will vary between national authorities.

2.4 Impact of the Single European Sky

The European Commission, through the Single European Sky, is harmonising the approvals process. The industry is currently in transition to the new way of achieving approvals, a situation which may be further complicated by the proposed extension of EASA (European Aviation Safety Agency) competence to ATM. The extension of EASA competence will change the approvals process, as EASA will become responsible for certification of ATM systems – although the actual process will be delegated to the local NSA.

The interoperability regulation requires that all EATMN components are demonstrated to be compliant with the Essential Requirements and/or implementing rules using a process known as Conformity Assessment.

There are currently no SES documents specific to WAM. An Implementing Rule on Surveillance Performance and Interoperability (SPI IR) is under development. It is likely that the SPI IR will identify a number of Community Specifications that should be developed to support Conformity Assessment of surveillance systems including WAM.

Conformity Assessment includes:

- The Manufacturer makes a Declaration of Conformity or Declaration of Suitability of Use which demonstrates to the NSA that the equipment is consistent with the Essential Requirements, Implementing Rules and any Community Specifications of the Interoperability Regulation.
- The ANSP makes a Declaration of Verification which demonstrates to the NSA that the installed system is consistent with the Essential Requirements, Implementing Rules and any Community Specifications of the Interoperability Regulation.

Full details are provided in Guidance Note A.

3 Process Overview

3.1 Purpose

Figure 2 illustrates the 6 process steps. They are aligned to the overall procurement process. This helps identify where in the procurement process elements of the approvals process should be performed. Section 3.2 provides an overview of these steps (detailed descriptions are provided in Section 4).

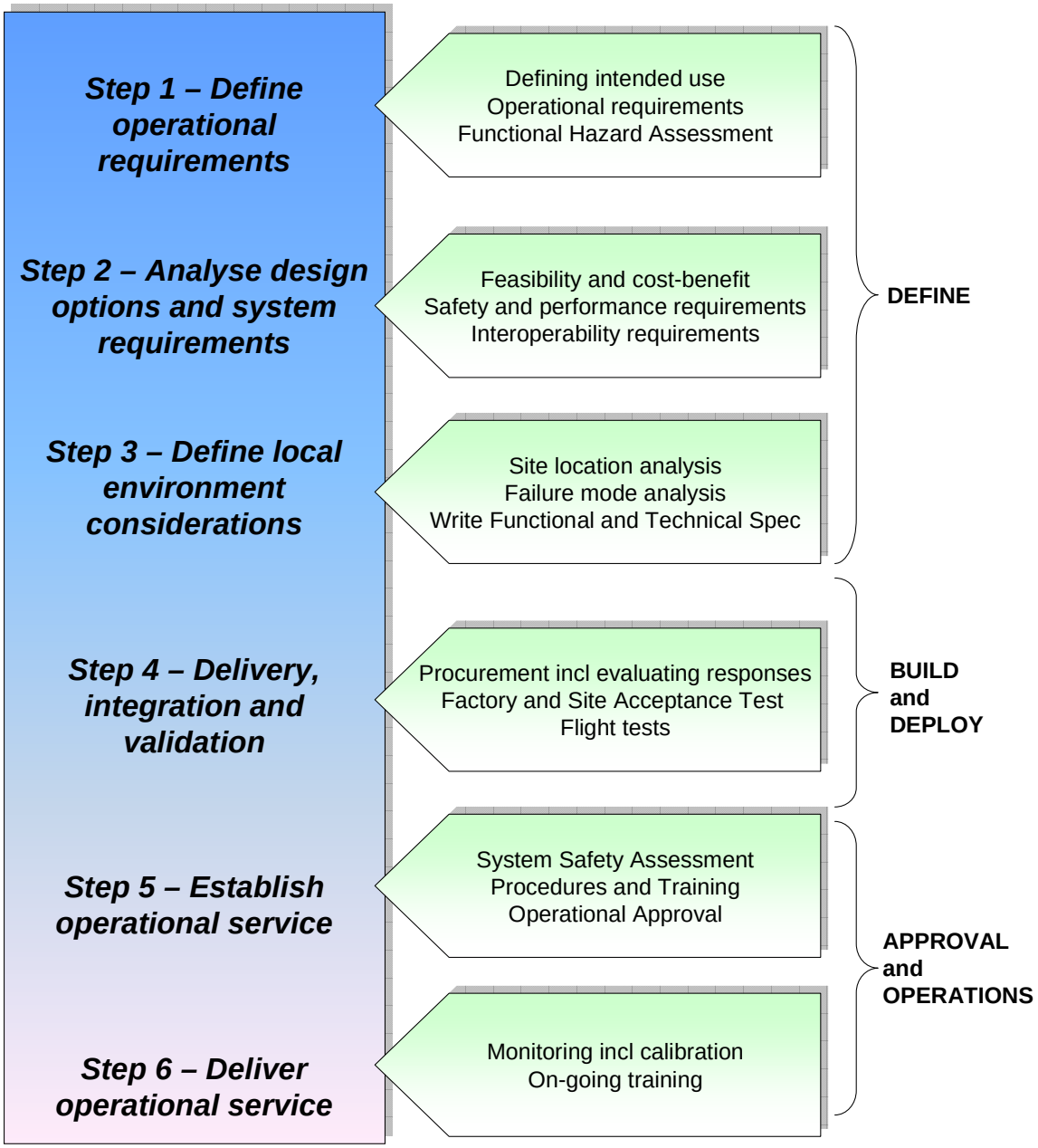


Figure 2: The Approvals Process

3.2 Process Steps

DEFINE

- **Step 1: Define operational requirements**: The process is begun by a clear business justification to update the surveillance system. The ANSP must establish the operational requirements for the system, to be subsequently mapped onto operational performance requirements. This will include the Air Traffic Services that the surveillance system is expected to support, and whether it will do so in isolation or in combination with existing surveillance infrastructure integration elements. The service volume is agreed at this stage, within which performance requirements are set. At this stage, it is advisable for the ANSP to conduct the Functional (or Operational) Hazard Analysis, independent of the technology used. At the end of this stage, the ANSP should have a clear understanding of 'what' the new surveillance is required to do.
- **Step 2: Analyse design options and system requirements**: At this stage the ANSP needs to select the best technological solution – considering WAM, ADS-B and Mode S - this step should include cost-benefit studies and feasibility analyses for the different options. Once a decision has been made (within this document, the assumption from this point on is that WAM is chosen), initial technical requirements will be captured. This may be aided by information from the manufacturer by instigating a Request For Information) For WAM, the information required is an initial estimate of the number and general location of ground stations and other constituents. The system performance requirements will also be defined (based on the operational performance requirements), along with interoperability requirements. A Preliminary System Safety Assessment is conducted to ensure that the application of the designed system is acceptably safe, and any driving safety requirements are identified. Early contact with the NSA including developing a joint understanding of the outline safety argument will help facilitate a successful approvals process.
- **Step 3: Define local environment considerations**: Specific local environment issues will be assessed in detail at this stage; detailed coverage planning (utilising EUROCONTROL or manufacturers' tools) will help set requirements and procurement requests. A clear Failure Mode analysis will be conducted, understanding the necessary mitigations (e.g. redundancy or procedural mitigations). The Transition Plan should also be outlined at this stage (mitigating risks during the transition). The outcome of this step is an Invitation to Tender for manufacturers (i.e. a Functional and Technical Specification). This will also include conditions on maintenance, spares, training etc as necessary. The preparation and release of the Invitation To Tender forms the final task in this step.

BUILD AND DEPLOY

- **Step 4: Delivery, integration and validation:** The evaluation of the received tenders forms the first part of this step. Following the awarding of the contract, different routes can be followed to gain the technical approval. The manufacturer may have already demonstrated compliance against a

recognised Standard (with technical approval from the National Supervisory Authority). Alternatively, there may be a need to conduct a conformity assessment through an EC Declaration of Conformity or Declaration of Suitability for Use; this will be done in coordination with a National Supervisory Authority, and will show conformance with the interoperability aspects of the appropriate Essential Requirements and the Surveillance Performance and Interoperability Implementing Rule (released 2009).

The Factory Acceptance Test shows the conformance against the stated requirements. ED-142 (WAM Technical Specifications), although currently in draft form, should give an Acceptable Means of Compliance against which manufacturers can conform, through referencing in a Community Specification.

As the system is installed on-site (deployed), Site Acceptance Tests are conducted. The WAM system is tuned, and validation takes place. Flight tests will be necessary to validate the system performance under nominal and failure mode conditions, to the satisfaction of the service provider and regulator.

Integration with the existing surveillance system is carried out and validated. Finally, a Declaration of Verification is applied for, showing that the WAM system is approved for use in the local environment.

APPROVAL AND OPERATIONS

- **Step 5: Establish operational service**: The operational approval is finalised, and the Safety Case updated taking account of the locally installed solution (i.e. System Safety Assessment is completed). Procedures and practices are defined.

  All evidence for operational approval is collated, including a formal Transition Plan describing procedures, maintenance and operational training. The evidence is presented to the NSA, and operational approval is gained (including the letter of conformity).

- **Step 6: Deliver operational service**: Once the system is in operational service, ongoing monitoring and calibration will be required to ensure the required performance continues to be met. Through-life support and decommissioning issues are also considered.

The initial steps (1-4) of the procurement process may be considered as an ‘evidence gathering’ period of the approvals process. In step 5, the approvals process requires the collation of this evidence into a coherent ‘approvals orientated’ structure. The Safety Case and Safety Argument are used to achieve this, organised around a logical flow of argument and supporting evidence.

A detailed description of each step is provided in the next section, including lower level actions and evidence required for the approval of operations using WAM.

3.3 WAM specific aspects

This section describes some of the specific aspects an ANSP may have to consider when looking to procure and gain approval for the use of WAM. It focuses on three areas:

- Procurement options
- Roles of the actors
- Contractual elements to be considered

3.3.1 Procurement options

When setting out to procure a WAM system, the ANSP has several valid options including:

- Sub-system procurement – procuring constituents of the WAM system from a manufacturer with the ANSP providing system integration in addition to day to day management. This may also be called component procurement.
- System infrastructure procurement – procuring a WAM system from a manufacturer as either a replacement or enhancement to the existing surveillance system. In this case the ANSP will be responsible for day to day operations including maintenance.
- Managed/outsourced service – ANSP procures a WAM surveillance capability from a third party service provider who provides surveillance data of an assured quality (level of which is to be agreed upon between the two parties) up to the agreed interface. This could be, for example, the tracker or the controller working position displays themselves. Essentially the responsibility in providing surveillance data rests with the third party (e.g. WAM manufacturer) up to the “WAM system interface” (ideally under the ASTERIX format – All purpose Structured EUROCONTROL surveillance Information eXchange). This option is used in other regions of the world, for example SITA provide surveillance services in collaboration with Airservices Australia; it is also consistent with the FAA procurement model for ADS-B.

Where an ANSP decides on sub-system / component procurement they take on additional responsibility for the design of the overall system such that the required surveillance performance is achieved (for example the number of stations, the level of redundancy and spare holding). When an ANSP decides on system infrastructure procurement, part of this responsibility is delegated to the manufacturer. The ANSP will still be responsible for presenting information to the NSA and will need to perform some delegated tasks at a high level to support the initial procurement decision which will need to define the level of freedom the tendering company has in determining elements such as site location.

This document uses system infrastructure procurement as the basic model and indicates key differences between system infrastructure procurement and sub-system procurement. **Managed/outsourced is not discussed further as a separate category – the processes defined here would need to be followed by the third party service provider.**

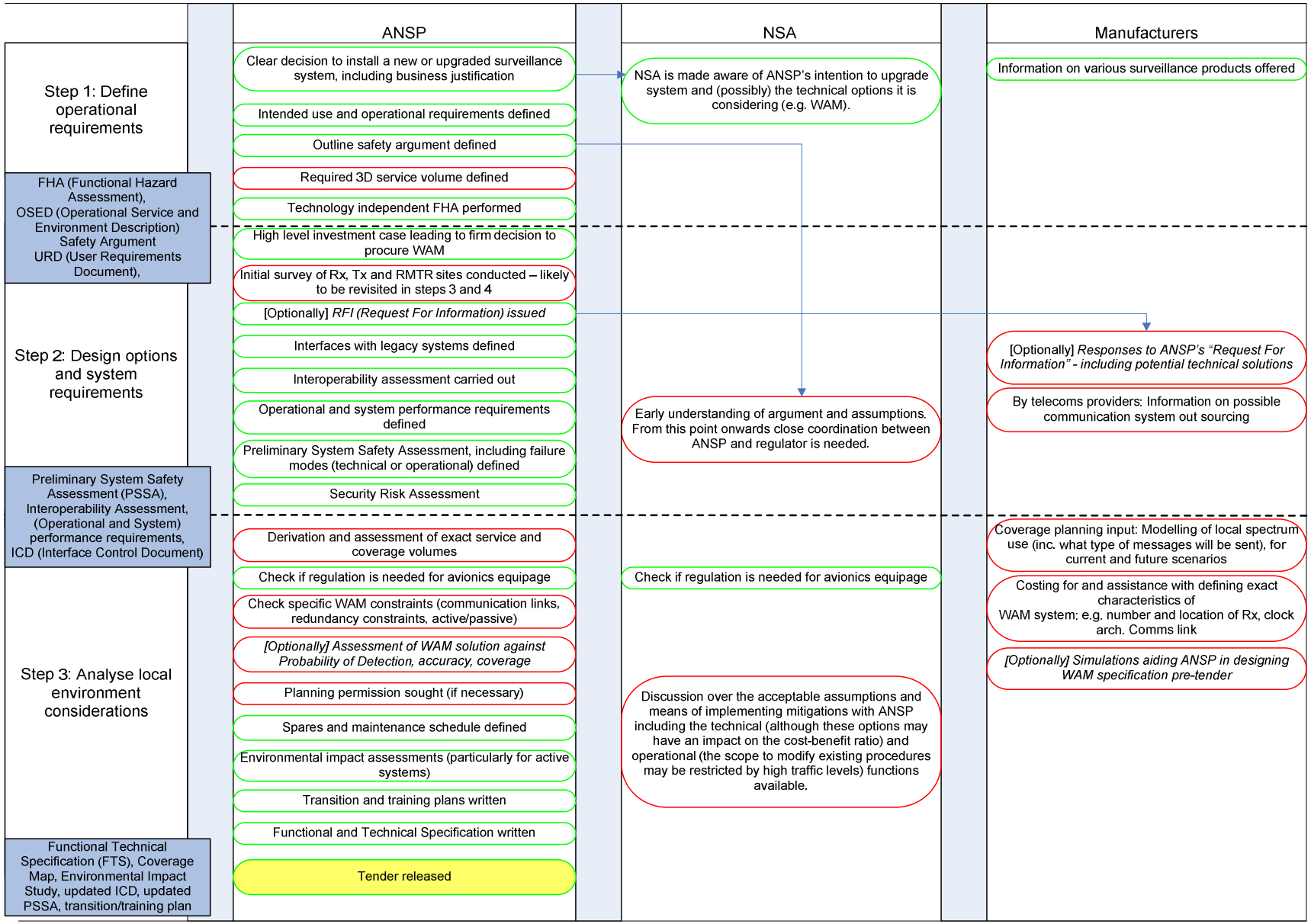
Guidance Note C discusses this in more detail.

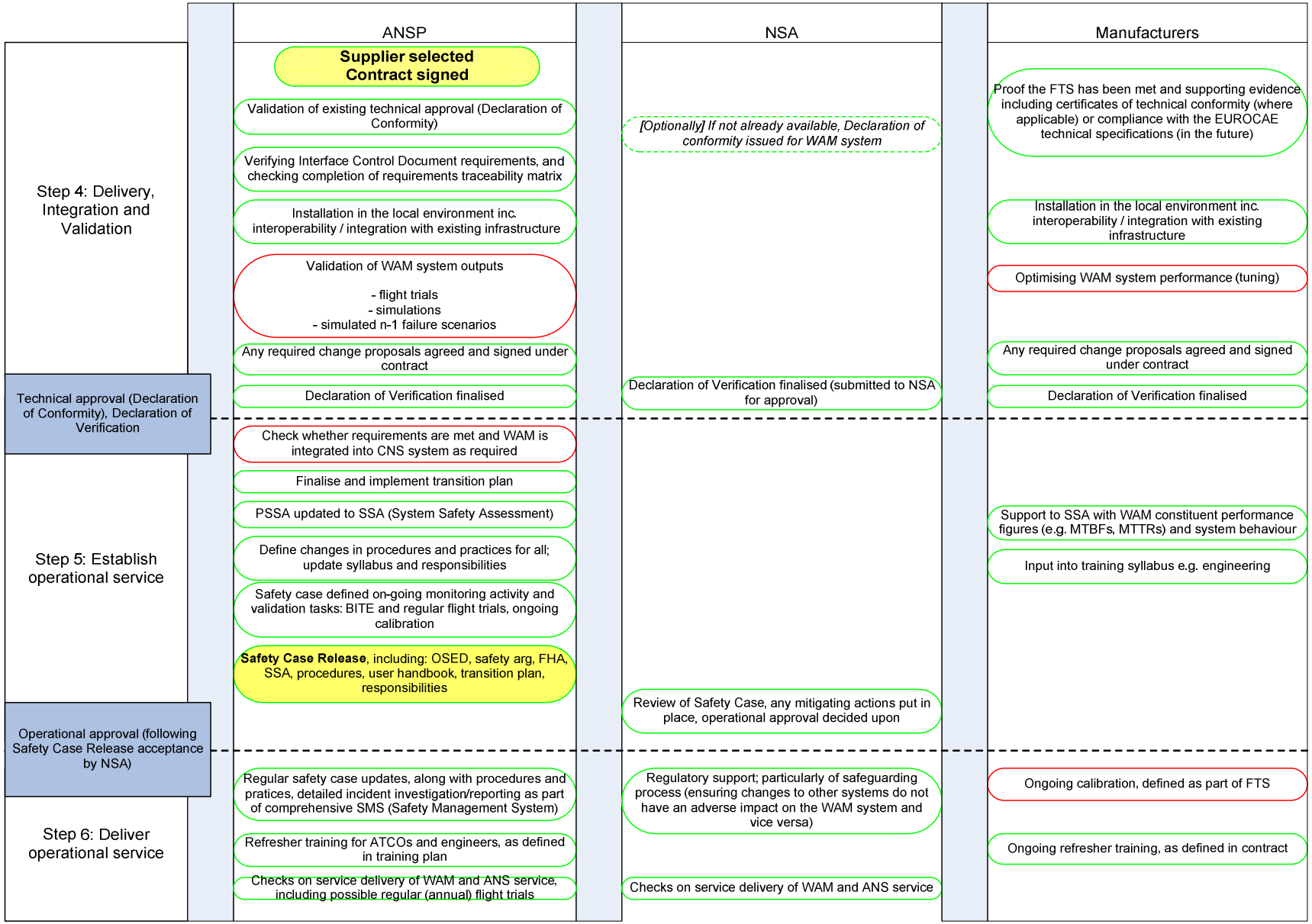
3.3.2 Roles of the actors

Each of the key actors in the process outlined above has tasks at each step. The ANSP, NSA and manufacturer must work together to ensure a successful and safe deployment of the WAM system.

The following diagrams give the main roles of each of the actors. The tasks correspond to those described in section 4 below, although slightly simplified to aid readability. Where a particular task may differ from legacy surveillance approvals (either as a new task, or as an existing task where WAM is significantly different to radar), the box is marked in red to highlight this to the reader.

Note that in some areas, tasks are duplicated across columns (actors) – for example, the installation of WAM in the local environment, and the subsequent preparation of the Declaration of Verification in step 4. This is to highlight the role that the manufacturers will take in ensuring the system is appropriately deployed, and the performance requirements met, leading to the preparation of the Declaration of Verification.


ANSP
NSA
Manufacturers
Step 1: Define operational requirements
Clear decision to install a new or upgraded surveillance system, including business justification
NSA is made aware of ANSP's intention to upgrade system and (possibly) the technical options it is considering (e.g. WAM).
Information on various surveillance products offered
Intended use and operational requirements defined
Outline safety argument defined
Required 3D service volume defined
Technology independent FHA performed
FHA (Functional Hazard Assessment), OSED (Operational Service and Environment Description) Safety Argument URD (User Requirements Document),
High level investment case leading to firm decision to procure WAM
Initial survey of Rx, Tx and RMTR sites conducted – likely to be revisited in steps 3 and 4
[Optionally] RFI (Request For Information) issued
Step 2: Design options and system requirements
Interfaces with legacy systems defined
Interoperability assessment carried out
Operational and system performance requirements defined
Early understanding of argument and assumptions. From this point onwards close coordination between ANSP and regulator is needed.
[Optionally] Responses to ANSP's "Request For Information" - including potential technical solutions
By telecoms providers: Information on possible communication system out sourcing
Preliminary System Safety Assessment, including failure modes (technical or operational) defined
Security Risk Assessment
Preliminary System Safety Assessment (PSSA), Interoperability Assessment, (Operational and System) performance requirements, ICD (Interface Control Document)
Derivation and assessment of exact service and coverage volumes
Coverage planning input: Modelling of local spectrum use (inc. what type of messages will be sent), for current and future scenarios
Check if regulation is needed for avionics equipage
Check if regulation is needed for avionics equipage
Check specific WAM constraints (communication links, redundancy constraints, active/passive)
Costing for and assistance with defining exact characteristics of WAM system: e.g. number and location of Rx, clock arch. Comms link
[Optionally] Assessment of WAM solution against Probability of Detection, accuracy, coverage
Step 3: Analyse local environment considerations
[Optionally] Simulations aiding ANSP in designing WAM specification pre-tender
Planning permission sought (if necessary)
Discussion over the acceptable assumptions and means of implementing mitigations with ANSP including the technical (although these options may have an impact on the cost-benefit ratio) and operational (the scope to modify existing procedures may be restricted by high traffic levels) functions available.
Spares and maintenance schedule defined
Environmental impact assessments (particularly for active systems)
Transition and training plans written
Functional and Technical Specification written
Functional Technical Specification (FTS), Coverage Map, Environmental Impact Study, updated ICD, updated PSSA, transition/training plan
Tender released


ANSP
NSA
Manufacturers
Supplier selected
Contract signed
Validation of existing technical approval (Declaration of Conformity)
[Optionally] If not already available, Declaration of conformity issued for WAM system
Proof the FTS has been met and supporting evidence including certificates of technical conformity (where applicable) or compliance with the EUROCAE technical specifications (in the future)
Verifying Interface Control Document requirements, and checking completion of requirements traceability matrix
Step 4: Delivery, Integration and Validation
Installation in the local environment inc. interoperability / integration with existing infrastructure
Installation in the local environment inc. interoperability / integration with existing infrastructure
Validation of WAM system outputs
- flight trials
- simulations
- simulated n-1 failure scenarios
Optimising WAM system performance (tuning)
Any required change proposals agreed and signed under contract
Any required change proposals agreed and signed under contract
Declaration of Verification finalised
Declaration of Verification finalised (submitted to NSA for approval)
Declaration of Verification finalised
Technical approval (Declaration of Conformity), Declaration of Verification
Check whether requirements are met and WAM is integrated into CNS system as required
Finalise and implement transition plan
PSSA updated to SSA (System Safety Assessment)
Support to SSA with WAM constituent performance figures (e.g. MTBFs, MTTRs) and system behaviour
Step 5: Establish operational service
Define changes in procedures and practices for all; update syllabus and responsibilities
Input into training syllabus e.g. engineering
Safety case defined on-going monitoring activity and validation tasks: BITE and regular flight trials, ongoing calibration
Safety Case Release, including: OSED, safety arg, FHA, SSA, procedures, user handbook, transition plan, responsibilities
Review of Safety Case, any mitigating actions put in place, operational approval decided upon
Operational approval (following Safety Case Release acceptance by NSA)
Regular safety case updates, along with procedures and pratices, detailed incident investigation/reporting as part of comprehensive SMS (Safety Management System)
Regulatory support; particularly of safeguarding process (ensuring changes to other systems do not have an adverse impact on the WAM system and vice versa)
Ongoing calibration, defined as part of FTS
Step 6: Deliver operational service
Refresher training for ATCOs and engineers, as defined in training plan
Ongoing refresher training, as defined in contract
Checks on service delivery of WAM and ANS service, including possible regular (annual) flight trials
Checks on service delivery of WAM and ANS service

3.3.3 Contractual elements to be considered

As an aid to ANSPs, the following is a collated list of contract elements mentioned in the course of the 6 step process and the guidance notes. They are listed here as guidance only; ANSPs have the option to include these elements in contracts with suppliers.

- Data to be provided by WAM system (both surveillance data and equipment data)
- WAM system performance elements (depending on the level of procurement, this may be measured at the output of the WAM central processor, or at individual component level in the case of availability requirements[2]) – these are derived from operational and technical performance and safety requirements. Typically, the manufacturer will be required to calibrate the system successfully to achieve the system performance requirements.
- WAM system interoperability requirements (including Interface Control Document)
- Declaration of Conformity (or Declaration of Verification)
- Statement of Work
- Required validation activities, including Factory Acceptance Test and flight trials as necessary. Note that clarification of contractual terms for the flight trials (including financial responsibilities) should be provided.
- Necessary support until approval (figures, paperwork etc)
- Individual constituents of WAM system (depending on the level of procurement, this could be defined by the ANSP or the supplier) and future options (see below)
- Provision for any changes in system design as a result of validation (the contract should be written in such a way as to make this possible)
- Remote monitoring and alarming requirements (including BITE), including control
- Spares and maintenance schedule (including spares availability, if applicable)
- Installation, integration and calibration support
- Warranty guarantees and post-warranty support (hardware and software, including optimisation and occurrence handling)
- Software upgrades
- Failure handling (including hidden problems)
- Tools, both administrative and corrective, including hardware and software testpoints
- Training, including handbooks and courses (describing level and completeness)
- Provision (and concept) for extension of WAM coverage volume (i.e. options) including ensuring that common components (e.g. central processor) can handle extension of data requirements.

Note that the communications link may be the product of a separate contractual agreement with a communications service provider (e.g. fixed line, VSAT etc). Certain communications links may be included in the contract with the WAM system supplier, in particular microwave links.

[2] For example, Mean Time Between Failure (MTBF)

4 Process Description

Each of the steps outlined in section 3 is described in more detail in this section. A standard format for each step is used, as follows:

- Title
- Overview (including why is WAM different)
- Step owner – the person/s who hold the responsibility for completing the step
- Scope
- Key inputs and outputs
- **Checklist and detail of each step**
- Contribution of step to approvals evidence
- Actors involved
- Background material available
- Frequently Asked Questions (FAQ)

The ANSP should read through the description of each step, understanding that information given is guidance and best practice rather than regulation or legislation (except where clearly stated).

Step 1: Define Operational Requirements

The starting point for any installation of a new surveillance system, and its approval for operational use, is the decision to upgrade the current surveillance system. This may be due to changing environmental conditions (e.g. traffic levels), perceived cost-benefit advantages or increased performance/data from newer technology. Whatever the reason, making a clear business justification for the decision is important.

Although most operational requirements can be kept technology-independent at this early stage, it is recognised that the safety argument, and specifics of the environment definition, are impacted by the choice of WAM. Therefore, although ideally the process should be completely top-down (i.e. based on operational demand, regardless of technology), there may be some pragmatism in an initial choice of technology at the very start of the process.

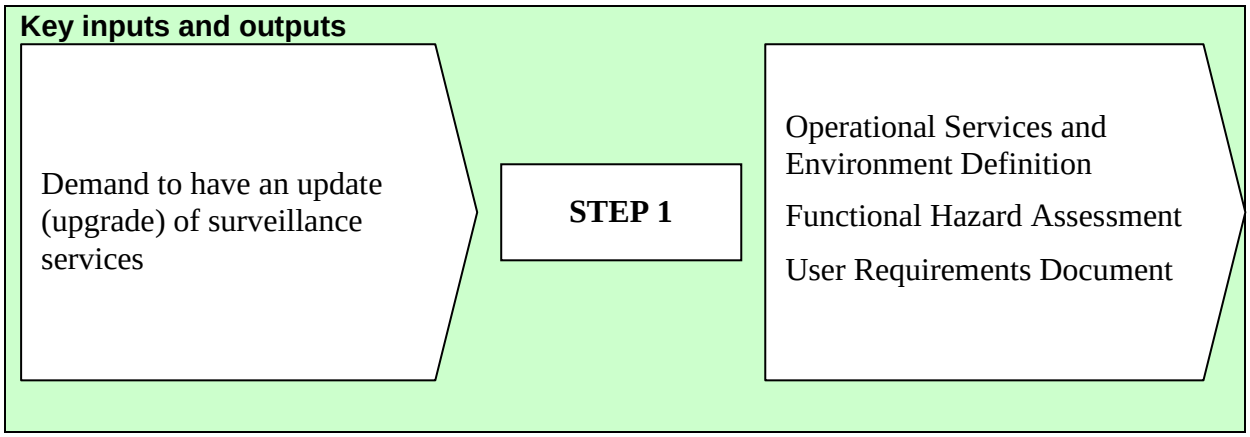
The definition of the operational services to be provided, and the types of information necessary at the start of the process, can be captured within an **Operational Services and Environment Definition (OSED)**. In developing the local OSED, an assessment of possible environmental issues shall be made. This is to include an overview of traffic patterns, routes, geography (siting issues e.g. terrain), service volume necessary etc. The service volume is critical in the WAM system definition – it must be defined in 3 dimensions, with close attention paid to low level coverage necessary. This will help inform the next step: design options.

Early engagement with the NSA is desirable to ensure a consistent and accepted argument for the safe deployment of the new system and applications. This can be achieved through the production of a **Safety Argument**, highlighting the key logical steps by which the ANSP will prove that the operation of the new system is acceptably safe. The Safety Argument also identifies the key evidence necessary to be collected at each stage of the approvals process. The **Functional Hazard Assessment (FHA)** should also be developed at this stage, as it informs which system may be appropriate for the local situation.

At the end of this step, a clear idea of the intended use, and requirements for use, of the new surveillance system should be formed.

Step owner:
[1] Surveillance Service manager or senior WAM requirements engineer **[ANSP]**
[2] Operations manager **[ANSP]**

Scope: This step should be carried out at an operational level; at this stage, the choice of new surveillance system has not been made, and therefore it is generic.



Checklist for Step 1: Define operational requirements

Step	Title	
1.1	Clear decision to install a new or upgraded surveillance system, including business justification	☐
1.2	Stakeholder expectations and desires identified	☐
1.3	Safety argument defined	☐
1.4	Operational services and environment description (i.e. intended use)	☐
1.5	Required service volume described (i.e. where should the services apply) – three dimensional assessment necessary	☐
1.6	Functional Hazard Assessment carried out	☐
1.7	Re-use of generic EUROCONTROL material validated (i.e. assumptions checked)	☐

Step 1.1 – Clear decision to install a new or upgraded surveillance system, including business justification

Much of the change in recent requirements development processes has had as an aim the introduction of clear top-down methodology. This process begins with a clear decision to procure and install a new (or upgraded) surveillance system for particular operational purposes. This may be due to changing environmental conditions (e.g. traffic levels), perceived cost-benefit advantages or increased performance/data from newer technology. The business justification for this installation of a new surveillance system must be clear at the start of the planning process.

It is recommended to keep the requirements at a “generic surveillance” level; there is no need to choose the required technology without first understanding the uses and cost-benefits. This is therefore an ANSP-centric step; clearly defining what Air Traffic Services need to be provided (and which controller tools supported), and within which context the new surveillance system will operate.

Step 1.2 – Stakeholder expectations and desires identified

In the light of the top-down methodology (e.g. ED-78A [ref 9]), stakeholder expectations and desires should also be identified. Typically, this may be an operational workshop, to understand what ATCOs need from the new system. It will be important to capture the operationally required coverage volume at this stage (see also step 1.4 below).

There will be a need to capture differences from the current surveillance and Air Traffic Services; for example, due to changes in airline routes, airports, military activity etc.

Step 1.3 – Safety Argument defined

Early engagement with the National Supervisory Authority is desirable to ensure a consistent and accepted argument for the safe deployment of the new WAM system and the associated applications. This can be achieved through the production of a **Safety Argument**, highlighting the key logical steps by which the ANSP will prove that the operation of the new WAM system is acceptably safe. The Safety Argument also identifies the key evidence necessary to be collected at each stage of the approvals process.

EUROCONTROL has developed sample safety arguments to act as a basis for the ANSP's own [refs 1, 2 and 3]. Explanation for the re-use of this example safety assessment is contained in Guidance Note I.

Step 1.4 – Operational services and environment description

Following the stakeholder expectations, a more formal write-up of the intended use of the new system should be carried out. The **Operational Services and Environment Description (OSED)** acts as a comprehensive check of the foreseen applications, likely changes to roles, procedures and actions, and local environment in which the applications will take place. It will highlight whether it is a complementary or replacement surveillance system. This document encompasses the **User Requirements Document**, which traditionally might be produced by the purchaser of a new system.

Again, EUROCONTROL has developed a sample generic OSED for use with surveillance services; this is available [ref 1] within the Generic WAM Safety Assessment. This generic OSED is based on an assumed environment and the provision of 3NM and 5NM separation services; any re-use of the material contained should be subject to thorough validation, to ensure its applicability in the local environment (see note 1.7). Guidance Note I contains further guidance on the re-use of the generic OSED and Safety Case, showing ANSPs what can be altered in the generic material to reflect the local environment. ICAO PANS documents should also be used as a source [refs 14 and 15].

In developing the local OSED, an assessment of possible environmental issues shall be made. This is to include an overview of any spectrum issues, siting issues (e.g. terrain), traffic density to be supported etc. It will also contain the coverage volume requirements, particularly specifying where different levels of service performance may be required in different volumes of airspace. This will help inform the next step: design options.

Ideally, the OSED should be iterated throughout the design lifecycle, acting as a central source of information for operational requirements and environment definitions.

Step 1.5 – Required service volume defined

As part of the OSED, a definition of the required service volume should be made. Importantly, this needs to be in three dimensions – it is not enough merely to have a plan view. For example, the ANSP may decide that coverage is only needed over 3000ft. This has an important impact on the choice of the surveillance system in step 2. This definition of service volume may be more detailed than ANSPs are used to with radar-based surveillance. In particular WAM gives you the ability to focus on the exact service volume requirements, for example minimum altitude of coverage. In comparison to a centralised radar installation, this may mean the controller will not have 360 degree coverage. Any additional coverage may impact the cost of the WAM system.

As it is a distributed coverage system, WAM gives greater flexibility, and therefore needs a more accurate required coverage volume to adequately define the procurement specifications.

Step 1.6 – Functional Hazard Assessment carried out

The **Functional Hazard Assessment (FHA)** describes how safe the system (or application) needs to be. It assesses the hazards associated with the provision of the specified operational services (in the OSED), allocating risk (severity and probability) to each. Safety objectives are set on the basis of meeting the overall Target Level of Safety, agreed with the National Supervisory Authority. These Safety Objectives are normally set per hazard (e.g. the probability of an undetected corruption of position information on the controller's display shall be less than 1E-07).

A generic FHA is available from EUROCONTROL [ref 2], with guidance (section 6 in the Generic Safety Assessment) on its re-use following validation of each assumption and input requirement.

Step 1.7 – Re-use of generic EUROCONTROL material validated

Any time the ANSP draws on material produced at a generic level (or as guidance material), it must be validated for re-use in the local environment. In practice, when re-using the EUROCONTROL Generic WAM Safety Assessment material [refs 1, 2 and 3], all assumptions must be checked, and any additional assumptions added to cover the local environment. For example, the generic material makes assumptions on traffic density which will certainly need to be adjusted to reflect the local environment. Note that when making these assumptions (as with every safety case), they must be future proof; i.e. traffic density should be forecast over the life of the new surveillance system, and the highest value used.

The operational, functional and safety assumptions and requirements resulting from the OSED and FHA shall begin to inform the decision regarding design options, which forms the scope of Step 2.

Contribution to approvals evidence:

Operational Services and Environment Definition (or User Requirements Document)
Functional Hazard Assessment (including Hazard ID results)

Actors involved
Manager responsible for:
[1] Surveillance Service [ANSP]
[2] Operations [ANSP]
[3] Safety [ANSP]
[4] Operational experts [ANSP]
and (optionally)
Approving regulator [NSA]

Background material available
[Ref 1] EUROCONTROL Generic OSED for provision of 3NM and 5NM separation services
[Ref 2] EUROCONTROL Surveillance Functional Hazard Analysis (for provision of 3NM and 5NM separation services)
[Ref 14] ICAO PANS-OPS Doc 8168
[Ref 15] ICAO PANS-ATM Doc 4444

Frequently Asked Questions

1. Can I take the EUROCONTROL Generic Functional Hazard Assessment, and re-use the results in my own scenario*?*

The EUROCONTROL work was conducted based on a generic European scenario, taking high-level traffic densities and complex routes to show that WAM is acceptably safe in most environments in Europe. The unique assumptions made within the EUROCONTROL work may differ for the ANSP's own local situation. As such, any results must be validated, with changes to the assumptions validated and the analysis re-done.

2. Why should I define the required operational services and hazard assessment at this early stage?

Two key reasons: i) a top-down definition helps to ensure that the eventually procured system is fit for purpose, in this case use by the operational ATCOs, and ii) both the operational service definition and the hazard assessment are key cost drivers for the procurement; ensuring rigorous analysis of these elements will help generate the most efficient balance between cost and performance/safety.

3. How might WAM help with changing safety requirements and processes?

As the safety processes mature, and various new methods of showing that a system is safe are developed, it will be important for an ANSP to show it is keeping track of the changing ways of looking at safety, and responding appropriately to them. WAM helps this, as it is both modular and upgradeable. Therefore, if additional requirements come to be placed on the system as the result of a new process, the flexibility of the WAM system in placing additional mitigations on the system will help the process (e.g. by adding a new receiver for redundancy).

Step 2: Analyse Design Options and System Requirements

For a co-operative surveillance system, there are three main choices available to an ANSP at present: SSR (including Mode S), ADS-B (Automatic Dependent Surveillance – Broadcast) or WAM (Wide Area Multilateration). Although this guidance document focuses on the latter, the decision to procure WAM should only be undertaken after an **investigation of all options**. Assuming the WAM system is decided upon, it should also be understood at this stage whether it be sole means surveillance or integrated with other sources (e.g. Mode S SSR).

WAM system design is expected to follow similar processes to other surveillance technology; i.e. a process based on ED-78A [ref 9]. Although following the same process, some of the details necessary for WAM are very different, for example potential failure modes, performance levels and interfaces. Obviously, the functional architecture of the WAM system is unique, including specific communications links between the sensors and the central processor.

The ANSP captures any requirements that are immediately driven by design selection, for example functional components and system specific safety, performance and interoperability requirements. The system performance should be based on the operational performance requirements, including defined service volume and data quality. A recommended method of **describing system performance requirements** is through comparison with existing performance (i.e. if controllers can use data at a given accuracy for 3/5NM separation services today, it should be suitable for WAM systems to provide the same).

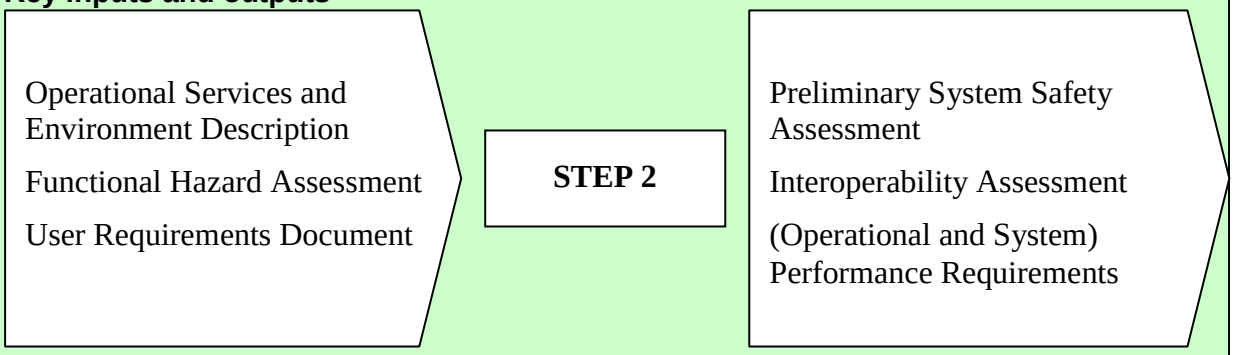
For the safety process, the **Preliminary System Safety Assessment (PSSA)** will consider whether the designed system is acceptably safe. The PSSA should also look at nominal failure modes, and determine what mitigations will be put in place. The ANSP has a broad choice between ensuring service provision by providing redundancy (i.e. technical mitigations), or accepting reduced performance on occasion (i.e. operational mitigations through new procedures may be applied). The output of the PSSA is a set of Safety Requirements to be proved by the ANSP and supplier. This forms part of the evidence provided in the Safety Case. The strategy for providing mitigations should be agreed with the regulator; understanding whether operational mitigations are at all feasible (for example, in a busy TMA) is a key question to be answered.

The **Interoperability Assessment** must consider the interface between the WAM system and existing ATC systems, for example through the use of ASTERIX categories. Data formats, communications formats and the affordability of any solution should be considered.

Step owner:
[1] Surveillance Service manager or senior WAM requirements engineer **[ANSP]**
[2] Operations manager **[ANSP]**

Scope: This step, having decided that a WAM system should be implemented, is now specific to the WAM technology.

Key inputs and outputs



Checklist for Step 2: Analyse design options and system requirements

Step	Title	
2.1	Investigate surveillance options through investment planning	☐
2.2	Determine procurement options and tendering process	☐
2.3	Determine high level functional architecture of WAM system	☐
2.4	Operational and system performance requirements defined	☐
2.5	Understand need for active or passive WAM system (i.e. R/F spectrum)	☐
2.6	Integration with other surveillance sources understood	☐
2.7	Interfaces with legacy systems defined (Interface Control Document)	☐
2.8	Interoperability assessment carried out	☐
2.9	Potential nominal and failure mode procedures design for local environment	☐
2.10	Preliminary System Safety Assessment	☐
2.11	Liaison with NSA to understand argument and assumptions	☐
2.12	Identification of BITE and RMTR requirements	☐
2.13	Security risk assessment	☐

Step 2.1 - Investigate surveillance options through investment planning

Having determined the operational requirements and objectives of the new surveillance system, the ANSP should now explore which surveillance system provides the best **high level cost benefit case**, to support the decision making for the rest of the process. A good starting point for such an exploration is a review of the Guidance Note C "Procurement options for ANSPs".

For a co-operative surveillance system, there are three main choices available to an ANSP at present: SSR (including Mode S), ADS-B (Automatic Dependent Surveillance – Broadcast) or WAM (Wide Area Multilateration). There are advantages and disadvantages to each solution (e.g. WAM may cost more in terms of communications links, ADS-B may impose more requirements on the airborne user, radar may cost more in terms of maintenance etc). This investment planning stage should assess the end-to-end lifecycle of the new system, including maintenance, spares and operational lifetime issues.

In order to generate a robust cost-benefit analysis, the ANSP may wish to get more information from the possible suppliers, and therefore may release a Request For Information (RFI) to help support any judgement made. **This may include a request for estimated system architecture and cost, given the required service coverage volume.**

It is assumed from this point on that WAM has been chosen as the new surveillance system. It should also be understood at this stage whether it is sole-means surveillance or integrated with other sources (e.g. Mode S SSR).

At this point, it is also best practice to carry out a risk analysis of the procurement, identifying the key risks and mitigations. For WAM-specific procurement, this should include the risks specific to WAM (such as delay due to performance modelling, siting of receivers, environmental impact studies, and operational impacts). The WAM report produced for EUROCONTROL contains more information on specific risks to WAM [ref 17].

Step 2.2 - Determine procurement options and tendering process

The possible procurement options are described in section 0. The ANSP may also decide to outsource the control of the communications between the receivers and the central processor, through the signing of a Service Level Agreement.

Guidance Note C gives more details on the options open to the ANSP. As an example, the purchaser may wish to define a Request For Information (RFI) at an early stage, to help define the procurement terms. As part of this, the purchaser may ask for initial quotes for the various procurement options (e.g. managed/outsourced versus WAM system infrastructure procurement), allowing them to understand which model may be best. Alternatively, the ANSP may ask for suppliers to tender options for each procurement model in the final tender, allowing a comparison to be made prior to contract signature.

The level of required fidelity in the procurement document will depend on the model used; i.e. the component level procurement would need much greater detail than if the WAM system was procured on a system wide level. It is recommended that this is decided upon early in the process, to ensure remaining requirements are defined to an appropriate level of detail.

Step 2.3 – Determine high level functional architecture of WAM system

To initialise the design process, a rough estimate of the likely WAM components should be made. This will include receivers, interrogators, central processor units, and communications. For the full list of WAM components, see the FAQ section at the end of Step 2. This design will then be iterated as detailed coverage planning, RF spectrum use, safety mitigations (redundancy, e.g. in receivers as a result of failure mode analysis – see step 2.9), built-in monitoring (see step 2.12) and performance requirements are developed.

The iterative dependency between performance coverage planning and receiver/transceiver site planning is particularly important to mature early on as this will be one of the most influential elements in dictating where the architecture of the WAM system will sit on the ground. This also has the potential to impact upon contractual liability for whether the required performance was achieved i.e. it is better to know that two more receivers and datalinks are needed prior to deployment, as opposed to post deployment (see also step 3.1).

In common with note 2.2 above, this estimate of the functional architecture may be achieved by asking the manufacturers to respond to an RFI.

Step 2.4 – Operational and system performance requirements defined

In line with ED-78A [ref 9], any performance requirements should flow top-down out of the user (or operational) requirements. The ANSP should use as a reference the WAM vs SSR comparison paper produced by the ICAO Separation and Airspace Safety Panel [ref 16]. Guidance Note E has been written outlining how to go about re-using the reference material. Elements that the ANSP should consider include the accuracies, the error budgets, and the tail errors. Note that this does not allow for possible improvements in performance necessary for new controller tools, something that should be assessed to ensure the WAM system is designed for the local environment (including the installed ATC system).

Within the performance requirements, the ANSP may also wish to consider the environmental, transport and power requirements (see the draft WAM technical specification: ED-142 [ref 13]). In addition, radio certification issues may also be defined, such as Low Voltage Directives, EMC and EMP (Electro-Magnetic Compatability and Pulse protection).

In time, a Community Specification may be available to reference against for performance requirements, helping to show that the Implementing Rule is met (i.e. the Surveillance Performance and Interoperability Implementing Rule – SPR-IR).

Note that because of the local environment impact on Wide Area Multilateration performance, the Community Specification cannot act as a direct means of compliance with the Implementing Rule. Therefore, in the case of WAM, the ANSP will always need to take into account local conditions to ensure compliance with the appropriate Implementing Rule.

Step 2.5 – Understand need for active or passive WAM system

The ANSP should determine whether dedicated interrogators are required as part of the WAM system. In practice, this depends on there being a sufficient level of 1090MHz returns in the service volume to enable the WAM system to meet the required performances. If the RF levels in the service volume appear to be too low (for example, only ACAS signals are being picked up as there are no Mode A/C/S radars in the vicinity), interrogator functionality will be required.

The safety case produced for the introduction of the new system will also inform the interrogator requirements – any redundancy necessary will be a result of mitigation means applied in the safety assessment. This is also true for reference transponder requirements in the coverage volume, as integrity monitoring.

The manufacturer may be well-placed to ascertain the requirement and siting of any interrogator functionality, and may specify this as part of their functional architecture.

If an active WAM system is required, the placement of the interrogator must be assessed (possibly using EUROCONTROL's CAPT2 tool), requirements on the interrogator settings must be placed (e.g. minimum pulse repetition frequency, and power to achieve requirements), safety criteria must be followed, and any transmission licence requirements must be met. In addition, the impact of the new interrogators on the ANSPs overall interrogation strategy must be understood, including the designation of appropriate II codes and according to the needs of the local environment (e.g. density of Mode S and Mode 3/A/C aircraft). In particular, II codes will need to be considered in an environment where:

- the surveillance system is required to monitor airspace in which aircraft are selectively down linking parameters to a specific interrogator (i.e. active Mode S enhanced surveillance) and;
- the data fusion process at the tracker does not compensate for the loss of target detection at one sensor (i.e. by replacing the lost data with that gleaned from anther interrogator).

Step 2.6 – Integration with other surveillance sources understood

The ANSP must understand what integration with other surveillance sources may take place. Equally, there may be an evolution of the coverage volume (as confidence with the new system grows), or integration with existing multilateration systems at airports to give a fused picture of surface and terminal operations.

Different sources of surveillance may have varying performances (even though the final operational requirement may be the same). Integration within the tracker (i.e. within the surveillance system) is therefore necessary, and the impact of this integration should be considered at this stage.

ASTERIX Cat019 [ref 10] and Cat020 [ref 12] are recommended to ensure interoperability for the multilateration data set.

There may be different operational procedures when using WAM than when using other surveillance sources within the service volume. For example, does the controllers' display need to be different, in terms of symbology, dependent on functional requirements or the performance of the solution? Also, do controller tools need to accept new inputs from the WAM data (for example, at a greater update rate), and if so, what is the likely impact in terms of software re-design and implementation?

Step 2.7 – Interfaces with legacy systems defined

The interfaces with the legacy system must also be defined. Clear indication of where the interfaces exist, and how they will be provided, should be collated. Typically, an **Interface Control Document (ICD)** will be used as part of the tender, giving the location, number of outputs and the data and communications formats where appropriate (e.g. ASTERIX

categories such as Cat020 for target data reports [ref 12] and Cat019 for service messages [ref 10] and an interface to a centralised remote control and monitoring system if necessary). The ANSP may need to consider the interfaces for the communications between receivers and central processor, including the certification for use (if a public communications network is used). Affordability and reliability of the interface will also be factors in the decisions taken (this may be iterated with the PSSA below).

Having the Interface Control Document defined at this early stage, and including it in the procurement specification, should avoid a “requirements creep” later on in the process.

Step 2.8 – Interoperability assessment

The Interoperability Assessment builds on the ICD, and looks at air-ground interoperability as well as ground-ground. It is intended to specify the requirements for the overall CNS/ATM system to work together correctly in order to provide the service necessary (i.e. the surveillance service, or at a wider level, the Air Traffic Service). Interoperability requirements may also be specified in order to design systems robustly for future growth (for example, for additional WAM coverage areas, or for increased traffic).

In particular, the Interoperability Assessment ensures that the airborne equipage and performance is suitable for the WAM application. This may be straightforward for the ANSP if a transponder carriage mandate already exists in the airspace, although checks and monitoring may still need to be specified.

ICAO Annex 10 [ref 4] contains many of the requirements for interoperability. ED-126 [ref 11], the ADS-B requirements document, also contains a useful example of a set of Interoperability Requirements.

Step 2.9 – Potential nominal and failure mode procedures design

When the ANSP is developing the failure modes and mitigations for the new WAM system, it is helpful to consider the operational and technical impacts. In particular, the ANSP must understand how the system degrades when a component fails (for example, a receiver or an interrogator).

This step develops a general approach to the mitigations; for example, the ANSP may wish to provide a highly available service in the airspace, leading to the need for redundancy in the design. Other approaches to mitigations may be noted at this point (e.g. a procedural solution to failure of a receiver may be developed, such as higher separation minima being applied, or sectorisation of the service area dependent on which receiver has failed). There will evidently be a difference in approach if the WAM system is intended to be used as a sole means of data for the surveillance service, or if other sources are deployed, such as SSR or ADS-B (note though that ADS-B and WAM, if sourced from a common sensor, have many common failure modes).

Note that WAM is different from radar in the respect that the failure of each receiver has a unique effect on the performance of the overall service. Thus, the failure mode and effects analysis may be a larger piece of work than for radar design and installation.

A Guidance Note J on defining failure modes and mitigations has been written.

Step 2.10 – Preliminary System Safety Assessment

Having understood the possible failure modes, an initial **Preliminary System Safety Assessment** may be drawn up. This assessment asks how safe the designed system is, for the applications in question (i.e. the defined operational service). The assumptions on the failure modes (and possible mitigations) should be written up in fault trees. The failure mode analysis was done before this step as many of the mitigations may be due to performance issues, rather than safety objectives not being met. If the mitigations are added at this stage, it may prevent the ANSP over-allocating requirements to other elements of the WAM system, other surveillance sources, or operational procedures.

The ANSP may choose to specify the "system" under assessment as the WAM system itself. Probably more usefully, the overall surveillance system should be assessed, allowing the ANSP to look at the availabilities of all components contributing to the surveillance service, and balancing the requirements appropriately.

EUROCONTROL has produced an example PSSA [ref 3] as part of the Generic Safety Assessment. This contains reminders of the many elements that need to be considered within the PSSA, and shows how fault trees may be built for the WAM system.

The PSSA will be iterated as the defined architecture becomes clearer; in practice, this may be done as part of the System Safety Assessment in Step 5.
The output of the PSSA is a set of Safety Requirements to be proved by the ANSP and supplier. This forms part of the evidence provided in the Safety Case.

Step 2.11 – Liaison with NSA to understand argument and assumptions

At this stage in the preparation for tender, it is recommended that the NSA is involved. The ANSP will now be able to show the key assumptions used, the safety argument, and the Preliminary System Safety Assessment including failure modes and proposed mitigations. Any changes in the approach or argument needed can be identified at this early stage, ensuring that the eventual tender specification meets the needs of the ANSP and regulator.

From this point on, it is recommended that regular contact with the NSA is kept, to ensure the deployed solution meets their requirements and concerns.

Step 2.12 – Identification of BITE and RMTR requirements

The ANSP must be able to define the test and monitoring requirements for the WAM system. Many of these will be highlighted in the PSSA; therefore, it is recommended that this step is undertaken immediately after that analysis.

There are many possibilities for monitoring requirements, both real-time and on regular updates. Built In Test Equipment (BITE) should be defined in the procurement specification to provide status updates to the WAM engineers of system performance and usability. Note that the BITE requirements must be consistent with the nature of the spares and maintenance schedule (e.g. if the BITE shows that a particular module is defective, the spares should be ordered on a module basis rather than a component basis). This helps define how detailed the BITE penetration should be.

A real-time integrity check can be provided via a test transponder (or more than one if the service volume is large) – this is sometimes referred to as the Reference and Monitoring Transponder (RMTR). The CPU may include an initial cross check of reports from receivers,

to determine if an obviously erroneous declaration is being received (this may be done before the tracker fuses and filters the data for display to the controller). The tracker itself may conduct a cross-correlation with other surveillance sources.

A central monitoring system may also be specified, depending on the ANSPs requirements and existing surveillance equipment.

Note that at this stage, depending on the operational impact, the ANSP may also define alarms to be given to operational or engineering personnel, based on the reports from the integrity checking equipment.

Step 2.13 – Security risk assessment

Security risk assessment is a new process in Europe; nevertheless, the ANSP may wish to consider a semi-formal analysis of the security risk for WAM receivers and interrogators. National regulations for securing critical infrastructure may also exist.
Although a distributed system allows flexibility in planning and coverage, it may lead to additional security concerns (as each ground station must be adequately secure).

Contribution to approvals evidence:

Preliminary System Safety Assessment
Interoperability Assessment
Operational Performance Requirements

Actors involved
Manager responsible for:
[1] Surveillance Service [ANSP] (or senior WAM requirements engineer)
[2] Operations [ANSP]
[3] Safety [ANSP]
[4] Investment [ANSP]
and (optionally)
Approving regulator [NSA]
WAM performance experts [suppliers]

Background material available
[Ref 1] EUROCONTROL Generic OSED for provision of 3NM and 5NM separation services
[Ref 2] EUROCONTROL Surveillance Functional Hazard Analysis (for provision of 3NM and 5NM separation services)
[Ref 3] EUROCONTROL Example Preliminary System Safety Assessment for WAM supporting 3NM and 5NM separation services
[Ref 10] EUROCONTROL Surveillance Standard ASTERIX Cat 019
[Ref 11] EUROCAE ED-126 (ADS-B in Non-Radar Airspace)
[Ref 12] EUROCONTROL Surveillance Standard ASTERIX Cat 020
[Ref 17] EUROCONTROL WAM report

Frequently Asked Questions

How can I re-use the comparative performance analysis?

See Guidance Note E on performance and interoperability requirements.

If I decide to use it, what should the initial Request For Information include?

The initial RFI is intended to be used as a feasibility study, with basic information given to the manufacturers. Information might include: required service volumes, possible land-sites to be used for receivers, interrogators and/or reference transponders, other surveillance infrastructure, and operational intended use. From this, the manufacturer would be expected to suggest a functional architecture and possibly outline costing, along with anything else needed by the purchaser to write a useful tender (for example, potential spares and maintenance arrangements).

What should be considered when planning the location and number of system components?

The ANSP should be aware that determining the number and location of components is likely to be an iterative process, particularly whilst requirements for coverage performance continue to evolve with the implementation of the system. The ANSP should be aware of the possibility of 'scope creep' and put in place mitigations (both pre and post contract) to manage this issue.

What constituents make up a core WAM infrastructure?

System constituents include:

- Interrogators (also called active transmitters (Tx))
- Receiving stations (or receivers) (Rx)
- RMTR (Reference and Monitoring Transponder)
- RCMS terminals (Remote Control and Monitoring Station)
  - Including BITE (Built-In Test Equipment) display
- UPS (Uninterruptable Power Supply)
- CPS (Central Processing System)

Apart from these, non-core aspects include the communications infrastructure (e.g. microwave link, fibre optics, VSAT link) and the internal ATM system interfaces, such as the data line from the CPS to the tracker.

Step 3: Define Local Environment Considerations

The purpose of this step is to establish the local environment for the proposed WAM system. Completion of this step includes production of the Functional and Technical Specification (FTS) and Invitation To Tender (ITT) documentation.

Critically at this stage, a significant amount of time and resources should be committed to considering the **required 3D coverage** in a given volume of airspace. This will include consideration of placement of interrogators and receivers (any site chosen must have planning permission secured by the ANSP, preferably before going to tender). The EUROCONTROL tool CAPT2 may help identify a catalogue of potential locations. The coverage volume must be able to match the identified service volume, at all altitude levels. Manufacturers may need to be consulted at this stage to understand how the individual WAM systems could be configured to meet the service volume requirements.

In order to meet the operational, safety and performance requirements, mitigations for failure modes will need be developed. The coverage planning must take these failure modes into account where technical mitigations are identified (for example, redundancy in receiver sensors).

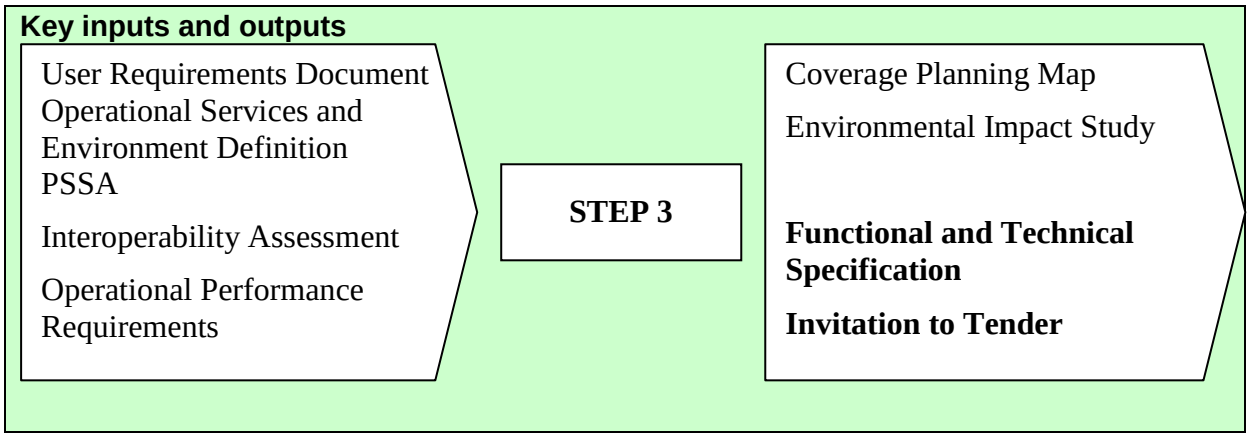
Should the ANSP determine that an active WAM system (i.e. including an interrogator capability) is necessary, consideration of the **effects on the R/F spectrum** should be made (as is done currently for radar). It is noted that any siting of new interrogators or receivers may also require an **environmental impact study**. Local regulations (specific to the State) will determine the extent of this task.

In preparation for going to tender, other elements impacting the contract should be investigated, including the spares and maintenance schedule, transition plan and training plan.

Having assessed the effects of the local environment, the ANSP should now have a complete set of requirements as part of the **Functional and Technical Specification** and can take this to tender by completing the contractual requirements.

Step owner:
[1] Surveillance Service manager or senior WAM requirements engineer **[ANSP]**
[2] Operations manager **[ANSP]**
[3] Local environment specialist (controller and/or technician) **[ANSP]**

Scope: This step focuses on the local environment analyses. It builds on the work done in step 2 in determining operational and system requirements.



Checklist for Step 3: Define local environment considerations

Step	Title	
3.1	Derivation and assessment of service and coverage volume	☐
3.2	Local mitigations for failure modes defined (based on placement of Rx and Tx)	☐
3.3	Check if regulation is needed for transponder equipage	☐
3.4	Check specific WAM solution for local environment (e.g. type of communication, amount of redundancy, active vs passive)	☐
3.5	Effects on R/F spectrum of active WAM system (incl transponder availability and ACAS)	☐
3.6	Environmental impact studies	☐
3.7	Spares and maintenance schedule defined	☐
3.8	Requirements on validation and ongoing calibration	☐
3.9	Update Preliminary System Safety Assessment with exact local design	☐
3.10	Functional and Technical Specification written	☐
3.11	Transition and training plans written	☐
3.12	Invitation To Tender released	☐

Step 3.1 – Derivation and assessment of service and coverage volume

The extent of the service volume (in three dimensions) should have been described in steps 1 and 2 as part of the operational performance requirements. If the ANSP has not asked the manufacturers to provide the coverage volume information, at this point the exact characteristics of the WAM solution should be assessed. The accuracy properties of the WAM system are determined by the geometrical deployment of the ground stations. Geometric Dilution of Precision (DOP) must be calculated. Note that the geometric height may be used for system integrity checking, but likely will not be used operationally (as long as Mode C barometric altitude is available from the aircraft).

The ANSP may decide to combine this DOP calculation with an assessment of the R/F spectrum (false replies and multipath being potential issues). It is considered in step 3.6 below.

Planning permission may need to be secured for sites at this stage.

Several tools are available to calculate the geometric DOP. Note that to be of the required integrity, the tools should include some element of terrain mapping (as each receiver is line of sight based). The EUROCONTROL CAPT2[3] tool should be suitable for this purpose. Alternatively, the ANSP may wish to involve suppliers, asking them to provide coverage and performance maps on the basis of the ANSPs supplying terrain mapping and receiver locations (see step 2). This may include pre-tender site surveys from suppliers who wish to quote. The solutions from the various suppliers could then be compared, including any performance modulation issues, and any assumptions used for the predictions.

As mentioned in step 1, it is recommended that ANSPs take care when defining the service volume within which performance must be maintained. Unlike SSR, coverage over 360 degrees is not a default of the WAM solution; service volume requirements should therefore only be defined in volumes where it is cost-beneficial. For example, low level coverage may not be needed. Conversely, if the ANSP requires integration with airport MLAT, there may need to be high performance in the TMA at low level, which may be one of the key drivers of cost (with additional ground receivers needed). For Innsbruck, additional performance from the WAM system is needed for the missed approach procedural area.

Equally, the coverage volume analysis must also consider failure modes (i.e. degradation in performance due to one or more ground stations becoming unusable). The effects on the system performance due to the failure of one or more components shall be documented (see Guidance Note J).

The ANSP may also wish to consider any cross border issues at this point. WAM sites may only be able to be installed within the national boundaries (ideally not the case). Sharing data with different sensors (cross-border) may lead to greater efficiencies, and should be investigated. If not sharing data, although WAM does give a certain level of performance on the boundary of the network, care should be taken that this still meets operational requirements.

In addition to the receiver site planning, the location of transmitters (interrogators) and reference transponders should also be planned.

More detailed consideration of coverage volume and receiver site planning is given in Guidance Note F. Guidance Note K also talks about the validation of the coverage volume and service volume.

Step 3.2 – Local mitigations for failure modes defined

Building on the work done for the PSSA in step 2, this action seeks to iterate the failure modes based on the likely final location of the WAM receivers and interrogators (see note 3.1). A better understanding of the degradation in performance due to failure of individual

[3] Coverage Analysis and Planning Tool; originally released to cover SSR and ADS-B, an update is currently being produced which will support WAM deployment.

components should lead to precise failure mode conditions and mitigations. For certain receivers, it may be possible to state that nearby units act as redundant means in case of failure, and full operational service can be maintained. For others, this will not be the case.

Step 3.3 – Check if regulation is needed for transponder equipage

The ANSP will have a good understanding of the avionics equipment being carried by the aircraft passing through their airspace, through operational experience. In particular, this will include the transponder carriage, percentage of aircraft with and without transponder carriage the carriage of Mode A/C / Mode S / Extended Squitter transponders, IFR/VFR operations and the locations in which they are conducted. Based on the operational requirements (for example, some ANSPs may wish to have Downlinked Aircraft Parameters included in the WAM reports), some carriage requirements for aircraft may need to be defined. This may depend on whether mandates for transponder carriage already exist.

Step 3.4 – Check WAM solution for local environment

A further check of the assumptions made on the functional architecture should be carried out. This will include any assumptions on the communications links between receivers and central processors, now dependent on the exact location of the receivers (for example, some sites may be hard to access with communications lines), and any assumptions on the level of redundancy of the WAM system.

The costs associated with establishing power supplies and data links to each receiver station should also be considered. The communications may already exist, they may need to be procured, or they may need to be hired. The latter solution may be a different procurement model from the wider WAM system; a Service Level Agreement may be signed with a third party supplier to guarantee a level of communications performance (availability, reliability etc). In any solution, the through-life cost should be considered. Additionally, any licences required must be applied for.

Any additional interfaces identified here should be precisely defined and added to the Interface Control Document.

Step 3.5 – Effects on R/F spectrum of active WAM system

Active WAM systems include additional interrogation of the R/F environment. A model of the R/F environment within which WAM will operate should be developed, looking in particular at the effect on transponder occupancy levels and ACAS operation, since the additional interrogation may alter existing probabilities of detection (e.g. from SSRs).

This may form part of the Environment Impact Study. ICAO Annex 10 [ref 4] should be referenced for communications and spectrum requirements.

Step 3.6 – Environmental impact studies

Any siting of new interrogators and receivers may be subject to an Environmental Impact Study, with exact terms dependent on the local regulations and laws. This will also apply to the communications links used (for example, microwave links). ICAO Annex 10 [ref 4] should be referenced.

Step 3.7 – Spares and maintenance schedule defined

As part of the procurement specification, the spares and maintenance schedule should be defined. This will depend on the required reliability of the system and the cost-benefit issues. It could be documented in an Installation and Logistics Support (ILS) document.

The ANSP should look to define the method of maintaining the WAM system, including any down-time requirements (and its effect on the availability of the operational service). The lifecycle of components (or the overall system) should also be defined, dependent on the procurement model being used. This will lead to the spares quantity being set down. Configuration control requirements for the delivered product will also be outlined. Hardware repairs should be covered. The best method of updating receivers (i.e. when and how they should be taken offline) will also be defined.

The service levels requirements with the supplier should also be defined; warranties (in terms of extent and duration), SLAs for during and after warranty (including cost), and cost of change proposals must all form part of the procurement specification. The SLA should include user manuals (CD-ROM and paper based), turn-around times, help desk provision, and regression testing (to ensure no unforeseen issues occur when solving other technical bugs).

Each option is likely to have a different MTTR (Mean Time To Repair). The option selected must meet the MTTR required to provide the safety and availability requirements established earlier in the process – for example in the SPR/INTEROP requirements.

Step 3.8 – Requirements on validation and ongoing calibration

The requirements for validation during transition should be specified, including whether the particular ANSP or NSA requires flight trials to be conducted as part of the performance validation. If the ANSP wishes the manufacturer to manage and run the validation programme, this will need to be specified in the Functional and Technical Specification (FTS). Step 4.6 (and Guidance Note K) talks about this in more detail.

The requirements for calibration need to be defined as part of the Functional and Technical Specification. The ANSP may require some means of assessing drift from the calibrated state, for example by defining a specific BITE status report and alarm. The supplier should be required to calibrate the system on a regular basis, with the frequency, test equipment and independence of the testing all defined in the FTS, and costs received as part of the procurement response.

Step 3.9 – Update PSSA with exact local design

Having defined the exact system redundancy and architecture (along with operational effects of failures), the PSSA must now be updated to reflect the situation. This may mean altering availabilities or adding components to the fault trees.

Step 3.10 – Functional and Technical Specification

The final step in preparing for procurement is to collate all requirements and guidance to suppliers in the **Functional and Technical Specification** document, ready for release to

tender. Note that this may be the same as a User Requirements Document and System Requirements Document (as defined by certain ANSPs).

Step 3.11 – Transition and training plans written

It is recommended that the ANSP begin writing the Transition Plan and Training Plan for the new system and operational procedures applied using the surveillance information derived from the data provided by the new WAM system. Note that if the surveillance information to the controller is unchanged following the implementation of the WAM system, this training may not be needed. This should occur prior to the tender process, as they may wish to apply requirements on the manufacturer (e.g. the manufacturer may be required to provide training to the ANSP technicians). See also step 5.3, as the training plan is updated in preparation for operational approvals.

Step 3.12 – Invitation To Tender released

The final sub-step is to write and release the invitation to tender. Potential contract elements to be referenced in the ITT are outlined in section 3.3.3. This will include making clear the roles and responsibilities expected of the supplier, for example in achieving system performance. It also includes the commercial aspects of the procurement.

Contribution to approvals evidence:

Coverage planning map (including failure modes)
Environmental impact statement
R/T spectrum study
Spares and maintenance schedule
Functional and Technical Specification
Training Plan (draft)
Transition Plan (draft)

Actors involved
Manager responsible for:
[1] Surveillance Service [ANSP] (or senior WAM requirements engineer)
[2] Operations [ANSP]
[3] Safety [ANSP]
[4] Local environment specialist (controller and/or technician) [ANSP]
and (optionally)
Approving regulator [NSA]
WAM performance experts [suppliers]

Background material available
[Ref 4] ICAO Annex 10

Frequently Asked Questions

Why is the coverage volume different to the service volume?

The coverage volume is the manufacturer's estimate (and hopefully subsequent operational reality) of how they will meet the required operational performances within the defined service volume. It represents the actual coverage of the WAM system (to required performances), rather than the volume within which the Air Navigation Service will be carried out.

When the coverage volume is greater than the service volume, this distinction should not affect the ANSP's operations. However, if during flight trials, the coverage volume is found to not be equal to the service volume (for example, through slightly reduced performance in one area of low level coverage), the difference is critical to understand what steps need to be taken (e.g. extra receivers, or a smaller service volume defined).

What elements should be written into the contract?

This question is dealt with in section 3.3.3.

Why does so much need to be done prior to procuring the system? Is it not possible to wait until after procurement to carry out much of the evidence gathering?

The reason for much of the work prior to going to tender is to accurately define what is needed by the ANSP. WAM is a flexible technology, and an inherent risk of over or under specifying the requirements exists. The work in understanding exactly what is required by the new system seeks to mitigate this issue.

Several ANSPs have found that they needed to subsequently modify the purchased system (for several different reasons) post-deployment. This possibility should be considered in any contractual arrangement, and provisions made.

Step 4: Delivery, Integration and Validation

Having tendered for the procurement of the WAM system, evaluated the responses and awarded a contract, the next task for the ANSP is the technical implementation of the WAM system. This step begins with the delivery from the selected manufacturer.

Within Europe, the Single European Sky Legislation requires that the manufacturer provides a Declaration of Conformity or a Declaration of Suitability for Use which demonstrates that the constituents are consistent with the regulatory requirements (See Guidance Note A).

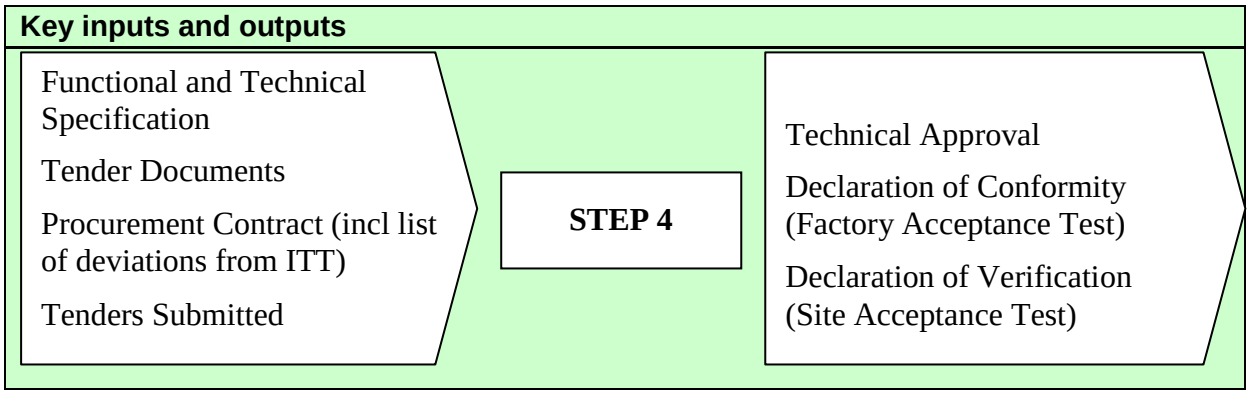
The ANSP needs to determine if the EC Declaration is sufficient, or if further evidence is required from the manufacturer to demonstrate compliance with the technical (interoperability) elements of the contractual requirements set out in the ITT and FTS. This would normally be achieved through a Factory Acceptance Test (FAT) against contractual requirements. Note that the EC Declaration will show that the technical constituents are fit for purpose prior to installation. Full conformity with regulatory requirements will only be shown in-situ following installation and validation of the WAM system.

The procured system may then be installed on-site. As the WAM system is brought into the local environment, the ANSP can validate it is acceptably safe in that context. The **Site Acceptance Test** ensures the performance of the WAM system in situ meets the requirements. This will involve interface control testing, and flight testing to validate system performance and verify performance simulations, including gaining an understanding of spectrum affects (see Guidance Note K for more).

Under the SES, the ANSP in also required to complete an EC Declaration of the Verification for the operational system (see guidance Note A).

Step owner:
[1] Surveillance Service manager or senior WAM requirements engineer **[ANSP]**
[2] Procurement manager **[ANSP]**

Scope: Following release for tender, evaluation of proposals, and award of a contract, this step is intended to capture the delivery and validation of the appropriate system, and assessment of technical conformity with respect to the local environment.



Checklist for Step 4: Delivery, Integration and Validation

Step	Title	
4.1	Validation of existing technical approval	☐
4.2	Verification of Interface Control Document	☐
4.3	WAM system is installed in the local environment	☐
4.4	Site Acceptance Test defined, run and passed	☐
4.5	WAM system integration	☐
4.6	Optimising WAM system performance (tuning)	☐
4.7	Flight testing to validate system performance and coverage (incl simulation verification)	☐
4.8	WAM within CNS/ATM system validation	☐
4.9	Declaration of Verification	☐

Step 4.1 – Validation of existing technical approval

Following the release of the ITT, evaluation of responses from manufacturers, and award of the contract to a successful manufacturer, the ANSP should ensure that the system is technically fit for purpose, prior to taking delivery and installing.

In practice, within Europe, the Single European Sky Legislation requires that the manufacturer provides a Declaration of Conformity or a Declaration of Suitability for Use which demonstrates that the constituents are consistent with the regulatory requirements (see Guidance Note A).

The ANSP needs to determine if the EC Declaration is sufficient, or if further evidence is required from the manufacturer to demonstrate compliance with the contractual requirements set out in the ITT and FTS. This would normally be achieved through a Factory Acceptance Test (FAT) against contractual requirements.

Note that particular attention should be paid where the contracted specification differs from the original design specification with those responsible for accepting the system aware of those differences.

A test demonstration may still be required, including calibration using test targets and signal generators. Simulation of faults may be provided to assess the BITE.

Step 4.2 – Verification of Interface Control Document

An important step in acceptance is verifying the Interface Control Document requirements have been implemented. Recording should be taken to ensure full integration with the legacy system, and then played back into the ANSP's technical monitoring station.

This may be particularly important where the ANSP has decided to use Cat 048 to transmit its WAM data (i.e. treating it as "pseudo-radar" data). Care should be taken that integrity of the surveillance data is not lost during the conversion from Cat 019 to Cat 048, in particular through the treatment of likely error distributions (e.g. radar data may be filtered differently to WAM data).

Step 4.3 – WAM system installed in local environment

The installation in the local environment should be the responsibility of the supplier, with support and validation by the ANSP as necessary. Any integration with legacy systems will be subject to the contractual conditions (described in the tender, and with reference to the Interface Control Document).

Step 4.4 – Site Acceptance Test defined, run and passed

The Site Acceptance Test forms part of the evidence that the installed WAM system and its associated application are safe in the local environment. A Test Plan and Test Report should be prepared.

The key element of the Site Acceptance Test is the acceptance from the ANSP that all design requirements have been met, and are applicable in the local environment. The design of the site acceptance tests (and flight tests – see step 4.7) should explore both nominal and failure modes (N-1) of system operation (see guidance notes D, F and J for more).

Note that it is at this stage that some issues with the design specification may come to light; change proposals may need to be actioned (and should be covered by the signed contract).

The results of the measurements of the parameters and performance in the live environment will form part of the operational approvals evidence. These will be defined via flight trials (see step 4.7 below).

Step 4.5 – WAM system integration

Integration of the WAM system with the existing surveillance and ATC system may be done by either the manufacturer or the ANSP, depending on the procurement model used. The Interface Control Document should be closely followed and validated (see step 4.2), whilst any Interoperability requirements (from the Interoperability Assessment – step 2.8) should be validated.

Step 4.6 – Optimising WAM system performance

Following integration, there should be a task on the manufacturer to tune (calibrate) the WAM system (possibly for the second time – they may have done this prior to integration also). This optimisation of WAM system performance, set within the surveillance system, will be also carried out by the ANSP, as it works with the tracker functionality to get the highest performance from the overall system.

Step 4.7 – Flight testing to validate system performance and coverage

The flight trial planning will differ from the radar case, in that the performance variations across the service volume will follow a very different pattern. Dependent on the service to be provided across the coverage volume and the mitigations in place, clear flight route planning needs to be addressed to ensure adequate validation of performance.

Note that the flight trial planning may have formed an aspect of the contract with the supplier. In either case, the number, prediction of results, duration and cost of flight trials should be planned before commencing the process.

Guidance Note K gives more information on flight trial design.

Step 4.8 – Validation of WAM within CNS/ATM system

The final part of the validation is to check whether requirements are met when the WAM system is integrated with the overall ATM system (i.e. with other surveillance sources, tracker and controller tools functionality active). This may include a shadow mode trial with controller participation, or a "virtual centre" replicating all aspects of the operational system. Particular points to note include any unique WAM symbology, update rates (at the tracker and HMI), and effect on the overall ATM system.

Step 4.9 – Declaration of Verification

Under the SES legislation, once the system is ready for operational use, the ANSP will need to submit the Declaration of Verification (DOV) to the NSA for approval. The DOV is accompanied by a Technical File which "***must contain all the necessary documents relating to the characteristics of the system, including conditions and limits of use, as well as the documents certifying conformity of constituents where appropriate."***

The technical file will include:

- Description of the system (including performance, functionality, design and interfaces)
- Documentation trail to show compliance with requirements, including any Software Requirements Documentation, and the Interface Control Document)
- Any reference documentation used (e.g. ED-142 [ref 13])
    - Validation and Verification Plan (Test Plan)
    - Factory Acceptance Test reports

Further details are provided in Guidance Note A. This may be done at the same time as the operational approval (see step 5.6).

Contribution to approvals evidence:

Validation and Verification Plan
Factory Acceptance Test report
Site Acceptance Test report
Record of any agreed deviations from contract
Declaration of Suitability of Use
Declaration of Verification

Actors involved
Manager responsible for:
[1] Surveillance Service [ANSP] (or senior WAM requirements engineer)
[2] Operations [ANSP]
[3] Safety [ANSP]
[4] Procurement [ANSP]
and
[5] WAM technical experts [suppliers]
[6] WAM business development [suppliers]
[7] Approving regulator [NSA]

Background material available

Not yet published: [Ref 13] Draft ED-142 WAM Technical Specifications

Frequently Asked Questions

Is a Factory Acceptance Test necessary?

WAM performance is more dependent on the local configuration of constituents than radar (for example, the Dilution of Precision between receiver units changes according to their exact location, leading to variable performance). Therefore, the use of a Factory Acceptance Test to ensure the technical correctness of the system is limited, as it can only be measured in the local environment (once deployed).

If the procured WAM system includes any bespoke components, it is advisable to conduct a FAT. However, in the event of a COTS system being used, the FAT may not be necessary beyond a simple delivery check of the constituents.

This may also impact the commercial aspects of the agreement between the ANSP and the supplier; whereas traditionally a stage payment is made at the completion of FAT, in the case of WAM (given the difference in percentage effort associated with the FAT compared to on-site validation), this payment may be split in alternative ways (e.g. on delivery and deployment on site).

Step 5: Establish Operational Service

The operational approvals will present all evidence collated thus far (see Steps 1-4) to the NSA as part of a Safety Case showing that the proposed application of the installed WAM system data in the local environment is acceptably safe. Besides the proof of WAM performance, and detailed service description and requirements, the ANSP will also need to produce:

- Procedures and practices: any new procedures, both nominal and failure mode, must be agreed with the NSA. This should have been initiated in Step 2.
- Transition planning: ensuring the transition to the use of the new WAM system data is acceptably safe;
- Training plan – final version (including both operational ATCOs and maintenance engineers);
- Responsibilities and accountabilities.

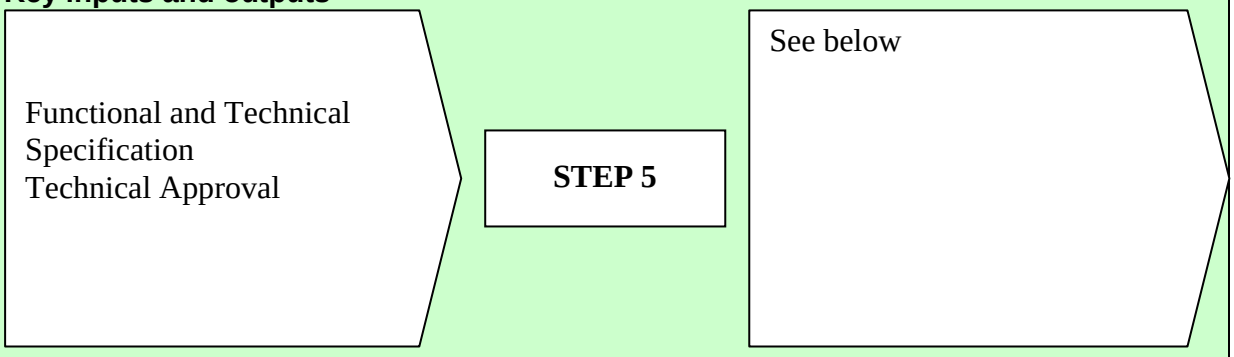
At this stage, it is also recommended that the ANSP update the Safety Case with the **System Safety Assessment (SSA)**. This evaluates the actual performances of the installed components and functions, and ensures they still meet the safety objectives defined for the applications being proposed (as per the FHA).

All the evidence outlined above will therefore be presented to the regulator, and if the argument is complete and clear, an operational approval (letter of conformity) should be gained.

Step owner:
[1] Surveillance Service manager or senior WAM requirements engineer **[ANSP]**
[2] Operations manager **[ANSP]**
[3] Safety manager **[ANSP]**

Scope: All remaining pieces of evidence to satisfy and reinforce the safety argument are collected at this stage.

Key inputs and outputs



Checklist for Step 5: Establish operational service

Step	Title	
5.1	Procedures and practices definition (including operational use of WAM, and failure mode procedures)	☐
5.2	System Safety Assessment carried out	☐
5.3	Training Plan finalised	☐
5.4	Responsibilities and accountabilities defined in line with SMS	☐
5.5	Transition Plan finalised, including identification of necessary mitigations during transition	☐
5.6	Safety Case collated and submitted to NSA	☐
5.7	Operational approval received	☐

Step 5.1 – Procedures and practices definition

In parallel with step 4, the establishment of the operational service should take place. ANSPs must define the changes in procedures and practices carefully, including the operational use of the WAM data, any restrictions on the use, and procedures in case of failure modes. The latter will possibly be more complex than for the radar case. Clear indication of the reliance that controllers can place on the information, and how they can use it in areas where no other radar coverage exists or where there may be a conflict between the information declared by conventional surveillance systems, should be given.

Controllers must be informed of system performance across the service volume, including documentation provided of the likely Dilution Of Precision (DOP). Symbology on the controller display may also be different for WAM plots, tracks and multi-source fused data (although in most cases so far, controllers have preferred the data source to be transparent to them, as long as the data performance meets operational requirements).

Step 5.2 – System Safety Assessment carried out

Following the flight trials and installation of the system, the safety assessment may be updated with actual values to become the System Safety Assessment. At this stage, clear margins of safety may also be identified to reinforce the argument for an acceptably safe system. This is not the end of the safety process; the Safety Case should be continuously updated based on operational data and resultant actions (see step 6).

Step 5.3 – Training plan finalised

The training syllabus will be finalised and executed, to ensure controllers and engineers are fully conversant with the new system, its impact on operations, and the differences between WAM and any SSR practices they may be used to. Note that this training may rely on the manufacturer (and be the subject of contractual requirements); if so, it should have been defined in the tender.

At the operational level, controllers will be made aware of any changes to operational data, including the behaviour of the data in case of failure (i.e. what happens if one ground station

fails, what tracker filters are used for the WAM data and do they differ from currently applied radar-based filters?). In general, if no change to the operational service entails from WAM implementation, there should be little need to train controllers.

At the engineering level, adequate training will be planned to ensure the availability and reliability of system components as they enter operational service.

Further detail of the training considerations is given in Guidance Note D.

Step 5.4 – Responsibilities and accountabilities defined in line with SMS

Where any changes in responsibilities and accountabilities need to be clarified, it should be done in the context of the preparation of the Safety Case (in line with the ANSP's Safety Management System). This should be in line with other surveillance systems; those accountable and responsible should ensure they are satisfied with the process that has been followed.

Step 5.5 – Transition plan finalised

WAM is a relatively new technology, and safety evidence based on experience is still weak. Therefore, ANSPs may wish to define a transition period for entry into operation of the new WAM system, including additional mitigations and checks. For example, initial use of the system may be restricted to hours when low density traffic is prevalent (e.g. night). Also, increased separation minima may be used for the first 6-12 months, whilst operational and technical data is collected to verify the use of the system. Care should be taken by the ANSP to look through the Safety Case and identify where safety margins may be dependent on experiential factors (e.g. a new component may need 1-2 years before its availability can be known). This may also apply as controllers become used to new procedures and practices.

The Transition Plan will have defined these additional mitigations and checks, and will relate to the Safety Case in terms of evidence that the system is always acceptably safe in operation.

The Transition Plan will also contain the detailed actions for ANSP personnel as the system is entered into operation (e.g. when will it be switched on, who needs to be present, how will monitoring occur initially). This involves installation, commissioning and integration. It may include decommissioning of replaced surveillance sources also.

The Transition Plan may also define NOTAMs and/or AICs that need to be released, if any changes in procedures or operational effects are relevant following the deployment and entry into operation of the WAM system.

The Transition Plan should have been defined in draft form prior to tender (as it may impose requirements on the manufacturer) – this step finalises the document in preparation for operations and operational approval. It also executes the Transition Plan, ensuring that the additional requirements laid down in step 3 are followed during deployment and entry into operations.

See also Guidance Note D, which talks about possible operational mitigations in the transition phase.

Step 5.6 – Safety Case collated and submitted to NSA

The Safety Case Release (SCR) will contain a number of sections (dependent on the ANSP and NSA involved). As a minimum, there will be the description of the system and applications, the safety argument, evidence for the safety argument (e.g. the Functional Hazard Analysis and System Safety Assessment), assessment of the significance of any open issues, responsibilities and accountabilities, performance monitoring, and maintenance requirements and plans. The Safety Case forms the core document submitted to the NSA for operational approval to be given. The full list of documents likely to be expected from the ANSP is given in the Frequently Asked Questions section below.

Step 5.7 – Operational approval received

Other documentation besides the Safety Case for the Operating Approval submission includes: users manuals, training plans, regulations for service, flight trial results, reliability data, integrity data (safety margins), and logistics information. This will include post-delivery support, warranty support, and post-warranty support.

Also, a Declaration of Spectrum Availability will be submitted at this stage. This is the result of steps 2.5 and 3.6.

Contribution to approvals evidence:

Procedures and practices definition
Transition Plan
Training Plan
Safety Case
Operational Approval
NOTAM or AIC, if required

Actors involved
[1] Surveillance Service manager [ANSP] (or senior WAM requirements engineer)
[2] Operations experts [ANSP]
[3] Safety function [ANSP]
[4] Procurement [ANSP]
[5] WAM technical experts [suppliers]
[6] Approving regulator [NSA]

Background material available
[Ref 1] EUROCONTROL Generic OSED for provision of 3NM and 5NM separation services
[Ref 2] EUROCONTROL Surveillance Functional Hazard Analysis (for provision of 3NM and 5NM separation services)
[Ref 3] EUROCONTROL Example Preliminary System Safety Assessment for WAM supporting 3NM and 5NM separation services

Frequently Asked Questions

Does the transition need to include a defined "phase" of time?

Guidance Note D considers this in more detail. Essentially, as WAM is a new technology, including a defined phase of time when the system is subject to additional mitigations (or has little operational impact by operating in shadow mode) can serve to build trust and acceptance in the new system from both a technical and operational view.

What is the full list of documents required of an ANSP prior to operational approval?

- Operational Services and Environment Description
- Preliminary System Safety Assessment (including Functional Hazard Analysis)
- Interoperability Assessment
- (Operational and System) Performance Requirements
- User Requirements Document
  Including Coverage Planning Map
- Environmental Impact Study (if necessary)
- Functional and Technical Specification
- Invitation to Tender
- Tenders submitted
- Contract
  Including list of contract deviations from Invitation to Tender
- Declaration of Conformity or Suitability for Use (including Factory Acceptance Test)
- System Safety Assessment
- Procedures and Practices
- Transition Plan
- Training Plan
- Safety Case Release
- Declaration of Verification (including Site Acceptance Test)

Step 6: Deliver Operational Service

Following entry into operational service, an **on-going monitoring activity** must be established; this is to provide evidence that the application of the WAM system is acceptably safe in operation.

This monitoring activity should include some form of independent check of system performance. Note that where WAM is installed as a sole means surveillance source, special provisions may need to be made. **Test transponders** (also called Reference and Monitoring Transponders) will be installed as a means of checking the integrity of the received data.

In Step 2, the design options should have included the identification of BITE (Built-In Test Equipment) and calibration checks. The system should also include Management and Status Reporting (to ensure real-time reporting of any unavailability of system components). These should be implemented to ensure the on-going safety and reliability of the WAM system and its application.

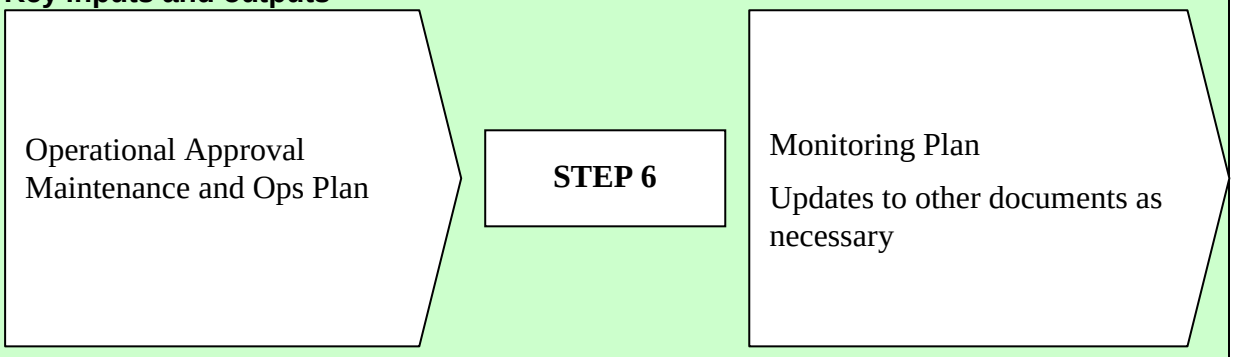
On-going training, and review of all procedures and practices through the analysis of incident reports, together with corrective action as necessary, should also ensure that the application of the system remains acceptably safe.

All these elements should be included in the Safety Case, so that the Regulator can be sure that the service will remain safe once operational.

Step owner:
[1] Surveillance Service manager or senior WAM requirements engineer **[ANSP]**

Scope: Following operational deployment and use of the new system, this step maintains the awareness of the requirements, and gathers evidence and initiates corrective action as necessary.

Key inputs and outputs



Checklist for Step 6: Deliver operational service

Step	Title	
6.1	On-going monitoring task defined (using test transponders and BITE as necessary)	☐
6.2	Continuous review of procedures and practices, and analysis of incident reports, including corrective action as required	☐
6.3	Service delivery including refresher training	☐

Step 6.1 – On-going monitoring task defined

As part of the Safety Case, an on-going monitoring and validation task will be defined. This should be enabled by the test transponders and BITE defined in Step 2 (design requirements). Additionally, the ANSP may wish to include regular flight trials to ensure continued performance over the service volume or conduct assessments based upon targets of opportunity. The BITE penetration (as mentioned in step 2) should be in line with the spares and repairs policy of the ANSP – if this changes during operation, a review of BITE procedures should also be carried out.

The monitoring task will also include regular calibration, which should be defined as part of the FTS such that the supplier has the duty to perform this at least annually.

Step 6.2 – Continuous review, analysis, and corrective action

Continuous review of operational data should lead to updates of the Safety Case and related procedures and practices as necessary. A safeguarding process may be used to ensure that changes to other systems do not have an impact on the safe operation of the WAM system (for example, by ensuring that no new buildings are built next to a receiver, breaking its line of sight for a portion of the service volume).

Analysis of the incident reports will lead to corrective actions (and possibly mitigations) being applied as necessary.

Step 6.3 – Service delivery including refresher training

On-going checks on the service delivery will be carried out (where the service here is the Air Traffic Service, supported by the surveillance service, of which the WAM service constitutes one element). Also, refresher training will be given by the ANSP or manufacturer (depending on the tender requirements). Particularly important is refresher training of control methodologies in case of WAM outages (for example, procedural control in a WAM sole means environment).

Contribution to approvals evidence:

On-going training requirements
On-going calibration and integrity monitoring
Incident reports and review

Actors involved
[1] Surveillance Service manager [ANSP] (or senior WAM requirements engineer)
[2] Operations experts [ANSP]
[3] Safety function [ANSP]
[4] Procurement [ANSP]
[5] WAM technical experts [suppliers]
[6] Approving regulator [NSA]

Background material available
n/a

Frequently Asked Questions

Does WAM require on-going calibration?

Yes, because WAM-derived surveillance reports depend upon the accurate and consistent timing of the 1090 MHz signals' difference in arrival time at the WAM system (e.g. at the receivers, or at the central processor, depending on system design). Ongoing calibration protects the system against possible timing drift and its resultant effect on positional accuracy.

Also, as the ANSP gains experience with operational use of the data arising from WAM, they may become aware of performance degradations in certain volumes of the airspace, either due to FRUIT, multipathing, or the behaviour of the system. Although some solutions to this will be operational in nature, there may be a role for technical mitigations through increased performance.

5 Acronym list

ADS-B	Automatic Dependent Surveillance – Broadcast
ARTAS	ATM Surveillance Tracker and Server
ASOR	Allocation of Safety Objectives and Requirements
ASTERIX	All Purpose STructured Eurocontrol Radar Information EXchange
CAPT	Coverage Analysis and Planning Tool (EUROCONTROL)
CEN	Comité Européan de Normalisation
CENELEC	Comité Européan de Normalisation Electrotechnique
CNS	Communication-Navigation-Surveillance
COTS	Commercial Off The Shelf
CPS	Central Processing System/Server
CS	Community Specification
DoC	Declaration of Conformity
DOV	Declaration Of Verification
DSU	Declaration of Suitability for Use
EASA	European Aviation Safety Agency
EC	European Commission
ECTL	EUROCONTROL
EN	European Norm
ER	Essential Requirement
ESARR	EUROCONTROL Safety Regulatory Requirements
ESO	European Standards Organisation
ETSI	European Telecommunications Standards Institute
ETSO	European Technical Standards Order
EUROCAE	European Organisation for Civil Aviation Equipment
FAT	Factory Acceptance Test
FHA	Functional Hazard Analysis
FMEA	Failure Modes and Effects Analysis
FTS	Functional and Technical Specification
ICD	Interface Control Document
ICAO	International Civil Aviation Organisation

ICB	Industry Consultation Body
IOP	Interoperability
IR	Implementing Rule
ITT	Invitation To Tender
MASPS	Minimum Aviation System Performance Standards
MLAT	Multilateration
MOPS	Minimum Operation Performance Standards
MTBF	Mean Time Between Failure
MTTR	Mean Time To Repair
NSA	National Supervisory Authority
OHA	Operational Hazard Analysis
OPA	Operational Performance Assessment
OSA	Operational Safety Assessment
OSED	Operational Services and Environment Description
PANS	Procedures for Air Navigation Services
PoD / Pd	Probability of Detection
PSR	Primary Surveillance Radar
PSSA	Preliminary System Safety Assessment
RCMS	Remote Control Monitoring Station
RMTR	Reference and Monitoring Transponder
RSP	Required Surveillance Performance
RTCA	Requirements and Technical Concepts for Aviation
SARPS	Standards And Recommended Practices
SAT	Site Acceptance Test
SES	Single European Sky
SPR	Safety and Performance Requirements
SRD	System Requirements Document
SSA	System Safety Assessment
SSR	Secondary Surveillance Radar
UPS	Uninterruptible Power Supply
URD	User Requirements Document
WAM	Wide Area Multilateration

6 References

Ref	Title	Latest version / date
1	EUROCONTROL Generic OSED for provision of 3NM and 5NM separation services, part of Generic WAM Safety Assessment	Version 4.0 April 22nd 2008
2	EUROCONTROL Surveillance Functional Hazard Analysis (for provision of 3NM and 5NM separation services), part of Generic WAM Safety Assessment	Version 4.0 April 22nd 2008
3	EUROCONTROL Example Preliminary System Safety Assessment for WAM supporting 3NM and 5NM separation services, part of Generic WAM Safety Assessment	Version 4.0 April 22nd 2008
4	ICAO Annex 10 Aeronautical Communications Vol III	2nd Edition, Am 82 July 2007
5	ICAO Annex 10 Aeronautical Communications Vol IV	4th Edition, Am 82 July 2007
6	EUROCONTROL Standard Document for Radar Surveillance in en-route Airspace and Major Terminal Areas, SUR.ET1.ST01.1000-STD-01-01, Edition 1.0, March 1997. *Note that a major update of this standard is currently in draft form, and should be released in 2009. It seeks to describe required surveillance performances, independent of technology.*	Edition 1.0 March 1997
7	Eurocontrol Safety Assessment Methodology (SAM) http://www.eurocontrol.int/	Version 2.1 November 2006
8	Eurocontrol Safety Regulatory Requirement (ESARR) 4 “Risk Assessment and Mitigation in ATM”, Edition 1.0 5th April 2001 http://www.eurocontrol.int/	Edition 1.0 April 2001
9	ED-78A, “Guidelines for Approval of Provision and Use of Air Traffic Services Supported by Data Communications”, http://www.eurocae.org/	December 2000
10	EUROCONTROL Standard Document for Surveillance Data Exchange, Part 14 : Category 019, Service Messages, (ASTERIX Cat 019)	Edition 1.1 March 2007
11	ED-126 “Safety, Performance and interoperability requirements for ADS-B in Non-Radar Airspace”, December 2006, http://www.eurocae.org/	Edition 1.0 December 2006
12	EUROCONTROL Standard Document for Surveillance Data Exchange, Part 14 : Category 020, Multilateration Data, SUR.ET1.ST05.2000-STD-14-02 (ASTERIX Cat 020)	Edition 1.5 April 2008
13	EUROCAE (DRAFT) “Technical Specification for Wide Area Multilateration based on the existing and planned requirements defined by the EUROCONTROL Multilateration Task Force”, Document in preparation, EUROCAE WG-70, http://www.eurocae.org/ (nominally ED-142)	Draft form - not released

14	ICAO PANS-OPS “Procedures for Air Navigation Services – Aircraft Operations,” Fifth Edition (Doc 8168)	Fifth edition 2006
15	ICAO PANS-ATM “Procedures for Air Navigation Services – Air Traffic Management,” Fifteenth Edition (Doc 4444)	Fifteenth edition 2007
16	ICAO SASP “Technical Comparison of SSR, ADS-B and Wide Area Multilateration”, Annex F, Report of Project team 13, ADS-B and MLAT. Separation and Airspace Safety Panel, (SASP), Tenth Meeting of the Working Group of the whole, 27 November – 8 December 2006	December 2006
17	“Wide Area Multilateration” Report, EATMP TRS 131/04 Version 1.1, August 2005, produced for EUROCONTROL by Roke Manor Research, HITT Traffic and the National Aerospace Laboratory of the Netherlands	Version 1.1 August 2005
18	Regulation (EC) No 549/2004 laying down the framework for the creation of the single European sky (Framework Regulation)	10 March 2004
19	Regulation (EC) No 550/2004 on the provision of air navigation services in the single European sky (Service Provision Regulation)	10 March 2004
20	Regulation (EC) No 551/2004 on the organisation and use of the airspace in the single European sky (Airspace Regulation)	10 March 2004
21	Regulation (EC) No 552/2004 on the interoperability of the European Air Traffic Management network (Interoperability Regulation)	10 March 2004
22	Initial Guidelines for Conformity Assessment of EATMN systems - EUROCONTROL	Edition 1.4 March 2006
23	Example controller handbook for Wide Area Multilateration, AustroControl	Version 1.0 July 2008
24	EUROCONTROL Safety Case Development Manual (SCDM)	Version 2.1 October 2006
25	ED-117, Minimum Operational Performance Specifications for Mode S Multilateration Systems used in A-SMGCS, www.eurocae.org	November 2003

7 Bibliography

The documents outlined in this section are those of key regulatory importance, in particular in outlining the regulatory (approvals) process or acting as a key reference. The notes describe their function, role and the inter-relationships between them.

7.1 ICAO

- **ICAO PANS-ATM "Procedures for Air Navigation Services – Air Traffic Management," Fourteenth Edition (Doc 4444)**

  Summary: Details the ATC services that are to be supported by the surveillance service (system) including separation (§ 8.7), vectoring (§ 8.6.5) and monitoring (§3.2.5).

  Reason for inclusion: Describes the types of procedures that will use WAM data. Impacts upon the operational requirements, and thus the safety, performance and interoperability requirements that define the WAM system.

- **ICAO PANS-OPS "Procedures for Air Navigation Services – Aircraft Operations," Fifth Edition (Doc 8168)**

  Summary: Describes the role of the controller and pilot when a separation service is being provided within the surveillance environment.

  Reason for inclusion: Describes the type of operations (in terms of roles of both Pilot and Controller) that WAM surveillance will support; note that many of the procedural elements will be common to all types of surveillance, but some failure modes may be specific to airspace service volumes covered by WAM alone.

7.2 EUROCONTROL

- **EUROCONTROL Standard Document for Radar Surveillance in en-route Airspace and Major Terminal Areas, SUR.ET1.ST01.1000-STD-01-01, Edition 1.0, March 1997**

  Summary: This document sets out the EUROCONTROL standards for the expected surveillance coverage and performance in en-route and major Terminal Areas. The 1997 version describes the technical means of achieving this performance (e.g. via dual SSRs in en-route), whilst the updated draft version is independent of the technological means of provision. The new version is due to be released in 2008/9, and is intended to be consistent with the Surveillance Performance and Interoperability Implementing Rule (being drafted under the Single European Sky legislation).

  Reason for inclusion: This document will directly influence the (technology independent) performance characteristics that will define a WAM system. It set

out the relevant performance level that WAM systems will be required to adhere to, in order to show equivalence to other surveillance means such as MSSR.

- **EUROCONTROL Safety Assessment Methodology (SAM)**
  (see http://www.eurocontrol.int/safety)

  Summary: Defines a methodology for assessing safety (primarily used in the construction of safety cases). Overall the methodology is to define the means for providing assurance that an Air Navigation System is safe for operational use.

  Reason for inclusion: Describes the structure and processes of creating a safety case for an item of ATM/CNS equipment, including WAM equipment. It is anticipated that it will be this methodology used by the majority of European ANSPs when they construct safety cases for their WAM equipment. It will certainly need to be considered if re-using the WAM generic safety assessment material of EUROCONTROL.

- **EUROCONTROL Safety Regulatory Requirement (ESARR) 4 "Risk Assessment and Mitigation in ATM", Edition 1.0 5th April 2001**
  (see: http://www.eurocontrol.int/)

  Summary: ESARR4 sets out the requirements that need to be satisfied for ATM systems to be deemed "acceptably safe". It has recently become legislation under the Single European Sky. An underpinning requirement of the safety argument for implementing a WAM system is therefore the need to demonstrate compliance with ESARR4. The document also describes overall target levels of safety and classifies hazards according to severity level (1 to 5) ranging from "a complete loss of safety margins" (1) to "no effect on safety" (5).

  Reason for inclusion: Underpins the risk assessment methodology used by EUROCONTROL in the Safety studies and risk allocation. Forms the basis (under law) of how service providers should show that their service is acceptably safe.

- **EUROCONTROL Example Generic Safety Assessment for ATC Surveillance using WAM (Wide Area Multilateration), Edition 4.0, 22nd April 2008, Draft**

  Summary: Provides an EXAMPLE safety assessment founded on EUROCONTROL Safety Assessment Methodology (incorporating the OSED, FHA and PSSA) for a generic functional architecture WAM system. The assessment draws upon the use of a functional model to create a fault/event tree analysis to ultimately derive safety objectives and example safety requirements.

  Reason for inclusion: The EUROCONTROL Generic Safety Assessment of WAM can be used by service providers as a basis for the local safety case, subject to detailed validation of all assumptions and requirements. The structuring and process of the Generic Safety Assessment should help implementers to generate a clear, concise and comprehensive safety case for the new WAM system.

7.3 EUROCAE

- **ED-78A, "Guidelines for Approval of Provision and Use of Air Traffic Services Supported by Data Communications"**
- (See: http://www.eurocae.org/)

  Summary: Provides guidance and templates for "Minimum Acceptable Criteria" needed to support operational approvals processes. The criteria require that the environment, processes, performance and interoperability issues surrounding the installation of a new system are considered prior to approval being granted. A collection of documents provide supporting evidence including the SPR, OSED, OSA, FHA, OHA, ASOR and OPA.

  Reason for inclusion: This document underpins the approval process that WAM systems will undergo before they enter service. It defines a methodology whereby it ensures that minimum acceptable criteria are met by a system that follows its processes.

- **ED-126 "Safety, Performance and interoperability requirements for ADS-B in Non-Radar Airspace", December 2006**

  Summary: The ADS-B requirements document (in terms of safety, interoperability and performance requirements) in areas where ADS-B is the sole means of surveillance, in accordance with ED-78A.

  Reason for inclusion: Defines the requirements, assumptions and performance characterises that may be used as input to WAM-based surveillance. Shows the development of Safety, Performance and Interoperability Requirements, a process that is recommended to be followed to define the WAM-based functional and technical requirements (note this may be achieved by the use of ED-142 WAM Technical Specification).