

## CAP 670 ATS Safety Requirements – Amendment 13

### External Consultation 19 November 2012 – 13 January 2012

Comments are invited on the following proposed amendments to CAP 670. All new text is shown in blue; deletions are shown in ~~red-strikethrough~~.

The SUR Sections have been completely revised and should be read in their entirety.

## Part C

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### Part C, Section 1

#### COM 03 Voice Communications Control Systems

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~~6.1.15 Recommendation: All lines of communication should incorporate an automatic gain control function in order to maintain adequate speech signal levels (1106).~~

~~6.1.16 Where an automatic gain control function is used, only one device or function shall operate on any signal path (1107).~~

~~NOTE: Where such devices or functions are incorporated, a signal gain path memory or similar feature can be used to prevent distortion of the initial syllables of speech at the beginning of a transmission or after pauses in speech. The principle of operation being that the last dynamic gain/attenuation setting is stored and used for subsequent transmissions.~~

6.1.15 The return path of each communication function shall incorporate an automatic gain control (AGC) function to ensure an acceptable signal to noise level and to minimise the possibility of hearing damage (acoustic shock) by preventing extremely loud signals from being delivered into the ATC headset (1106).

**NOTE:** A signal gain path memory or similar feature can prevent distortion of the initial syllables of speech at the beginning of each received message or after pauses in speech. The principle of operation is that the last dynamic gain or attenuation setting is retained for future use.

6.1.16 **Recommendation:** The presence of two or more AGC devices in a signal path could degrade the received audio signal and only one single AGC device or function should therefore be employed in each signal path (1107).

## Part C, Section 2

- 4.3 For calculating the IRVR value, ~~20 per cent of the peak~~ a maximum of 40 per cent of the ~~averaged~~ beam on axis intensity of the runway edge lights (rounded to the nearest 100 cd) shall be assumed (1644).

**NOTE:** The basic de-rating factor of 40% is based upon the serviceability requirement set out in Chapter 6, paragraph 12.4 of CAP 168 (Licensing of Aerodromes). ANSPs are however encouraged to submit copies of results obtained from photometric inspection of their runway edge lighting system to the appropriate CAA regional office. The relevant staff will then assess whether the de-rating factor (previously set at 20% of peak beam intensity) can be adjusted upward toward the ICAO recommended maximum of 80% (Doc 9328 Chapter 6.5, "Light and Light Intensity") but continuing operation at this level will depend upon satisfactory evidence of ongoing inspection and subsequent maintenance being presented by that ANSP to the CAA. Typically such evidence would comprise results from a minimum of 4 photometric inspections (one in each quarter) taken during the previous 12 months. The results being used to confirm the continued serviceability of the runway edge lights and average luminous intensity recorded during each inspection.

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- 4.6 The 1 minute averaged IRVR value presented to ~~the user~~ ATC shall be rounded down to the nearest increment specified in paragraph 8.5 (1647).

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- 8.1 ~~Displays shall present the RVR data in the manner described below:~~

- a) ~~In an alphanumeric format with indication of trend over successive readings (1658);~~
- b) ~~Any changes in system status, including blanking of displayed data, or RVR value, shall be presented at operational displays within 15 seconds of the change (1762).~~

ATC operational displays shall present the RVR data in an alphanumeric format with indication of trend over successive readings (1658).

**Recommendation:** All changes in either system status (including blanking of displayed data) or RVR value should be displayed at ATC operational positions within 15 seconds of such changes (1762).

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- 10.1 **Safety objective**

~~Sensor measurements shall be used to derive an RVR value that is representative of the pilot's perspective of the visibility along the runway(1766).~~

- a) Sensor measurements shall be used to derive an RVR value that is representative of the pilot's perspective of the visibility along the runway and in the prevailing weather conditions including background luminance (1766).
- b) One or more background luminance meter (BLM) sensors must be installed at locations which are known to be unaffected by artificial lighting from the runway in use at that time, from the apron area, or from aerodrome and external sources such as road lighting schemes.

**NOTE:** The current state of BLM technology is such that direct sunlight has to be avoided and for this reason, the majority of UK BLMs are aligned to view the north sky at an elevation of 22.5 degrees above the horizon. However, due to the prevailing wind directions in the UK, the majority of precision runways in the UK are constructed in an east-west orientation. This implies that a pilot who is observing the runway against a rising sun or setting sun may experience a lower RVR than that generally reported by an instrumented system unless the relevant BLM was observing the same portion of brightly lit sky.

**Please note that the SUR sections have been completely revised and should be read in their entirety.**

## Part C, Section 3 – Surveillance

### 1 Introduction

Section 3 of Part C contains safety and engineering requirements for surveillance systems and their constituent elements, including requirements for performance assessment trials. These documents should be used in conjunction with the Generic Requirements and Guidance contained in Part B as appropriate.

### 2 Scope

- 2.1 The purpose of the “SUR” sections of CAP 670 is to provide guidance to ANSPs for obtaining approval for surveillance systems and their constituent equipment, which require regulatory approval under Article 205 of the ANO. The equipment subject to regulatory approval includes surveillance systems/equipment used as an essential element for the provision of air traffic services or where such systems/equipment are deemed to be safety-related and used to support the provision of an air traffic service (See Part B, Appendix A for the schedule of equipment to be regulated under Article 205 and 206 of the Air Navigation Order).
- 2.2 Surveillance systems which are deployed in an aviation environment to support functions that are not related to air traffic management, such as fleet management, are outside the scope of CAP 670 and the CAA’s regulatory responsibility for air traffic services regulation. The requirements in CAP 670 are also applicable to surveillance data feeds sourced from third parties, e.g. the use of Onward Routed Radar Data.
- 2.3 The use of surveillance systems as planning aids or for Secondary Surveillance Radar (SSR) for labelling purposes only is outside the scope of the requirements defined in CAP 670 unless the related planning and labelling functions have safety implications.

### 3 Overview of SUR Sections

- 3.1 The ‘SUR’ documents contain guidelines and requirements for surveillance systems and their constituents. SUR 01 provides general guidance on the specific regulatory provisions applicable to air traffic surveillance systems and contains current national policy statements on operational aspects.
- 3.2 SUR 02 provides technology independent generic guidance and requirements regarding the derivation of the performance criteria applicable to various surveillance systems. SUR 03 contains requirements to be complied with when using surveillance data from combined

sensors or by using multiple techniques. The subsequent SUR sections address technology specific requirements for Primary Surveillance Radar (PSR), SSR, Automatic Dependent Surveillance (ADS) and Multilateration Surveillance (MLAT). These requirements are identified specific to various applications where possible (e.g. en-route and surface surveillance).

- 3.3 SUR 08 and SUR 09 identify requirements that are application specific (e.g. Aerodrome Traffic Monitoring and Airport Surface Surveillance) and are independent of the technology being used.
- 3.4 SUR 10 and SUR 11 identify requirements applicable to key constituent elements within a typical surveillance system including the recording and replay system, data processing and display systems. SUR 12 addresses requirements applicable for the performance assessment process, which includes pre-operational trials.
- 3.5 Annex B to the SUR sections document provides some useful guidance as regards the use of multistatic primary radars which is an emerging non co-operative surveillance technology.

## **SUR 01 Provision of Surveillance for Civil ATS Operations**

### **Part 1 Preliminary Material**

#### **1 Introduction**

- 1.1 There are international, European and national standards and regulations applicable to ground based surveillance systems in the UK.

#### **2 Scope**

- 2.1 SUR 01 identifies the ICAO SARPS provisions, European level regulations exclusively applicable to surveillance systems and current national policy on the minimum surveillance coverage requirements required in the UK.

**NOTE:** The current European regulations identified in SUR 01 do not mandate specific ground-based surveillance capabilities to be implemented. The national policies on ground-based surveillance strategy and airborne equipage requirements in UK airspace are being reviewed. Further information on the UK approach to surveillance for ATS can be found in Annex E to the SUR Sections.

## Part 2 Requirements

### 3 General

- 3.1 The following European level, ICAO level and national legislative requirements must be considered for applicability for all ground based surveillance systems deployed in the UK and relevant provisions shall be complied with as applicable.
- 3.2 These requirements shall be considered in addition to the generic requirements/legislation applicable to the regulation of all CNS/ATM systems described in Part B of this document.

### 4 Single European Sky Legislation (Mandatory)

- 4.1 ANSPs shall comply with the relevant sections of the following regulations as applicable:
- a) **Commission Regulation (EU) No 1207/2011:** Surveillance Performance and Interoperability Implementing Rule (SPI IR) - Laying down requirements for the Performance and Interoperability of Surveillance for the Single European Sky.  
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:305:0035:0052:EN:PDF>
  - b) **Commission Regulation (EC) No. 262/2009:** Laying down requirements for the co-ordinated allocation and use of Mode S interrogator codes for the single European Sky.  
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:084:0020:0032:EN:PDF>
  - c) **Commission Implementing regulation (EU) No. 1206/2011:** Aircraft Identification Implementing Rule - Laying down requirements for the Aircraft Identification for the Single European Sky  
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:305:0023:0034:EN:PDF>

### 5 Other European Level Requirements Imposed by the European Commission

- 5.1 Where applicable, Surveillance equipment is also required to comply with the following EU Directives (refer to CAP 670 Part A paragraph 5.2 for details):
- a) Radio and Telecommunications Terminal Equipment Directive (R&TTED) 1999/5/EC (See CAP 670 Part A The Regulatory Framework, paragraph 4.2.3 for further information).  
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1999:091:0010:0028:EN:PDF>
  - b) Waste Electrical and Electronic Equipment Directive (WEED) (2002/96/EC)
  - c) Restriction of Hazardous Substances (RoHS) (2002/95/EC)

**NOTE:** The Commission may also produce regulations or directives to address various aspects of CNS equipment outside the scope of the SES, which are nevertheless applicable to the EU member states.

**NOTE:** Furthermore, as the role of the European Aviation Safety Agency (EASA) is expanding to include safety assurance of CNS/ATM systems. Implementing Rules and

Certification Specifications relevant to surveillance systems may be generated by EASA in future and this document will be updated accordingly.

## 6 Global Level (ICAO) requirements

6.1 **Rationale:** Under the obligations placed on the UK under the Convention on International Civil Aviation, it is necessary to implement the ICAO Standards and Recommended Practices (SARPS) in respect of CNS/ATM equipment. Further details can be found in paragraph 1.1 of Part A The Regulatory Framework.

6.2 The following SARPS shall be applied to surveillance systems as applicable:

**NOTE:** This list will be updated when SARPS are developed by ICAO for surveillance technologies not currently covered.

a) SARPS Annex 10 Volume 4 – Surveillance Radar and Collision Avoidance Systems

**NOTE:** Annex 10 Volume 4 contains SARPS for Mode A/C conventional SSR systems, Mode S systems, Mode S Extended Squitter systems and for Multilateration systems.

b) SARPS Annex 10 Volume 3 – Communication Systems

**NOTE:** Annex 10 Volume 3 contains SARPS relevant for Automatic Dependent Surveillance Systems.

## 7. National Surveillance Coverage Requirements

### 7.1 General

7.1.1 Primary Surveillance Radar (PSR) is normally the minimum level of equipment necessary to provide Radar Control, Traffic Service or Deconfliction Service. SSR or other surveillance technologies may, to varying extent, be required to supplement PSR in order to safely accommodate increases in traffic complexity or density.

7.1.2 Failure of surveillance systems must be catered for by provision and publication of operational and engineering contingency arrangements and procedures.

7.1.3 Non-co-operative surveillance systems shall not be permanently withdrawn from service unless all ATSU's using the system can demonstrate that the traffic demand and complexity can be safely handled using procedural control or remaining surveillance systems.

7.1.4 The co-operative surveillance system where provided shall not be withdrawn from service unless the demand and complexity of traffic can be safely handled using non-co-operative surveillance alone.

### 7.2 Provision of Surveillance Systems According to Airspace and Air Traffic Services

7.2.1 The national surveillance coverage requirements applicable to en-route and terminal environment in the UK are listed in Table 1 and Table 2 below.

7.2.2 Terminal and en-route airspace where non-co-operative surveillance is not mandatory according to Tables 1 and 2, non-co-operative surveillance is required in addition to those listed in the tables wherever an ATSU providing surveillance based air traffic services identifies that it is probable for non-transponder equipped aircraft, whether identified or not, to

present a hazard to operations due to the uncertainty of their positions, which cannot be mitigated by other measures.

- 7.2.3 In airspace not identified in Tables 1 and 2, non-co-operative surveillance shall be required wherever an ATCU providing surveillance based air traffic services identifies that it is probable for non-transponder equipped aircraft, whether identified or not, to present a hazard to operations due to the uncertainty of their locations, which cannot be mitigated by other measures.
- 7.2.4 In airspace not identified in Tables 1 and 2, if providing services in an environment where there is a mixture of non-co-operative and co-operative targets, where surveillance services are provided exclusively using co-operative surveillance techniques, methods necessary for the safe operation of non-co-operative targets shall be defined and justified.
- 7.2.5 In airspace where types of surveillance techniques are not mandated or prescribed, the choice of surveillance techniques for the intended application shall be justified based on a hazard identification, considering equipage levels in the operational environment.

**NOTE:** The proportion of co-operative and non-co-operative targets and the possibility of presence of co-operative targets with faulty equipment in the intended coverage area must be considered.

**Table 1 - Surveillance Coverage Requirements in Terminal Environment**

	<b>Terminal environment</b>
Below FL 100	All <i>Terminal Control Areas</i> shall have at least a single layer of coverage by a suitable non-co-operative surveillance technique.  <b>NOTE:</b> Terminal Control Area is a control area normally established at the confluence of ATS routes in the vicinity of one or more major aerodromes. (ICAO)
	All <i>Terminal Control Areas</i> shall also have coverage provided with suitable co-operative surveillance technique/s.  <b>NOTE:</b> Co-operative surveillance data may be provided by one or a combination of more than one surveillance technique.
	The co-operative surveillance provision shall contain sufficient redundancy such that the operational requirement for coverage and accuracy to support the Air Traffic Service is met at all times (e.g. Dual SSR coverage or MLAT sensor network with some redundancy).
At and above FL 100	Adequate coverage by SSR or other co-operative surveillance system shall be provided as a minimum in <i>Terminal Control Areas</i> (i.e Non-co-operative surveillance is optional).
	Adequate coverage by SSR or other co-operative surveillance system shall be provided in all Major Terminal Control Areas.  <b>NOTE:</b> Major Terminal Control Areas in this document refers to London, Scottish and Manchester TCAs.

**Table 2 - Surveillance Coverage Requirements in En-route Environment**

	<b>Areas of high traffic density and/or complexity</b>	<b>Areas of low traffic density and/or complexity</b>
Below FL 100	Coverage shall be provided with at least a single layer of coverage by a non-co-operative surveillance technique.	Coverage shall be provided with data from a suitable co-operative surveillance technique as a minimum (i.e. non-co-operative surveillance is not mandatory but optional).
	Coverage shall also be provided with data from a suitable co-operative surveillance technique.	
	The co-operative surveillance provision shall contain sufficient redundancy such that the operational requirement for coverage and accuracy to support the Air Traffic Service is met at all times (e.g. Dual SSR coverage or MLAT sensor network with some redundancy).	
At and above FL 100	In areas of high traffic density ad/or complexity, coverage by a suitable co-operative surveillance technique shall be provided as a minimum.	Coverage shall be provided with data from a suitable co-operative surveillance technique as a minimum (i.e. non-co-operative surveillance is not mandatory but optional).

# **SUR02 Generic Requirements for Surveillance Systems**

## **Part 1 Preliminary Material**

### **1 Introduction**

- 1.1 This section sets out generic data and performance requirements for co-operative and non-co-operative surveillance systems used in the provision of air traffic services. It also introduces the concept of Required Surveillance Performance (RSP).

### **2 Scope**

- 2.1 The safety and performance requirements identified in this section are generic safety and performance parameters independent of technology. Where performance criteria have already been developed for specific surveillance applications by ICAO or at a European level, this section also identifies such material as guidance for users.

## Part 2 Requirements

### 3 Safety Objective

To ensure the surveillance system achieves the required level of performance and safety for the intended application independent of the type of surveillance technique or the architecture used.

**NOTE:** Description of surveillance services and applications can be found in Annex C.

### 4 Required Performance of surveillance systems

4.1 In order to support a selected ATM application, the surveillance system shall meet a minimum level of performance suitable for the operational requirements of the selected application defined herein as the Required Performance of a surveillance system. These performance criteria shall be appropriate to the chosen application and the air traffic services provided in the airspace concerned.

**NOTE:** ICAO has introduced a concept called “RSP-Required Surveillance Performance” for the minimum level of performance of a surveillance system defined above.

4.2 The chosen application and the operational requirements necessary for the application shall be clearly defined.

4.3 The required performance shall be specified and justified for the chosen application and the air traffic service provided in the airspace concerned.

**NOTE:** This shall either be derived by the ANSP themselves or be taken from an appropriate Global level/EU level standards document (e.g. A Community Specification).

4.3 Where such minimum required performance is already defined in ICAO SARPS by means of RSP criteria for an application or mandated by law (e.g. SES IRs), the system shall meet the performance criteria defined therein.

4.4 In addition, the national requirements defined later in CAP 670 for particular surveillance systems or applications shall apply.

4.5 Where minimum performance criteria is not mandated in SARPS or in European Law or defined in CAP 670, however are defined in European Specifications or standards that form an acceptable means of compliance to the requirements laid down by European legislation, the ANSP shall endeavour to meet the required performance criteria defined therein. In all other cases the ANSP shall define and justify their own required performance.

4.5 The required performance criteria shall be measurable and verifiable.

**NOTE:** Where the required performance is defined for the end-to-end surveillance system containing airborne and ground elements of the surveillance chain, the ANSP shall be able to apportion the performance the ground surveillance sub system must deliver and verify performance of the ground sub system. See Annex A for a schematic diagram of a typical surveillance system.

4.6 Required performance shall be met throughout the coverage volume where the service is provided.

## 5 Required Performance – Data Items

- 5.1 If deployed, all non-co-operative and co-operative surveillance systems shall deliver the minimum required data items as defined in Annex 1 (points 1.1 and 1.2) of Commission Implementing Regulation (EU) No. 1207/2011 Surveillance Performance and Interoperability Implementing Rule (SPI IR).
- 5.2 Certain surveillance applications may require additional data items depending on the operational requirements (e.g. for safety nets). Data items essential for safe operation and data items that are deemed as beneficial for additional functions (such as safety nets) shall be identified with an indication of their criticality for a safe operation.
- 5.3 Loss of each data item shall be analysed for operational significance. Where loss of such data has a safety impact (e.g. loss of a safety net) necessary measures shall be in place for maintaining an acceptable level of safety.

## 6 Required Performance – Performance Parameters

- 6.2 When defining the required performance, the performance parameters shall adequately address the performance aspects required for the delivery of data items necessary for the intended application.
- 6.3 When defining performance requirements for the local surveillance sub system, the performance of the data transmission link between the local and the remote sub system shall be taken into account (e.g. latency).
- 6.4 The following performance parameters shall be defined and justified for the surveillance system supporting a particular application.

**NOTE 1:** There may be one or more low level parameters/attributes that contribute to each key performance parameter. Lower level performance metrics may be further defined as necessary.

**NOTE 2:** Where performance requirements that are necessary to achieve an acceptable level of safety (e.g. reliability) are chosen from a document with a non-mandatory status (e.g. Eurocontrol specification), a local safety assessment shall demonstrate that the requirements are adequate and justifiable.

**NOTE 3:** The definitions of accuracy, availability, integrity, continuity and timeliness can be found in Article 3 of the SPI IR.

- 6.4.1 **Update period** [Example parameters; Scan rate, Probability of update of positional data]

The update period required for the intended application shall be defined and justified.

- 6.4.2 **Accuracy/Precision** [Example parameters; maximum allowable horizontal position error, horizontal position RMS error, Azimuth error, Range error]

**NOTE:** The accuracy of a measurement system is the degree of closeness of measurements to the actual/true value. The precision of a measurement is the degree to which repeated measurements under unchanged conditions show the same results.

6.4.2.1 The positional accuracy and data precision required for the selected application shall be identified.

The data precision used shall be consistent with the positioning performance required from the system.

**NOTE:** The horizontal position may take various forms depending on the surveillance technique used:

- Range and Azimuth;
- Latitude and Longitude;
- Specific system X and Y co-ordinates.

6.4.2.2 An assessment of the horizontal position error shall indicate the surveillance system is capable of meeting the accuracy and resolution requirements for the intended application (refer to SPI IR Annex 1, 2.2).

6.4.2.3 The assessment of horizontal position error shall indicate the factors considered for the error calculation and shall be the total error at the time of display.

6.4.2.4 Maximum allowable horizontal position error shall be less than half the separation minima and shall be such that two aircraft are still resolvable at the time of display.

6.4.3 **2D Resolution** [Example parameters. Range resolution, Azimuth resolution]

The system shall be able to resolve two targets having the maximum horizontal position error at any time.

**NOTE 1:** Although perfect resolution is desired, the actual resolution achievable is limited by the capability of the surveillance technique being used. However, two aircraft with a maximum horizontal position error shall be resolvable as 2 targets on display. This is a balance between the practically achievable resolution and the maximum horizontal distance error that 2 aircraft could have in reality (i.e. half the **separation distance**).

**NOTE 2:** Resolution of techniques such as ADS-B and Multilateration depends on the positional accuracy of the system whereas the resolution of a conventional rotating radar system is typically determined by its pulse width (range resolution) and beam width (azimuth resolution).

6.4.4 **Continuity**

The system continuity shall be assessed and justified for the intended application.

6.4.5 **Reliability**

6.4.5.1 The reliability of the surveillance sensor shall be defined and justified.

6.4.5.2 The expected reliability either from theoretical analysis or a practical trial shall be demonstrated (508).

6.4.5.3 This reliability assessment shall extend to the power supplies and landlines (509).

6.4.5.4 The reliability analysis shall be combined with a hazard analysis to produce a functionally based reliability analysis (510).

#### 6.4.6 **Availability**

6.4.6.1 The factors affecting the availability of the surveillance system suitable to provide service shall be identified.

6.4.6.2 The redundancy mechanisms shall be identified. The ANSP shall ensure that safety is not compromised during system unavailability or redundancy.

6.4.7 **Latency** [e.g. the delay from the detection of a data item to the provision of that item to the display system]

The ANSP shall ensure that the system latency is such that the accuracy of the required data items have not degraded to be unsuitable to use at the time the surveillance data items are used for the intended application.

6.4.8 **System Integrity** [e.g. undetected incorrect altitude code, undetected incorrect aircraft identification]

6.4.8.1 The system shall be capable of achieving the operationally required level of integrity.

6.4.8.2 Techniques such as Failure Modes and Effects Analysis (FMEA) shall identify the possible system integrity failures and their effects on the system performance.

6.4.9 **Data Integrity** [e.g. Navigation Integrity Category (NIC), number of incorrect aircraft identifications]

6.4.9.1 The equipment shall contain error detection processes to ensure appropriate data integrity during operation.

6.4.9.2 Where processes are employed in the ground system to determine corruption of data these shall be identified and the tolerable rate of undetected errors shall be assessed.

6.4.10 **Coverage** [e.g. probability of detection, the percentage of actual detections compared to expected detections]

6.4.10.1 The required coverage volume in which the selected application will be provided shall be defined (i.e. both horizontal and vertical limits).

6.4.10.2 For the intended application, the acceptable number of aircraft as a percentage of the total number of aircraft in the coverage volume required to be detected and displayed at any update during the operation shall be defined and justified depending on the aircraft equipage and the type of surveillance techniques used in the operational context.

6.4.10.3 Probability of detection shall be defined for the intended application. The probability of detection shall meet the operational requirement throughout the required coverage volume, i.e. up to the maximum range and at all operational altitudes.

6.4.10.4 If areas with lower than required probability of detection are identified, the ANSP shall clearly identify such areas, and measures for safe operation of aircraft within such areas shall be justified.

6.4.10.5 Where services are provided in airspace where carriage of a transponder is mandatory for all aircraft, the co-operative surveillance system shall be capable of exceeding 97% probability of detection.

6.4.10.6 **Recommendation:** Probability of detection should be at least 90% for conventional radars and exceed 97% for Monopulse and Mode S radars and other co-operative techniques.

6.4.11 **False targets** [e.g. density of false targets, rate of false targets, number of false tracks per hour]

6.4.11.1 The presence of false targets and targets exceeding the maximum allowable horizontal position error displayed at any update shall be assessed and the maximum criteria shall be defined and justified for the intended operation.

**NOTE:** The criteria shall include the false targets including, clutter, reflections and erroneous targets exceeding maximum allowable positional error affected on all co-operative and non-co-operative techniques being used.

6.4.11.2 **Recommendation:** Within any one update, the false target count should be less than 2% of the total target count.

## 7 Application Specific Guidance on Performance Requirements

### 7.1 Separation

7.1.1 Co-operative surveillance systems supporting the separation application shall provide horizontal position, pressure altitude and the identity (aircraft identification or Mode A code) as a minimum.

7.1.2 The pressure altitude reported to the surveillance data user shall be the most recent pressure altitude received from the aircraft.

7.1.3 Maximum horizontal position error shall be less than half of the chosen separation minimum minus a specified safety buffer.

**NOTE:** This is the maximum error. Other horizontal position accuracy requirements are applicable depending on the actual separation used. See below.

7.1.4 **Recommendation:** Surveillance systems supporting separation applications should provide ground speed and track information of the aircraft.

### 7.2 Performance Requirements for 3 NM/5 NM Separation Application

7.2.1 Surveillance Performance criteria have been developed by Eurocontrol for 3 NM and 5 NM applications for both co-operative and non-co-operative surveillance techniques.

7.2.2 The values in the following specification may be used as guidance by ANSPs. This document will be updated as new standards are developed by ICAO or European bodies such as EASA or Eurocontrol.

7.2.3 The ATM Surveillance System Performance Specification is available at:

[www.eurocontrol.int/documents/eurocontrol-specification-atm-surveillance-system-performance](http://www.eurocontrol.int/documents/eurocontrol-specification-atm-surveillance-system-performance)

## 8 Radio Frequency Characteristics

### 8.1 Interference

- 8.1.1 Existing services have operating priority. The existing electromagnetic environment in which the equipment is to operate shall be assessed to ensure that the proposed equipment will comply with all requirements (360).

**NOTE:** If, after installation, a new service experiences/creates interference from/to an existing service, modification of the new service must normally take place. The only exceptions are if the other service voluntarily agrees to change, or is in itself deficient and was installed after EMC Directive 89/336 (now replaced by Directive 2004/108/EC) or the Radio and Telecommunication Terminal Equipment (R&TTE) Directive 1999/5/EC came into force.

- 8.1.2 Ground-based transmitters shall be subject to spectrum protection requirements stated in Article 5 of the SPI IR (referred in SUR 02 paragraph 5.1) and compliant with the R&TTE Directive.

- 8.1.3 Where ANSPs have reasonable evidence to believe that their air traffic surveillance systems are subject to interference effects, the ANSP shall inform the relevant SRG Regional Inspectorate.

- 8.1.4 ANSPs operating 1030 MHz interrogators (e.g. SSR or MLAT) shall ensure that any 1030 MHz transmitter they operate transmits in accordance with National IFF/SSR Committee (NISC) requirements published in CAP 761 Operation of IFF/SSR Interrogators in the UK: Planning Principles and Procedures ([www.caa.co.uk/cap761](http://www.caa.co.uk/cap761)) and the conditions of the NISC Certificate issued for the relevant interrogator.

**NOTE:** National aircraft equipment requirements are published in AIP GEN 1.5 Aircraft Instruments, Equipment and Flight Documents.

### 8.2 Frequency Stability of Transmitters, Receivers and Transceivers

- 8.2.1 The surveillance system frequency stability shall be sufficient and within tolerance over the expected temperature range and variation in voltage.

### 8.3 Transmitter Output Power

- 8.3.1 Transmitter Output Power shall be tested and verified during commissioning of the system.
- 8.3.2 The transmitter output power budget shall be sufficient to achieve the required probability of detection throughout the required area of coverage.

### 8.4 Transmitter Unwanted Emissions

- 8.4.1 Unwanted transmitter emissions shall be minimised and be within applicable statutory limits.

**NOTE:** Transmitter unwanted emissions include out-of band emissions, spurious emissions, and harmonics.

## 8.5 Reducing Spurious Returns

8.5.1 All spurious return reduction techniques shall be defined and justified (363).

**NOTE:** Spurious returns include clutter, garble, spurious reflections etc.

## 8.6 Bandwidth

8.6.1 The bandwidth required shall be justified (356).

**NOTE:** A theoretical or practical evaluation of the frequency components of the output pulse could take the form of a Fourier transform of the theoretical output waveforms or a practical trial based on a spectrum analysis. In either case the evaluation should include the effects of tolerances on pulse spacing and duration and system non-linearity.

8.6.2 The equipment shall generate the output pulse patterns to minimise the bandwidth required (357).

8.6.3 The emission classification as defined in the ITU Radio Regulations Article 4 shall be stated (358)

## 9 Siting Requirements

### 9.1 Site Safeguarding

Refer to the Technical Safeguarding section, CAP 670 Part B Section 4, for appropriate guidance.

### 9.2 Site Restrictions

Access to the surveillance system and associated equipment shall be restricted such that the availability of the Air Traffic Service is not compromised accidentally or otherwise (340).

### 9.3 Aerial Support Structure

9.3.1 The stability of the aerial tower affects the system performance, especially clutter reduction and return position accuracy. The aerial stability limits allocated to the tower shall be justified (341) for sensors requiring an aerial support structure.

9.3.2 An analysis of the tower structure must show that limits are met at the stated operating wind speed and ice loading (342).

## 10 Surveillance Data Processing System Requirements (SDPS)

10.1 Processing equipment shall be able to handle the specified ground station capacity (i.e. the maximum number of targets expected to be processed at any given time).

10.2 The processing system shall not introduce excessive delay between detection and display.

10.3 The surveillance data processing and transmission chain shall not corrupt surveillance data items that are sourced from aircraft systems. Such data items include:

- a) Pressure-Altitude (also Barometric Altitude);
- b) Aircraft Identity (e.g. Mode A Code; Aircraft Identification);

- c) Special aircraft identification data (e.g. SSR Special Position Identification [SPI]);
- d) Data indicating emergency conditions;
- e) Other Mode S Enhanced Surveillance Parameters; and
- f) Surveillance Capability information.

10.4 The tolerable frequency of corruption of aircraft sourced data items shall be derived based on a safety assessment of the significance of the data items to the application.

10.5 The surveillance data processor shall not cause loss or corruption of data.

## 11 Environmental Conditions

11.1 The design and testing regime shall demonstrate that the equipment operates as required in the chosen environment (345).

11.2 **Recommendation:** All surveillance transmission equipment should be located in a controlled environment with appropriate heat dissipation and dust control (346).

## 12 Interoperability of Surveillance Systems

12.1 Any surveillance interrogator/receiver system using 1030 and 1090 MHz RF band shall comply with the power, spectrum, protocols and formats defined in relevant parts of ICAO Annex 10 Volume 4, Chapters 2, 3, 5 and 6, and Volume 3, Chapter 5 as applicable.

12.2 Surveillance systems shall be subject to Interoperability Requirements in Article 5 of the SES Surveillance Interoperability Implementing Rule referred in SUR 02 paragraph 5.1.

**NOTE:** Interoperability, in the context of surveillance systems, represents the ability of a local and a remote surveillance sub-system to inter-operate between each other which may be between the ground system and the aircraft transponder or another ground surveillance sub-system.

## 13 Performance Monitoring - Remote Control and Monitoring System (RCMS)

13.1 Annex 11 to the International Convention on Civil Aviation requires that a procedure be in place that informs ATS units of the operational status of the equipment used for controlling take-off, departure and approach to land. The system shall report any failures that will put restrictions on the performance or abilities of the equipment (499). How the system achieves this shall be defined and justified (500).

**NOTE:** An electronic system or a procedural reporting method from the maintenance department or to ATC can be used.

13.2 If a failure of a sub-system occurs, the remote control and monitoring system or the manual reporting system shall maintain a record of the event (501).

13.3 The RCMS information required depends on the configuration, and the ATS provider's intention to provide service in reduced redundancy. However, the following minimum information shall be available:

- a) An indication of present operating configuration (503); and
- b) An indication of unavailable sub-systems (504).

- 13.4 The RCMS shall enable the operator to select the correct course of action. The intended operating procedures shall be submitted for approval (505).
- 13.5 Any configuration changes undertaken by remote control shall not conflict with local control (506).

#### **14 Effect of Adjacent Band Spectrum Utilisation**

- 14.1 The operational impact of interference from the adjacent frequency spectrum band shall be assessed.
- 14.2 The surveillance performance required for the intended application shall not be compromised by the effects of interference or the mitigation mechanisms employed.

**NOTE:** The frequency band 2500 MHz to 2690 MHz is likely to become increasingly occupied by mobile communications transmissions in the future following a UK spectrum award and is adjacent to the Primary frequency band 2700 MHz to 3100 MHz (10 cm).

#### **15 Effects of Wind Turbines on Surveillance Systems**

- 15.1 Where the presence of wind turbines has an operational impact on surveillance systems, suitable mitigation mechanisms shall be applied such that any risks associated with the wind turbine effects are mitigated to an acceptable level.
- 15.2 The chosen mitigation solutions shall not compromise the surveillance performance required for the intended application.
- 15.3 Where the solutions involve changes to the surveillance data processing systems or processing data from multiple surveillance sensors, the additional processing mechanisms shall not cause a system overloading or an unacceptable processing delay.

## **SUR 03 Requirements for Surveillance Data Transmission Links and Systems Using Combined Surveillance Data**

### **Part 1 Preliminary Material**

#### **1 Introduction**

- 1.1 It is often necessary to combine the surveillance data from multiple surveillance sensors to obtain a complete surveillance picture suitable for the intended application. Certain co-operative ground based surveillance techniques require implementation of many receivers to obtain surveillance capability over the full coverage. It is also often the case that combination of surveillance data from a co-operative surveillance technique and a non-co-operative technique is necessary to ensure that all types of targets are displayed.

#### **2 Scope**

- 2.1 The requirements set in this document apply to surveillance data transmission links (e.g. Copper cable, Fibre optics, RF links, satellite links) from remote or local sensors that provide surveillance data feeds to the data processing systems. It also contains requirements where surveillance data from multiple sensors are used in a combined manner to provide the required surveillance data on the display for the provision of air traffic services.

## Part 2 Requirements

### 3 Requirements for Surveillance Data Transmission Links

- 3.1 The local or remote surveillance data feed shall provide complete and uncorrupted data such that the safety of the Air Traffic Service utilising it is not compromised (1718).
- 3.2 **Recommendation:** Duplicate data transmission links should be implemented to increase the availability where possible (784).
- 3.3 Where radio links (RF links) are used, the 'line of sight' path of the link shall be safeguarded (786).
- 3.4 **Recommendation:** Radio links should not cross active runways, taxi-ways, railways or roadways. This is due to the change of path characteristics in the presence of aircraft or large service vehicles (787).
- 3.5 **The Data Transmission Link performance**
- 3.5.1 The performance characteristics of the data transmission link shall be capable of meeting the overall performance requirements necessary for the intended application.
- 3.5.2 The suitability of the link shall be assessed against the operational requirement (775) and shall include the following aspects:
- Link integrity and effects of interference (776);
  - Link data rate and capacity (777);
  - Link distortion and effect on accuracy (778);
  - Link delay (latency) (779);
  - Link reliability (780);
  - Link availability and continuity; and
  - Data resolution on link (781).
- 3.5.3 The actual performance as regards bit rate, bit error rate, transmission delay and availability shall be defined and justified when compared with the required acceptable performance in the Operational Requirement (782).
- 3.5.4 The effects of pick-up of false signals including radio frequency interference, magnetic and electrostatic fields shall be determined (789).
- 3.5.5 The link bandwidth shall be determined and shown that it has sufficient capability of transmitting the data required to satisfy the OR (800).
- 3.5.6 The worst case data delay through the system shall be defined and be justified as being acceptable (802).

## **4 Requirements for Exchange of Surveillance Data between ANSPs/CNS Providers**

### **4.1 Unavailability of Surveillance Feeds Supplied by Third Parties**

4.1.1 Where surveillance data is received by a remote supplier, procedures shall be in place that require the remote supplier of surveillance data to supply details to the recipient of any maintenance or planned outages of the source surveillance system that may affect the supplied data (794). Any changes shall be assessed formally to determine the effect on the OR (795).

4.1.2 If such changes to remote surveillance feeds results in the failure to deliver the required data items and/or the required performance as per the OR, the relevant CAA inspector shall be informed of the change.

### **4.2 Formal Arrangements between ANSPs/CNS Providers**

4.2.1 ANSPs or CNS providers exchanging surveillance data with an ANSP shall establish formal arrangements between them as per the requirements set in Article 5(2) of the SPI IR referred to in SUR 01 paragraph 4.1.

### **4.3 Requirements for the Exchanged Surveillance Data Feeds**

4.3.1 Exchange of surveillance data shall be performed in accordance with regulations stated in Article 5(1) of the SES Surveillance Interoperability Implementing Rule referred in SUR 02 section 5.1.

4.3.2 **Recommendation:** All Purpose Structured Eurocontrol SuRveillance Information Exchange (ASTERIX) format is recommended for data interchange (483).

4.3.3 Correct operation of all data transformations shall be tested under all data formats used (796).

### **4.4 Alerts and Indications of Surveillance Data Supplied to a Third Party**

4.4.1 **Recommendation:** The equipment should send to the remote user all data link fault reports and warnings that are sent to the local user (793).

**NOTE:** This includes the status of the data transmission link equipment and the status of the surveillance sensor providing the surveillance information.

## **5 Combined Surveillance Data from Multiple Surveillance Systems**

### **5.1 Co-mounted PSR and SSR Systems**

5.1.1 Where co-mounted PSR and the SSR antenna systems are used to obtain combined target reports, the PSR and the SSR antennas shall be electrically aligned in azimuth with respect to one another either using a computer based plot analysis system or RFMs.

**NOTE:** The PSR active reflectors, PSR permanent echoes (PE), or the SSR remote field monitor may be used as the alignment reference depending on whichever system with greater accuracy of geographic alignment.

- 5.1.2 **Recommendation:** The radar should be aligned with geographical north within 0.1 degree.
- 5.1.3 In a shared coverage volume of a co-mounted PSR and SSR, the combination rate of target reports shall be suitable to meet the operational requirement.
- 5.1.4 All radar sensors providing data for combined use of surveillance data shall be correctly geographically aligned.
- 5.1.5 Where the PSR active reflectors, PSR PEs or SSR Remote Field Monitors are used as an on-going performance verification technique in a combined PSR/SSR system, appropriate monitoring mechanisms shall still be in place during PSR or SSR unavailability for alignment checking purposes.
- 5.2 **Requirements for Systems used for Combining Surveillance Data from Multiple Feeds**
- 5.2.1 The following requirements shall be met as a minimum by systems such as Plot Assigner Combiners and Multi Radar Tracking Systems that use multiple feeds for the integration of surveillance data.
- 5.2.2 The individual surveillance data feeds used for the combination process shall be defined including the following elements:
- a) Update rate of individual data feed;
  - b) Surveillance data formats before combining;
  - c) Data items provided by each feed;
  - d) The position information output format (e.g. range and azimuth) and the reference point for each feed;
  - e) Accuracy and resolution of each feed; and
  - f) Surveillance coverage provided by each feed.
- 5.2.3 The update rate of each feed shall be justified to the required update period output by the system.
- 5.2.4 Where feeds from radars (PSR or SSR) located at separate locations are combined, the methodology for slant range correction and azimuth accuracy of the combined positional data shall be justified.
- NOTE:** If two 2D radars are not co-mounted, there will be a difference in their slant range measurement of the same target. Unless altitude information of the target is available this slant range error cannot be corrected.
- 5.2.5 The output format of positional information of the combined feed shall be defined with the relevant reference point.
- 5.2.5 The methodology for the integration of positional information from different sources to obtain the positional information of the combined position in the format desired shall be clearly defined.

5.2.6 In multi-radar tracking systems where many surveillance sources are used to form a track of a single aircraft, the following shall be tested for all data feeds and combination scenarios to be used:

- Track discontinuities;
- Track jumps;
- Track deviations;
- Split Tracks; and
- False tracks.

5.2.7 The likely wind turbine interference effects or interference of adjacent bands on each individual surveillance source shall be assessed and justified.

### 5.3 Loss of Individual Surveillance Feeds

5.3.1 The impact of the loss of individual surveillance feed on the accuracy and the ability to provide surveillance data to meet the operational requirement shall be assessed.

**NOTE:** Loss of one or more feeds used for combining surveillance data may have an impact in terms of accuracy, coverage, and tracking capability.

5.3.2 Where it is necessary to use surveillance data from multiple surveillance sensors for the continued service provision, the strategy for continued operation including any back up plans in the event of unavailability of a sensor shall be defined and justified.

5.3.3 Where the unavailability of one or more surveillance data chain(s) results in reduced service levels, or providing procedural service, procedures shall be in place for the safe handling of traffic during the transition period.

### 5.4 Performance Monitoring

5.4.1 The system shall be capable of detecting an overload situation on the links (798).

5.4.2 The system shall provide information that allows the display or other system to advise the controller of this situation (799).

5.4.3 **Recommendation:** Error detection and correction algorithms should be used to check for data corruption (791).

5.4.4 The system shall provide warning indications for line loss and system status (792).

5.4.5 Where radar and other type of surveillance techniques are used (e.g. PSR and MLAT) to derive combined target reports, the system shall not be entirely reliant on the availability of either the radar or the other surveillance technique for ongoing performance verification, during unavailability of one system.

5.4.6 The performance monitoring methods shall be defined and justified.

## **6 Using an Additional Surveillance Data Feed as a Redundant Feed**

- 6.1 Where a surveillance data feed is used as a means of redundancy in order to provide continued service in the unavailability of the main surveillance data sources, the back-up feed shall meet the data transmission link requirements listed in paragraph 3 above.
- 6.2 The performance of the redundant feed shall meet the operational requirements of the service provided under reduced redundancy.
- 6.3 The unavailability of a redundant feed used as described above shall not impede continued provision of service using main surveillance data feeds and shall have no safety impact.

**NOTE:** If the unavailability of a surveillance data feed has an impact on the service provision within the required coverage area, this has to be identified in the safety assessment process by means of a safety requirement.

## **SUR04 Requirements for Primary Radar Systems**

### **Part 1 Preliminary Material**

#### **1 Introduction**

Primary Surveillance radar is the most widely used non-co-operative surveillance technique for Civil Air traffic Service applications in the UK. This document sets out safety and performance requirements applicable to such systems.

#### **2 Scope**

The requirements identified in this document are applicable to all PSR sensors that provide surveillance data for ATS services.

## Part 2 Requirements

### 1 Transmitter Requirements

#### 1.1 Primary Frequency Bands

1.1.1 The following bands shall be used (347):

- a) 1215 MHz to 1350 MHz (23 cm) medium/long range radar services;
- b) 2700 MHz to 3100 MHz (10 cm) short/medium range radar services;
- c) 9000 MHz to 9200 MHz and 9300 MHz to 9500 MHz (3 cm) short range radar services such as SMR;
- d) 15.4 GHz to 15.7 GHz (GMR) very short range radar services; and
- e) 34.5 GHz to 35.5 GHz (ASMI) very short range radar services.

#### 1.2 Primary Frequency Tolerance

1.2.1 The following stability tolerances shall be applied (348):

- a) Frequency Band Stability Tolerance 590 MHz–1365 MHz within 500 ppm
- b) 2700 MHz–9500 MHz within 1250 ppm
- c) GHz–35.5 GHz within 5000 ppm

#### 1.3 Frequency Characteristics

For Primary radar, the level of any spurious component shall be either 50 dB down on the mean power in bandwidth or less than 20 dBm (100 mW), whichever results in the least spurious output (355).

### 2 Siting Requirements for PSR

2.1 Local site obstructions shall be shown to be acceptable for the required coverage (337).

2.2 **Recommendation:** This should be provided by a 360 degree representation giving the elevation (in degrees) of any obstruction versus bearing and a 'line of sight' coverage chart for several target heights based on these radar obstructions and using the Radar earth curvature (338).

### 3 Performance of PSR systems

3.1 The required performance of the PSR system shall be specified.

**NOTE:** The performance of a PSR system is dependent on the operational requirement. The safety related performance requirements should be derived based on a risk assessment process. Typical performance requirements of a PSR can be found in the ICAO Doc 8071 Volume 3 - Testing of surveillance radar systems.

## **4 Performance Monitoring of PSR**

### **4.1 Geographic Alignment**

4.1.1 All PSR systems shall have methods to determine the correct geographical alignment (490).

4.1.2 The method of alignment checking, reference points, and the direction to which the system is aligned (e.g. true north) shall be specified.

**NOTE:** More information on the methods of PSR alignment checking can be found in ICAO Doc 8071 Volume 3, Testing of Surveillance Radar Systems.

### **4.1.3 Alignment Checking of the Analogue PSR Systems**

4.1.3.1 For an analogue primary radar, the system shall use appropriate video outputs to check the range/bearing error based on Permanent Echoes (PE) (491).

4.1.3.2 The controller or maintenance engineer shall check the error against established tolerances at suitable intervals (492).

4.1.3.3 The system shall identify at least one PE in the operational coverage area (493).

**NOTE:** It is recommended to have more than one PE. Where more than 1 PE is used each PE must be 60° separated from each one:

- a) Each PE must be located at a range greater than one third of the standard display range (494).
- b) In addition the separation of each PE from other permanent features must be at least 3 degrees in azimuth and  $\pm 0.5$  nautical mile in range (495).
- c) Each PE should not extend over more than 2 degrees of bearing (828).

### **4.1.4 Alignment checking of the Plot Extracted PSR systems**

4.1.4.1 For a plot extracted primary radar, one of the following shall be provided for alignment checking purposes:

- a) A raw radar feed for calibration purposes. This feed shall be independently aligned with the processed radar feed (532).
- b) A PSR active reflector to give a test target (MTI Marker) (533).
- c) Areas of radar coverage which are inhibited from processing to enable a PE to be displayed (534).
- d) For a PSR used in conjunction with a co-mounted SSR, a procedure in place to determine the collimation error between the Primary and Secondary data. This can either be achieved by ATC operator checks or equipment monitoring.

### **4.2 Measuring On-going System Performance**

4.2.1 Any methods used for the pre-operational evaluation of performance and on-going performance measurement of the PSR shall be specified (e.g. Built in test methods) along with the parameters (e.g. receiver noise level, transmitter output power) subject to monitoring.

4.3.2 The performance monitoring of the PSR shall be carried out at sufficiently frequent intervals.

## **5 Requirements for PSR and Markers used for Surveillance Radar Approaches**

### **5.1 Update Period**

5.1.1 A primary radar providing the positional data for the following SRAs shall rotate at the following effective minimum turning rates:

- a) SRA terminating at 2 NM from touchdown point, a rotation rate of 10 RPM (453);
- b) SRA terminating at 1 NM from touchdown point, a rotation rate of 15 RPM (454);
- c) SRA terminating at 0.5 NM or less from touchdown point, a rotation rate of 20 RPM (455).

**NOTE 1:** Touchdown Point: The point on the runway where it is intended for an approaching aircraft following visual or navigational guidance to intersect the runway surface. This may be the point of the intersection of the glide path with the runway; the point of intersection of the PAPI with the runway; or the point on the runway where a visual indication in the form of an Aiming Point (CAP 168) has been painted.

**NOTE 2:** The reference point used for the displayed distances shall be consistent with the distance reference point used in SRA procedures. (e.g. In certain airfields the SRA distances may be measured with respect to the runway threshold).

### **5.2 Coverage**

5.2.1 The radar coverage shall be suitable for the SRA termination distance.

### **5.3 Accuracy**

5.3.1 When used for surveillance radar approach (SRA) purpose, the accuracy of the range and bearing information of the target shall be as follows:

- a) The accuracy of the bearing shall be within a maximum of 1 degree of true bearing;
- b) The range accuracy shall be within 55m + 5% of target range of the true target position.

### **5.4 Marker Requirements for SRA**

5.4.1 When PSR is used for Surveillance Radar Approaches (SRA) with a termination range of less than 2 NM, an appropriate configuration of fixed returns or markers (active test targets/MTI marker) shall be used to confirm the correct position of the SRA approach line.

5.4.2 The marker configuration shall allow the controllers to confirm the correct position of the SRA approach line.

**5.4.3 SRA with a Termination Range of between less than 2 NM and 1 NM from Touchdown Point**

- a) Centreline markers shall be provided.
- b) There is no requirement for bracket markers for SRAs with a termination range of 1NM or more from touchdown point.

**5.4.4 SRA with a Termination Range of less than 1 NM from Touchdown Point**

- a) A set of bracket markers (543):
  - There shall be two permanent markers available that enable the identification of runway touchdown point (544);
  - These permanent markers shall be positioned equidistant from the runway centreline at the instrument touchdown point (545);
  - The distance from the runway edge shall be the minimum commensurate with runway operations but not closer than 15 m from the runway edge (546);
  - Any installation near the runway shall comply with the Obstacle Limitations defined in CAP 168.
- b) A set of Centreline markers (538):
  - There shall be two non-permanent markers available (539);
  - These shall be located as follows:
    - Within 2 degrees of the applicable approach centreline (540);
    - Between 3 and 6 NM of the applicable touchdown point (541);
    - Not within 1 NM of each other (542).

**NOTE:** For airports with reciprocal approaches, one permanent marker on each approach path may be used.

## **SUR05 Requirements for Secondary Radar Systems**

### **Part 1 Preliminary Material**

#### **1 Introduction**

- 1.1 Secondary Surveillance Radars are the most widely used conventional technique of co-operative surveillance used for Air Traffic Service Applications. SSR systems can be either Mode A/C capable or a Mode S capable system and ICAO have developed SARPS to standardise the use of both Mode A/C and Mode S capable SSR systems. SSR can also be used as a data link for communication between aircraft and ground systems, and SSR signals are also used in other surveillance techniques such as MLAT and ADS-B.

#### **2 Scope**

- 2.1 This document sets the safety and performance requirements for various aspects of SSR systems that provide surveillance data for the ATS, such as sensor performance, monitoring and implementation.

## Part 2 Requirements

### 3 SARPS Compliance

In addition to the requirements below, Secondary Surveillance Radar (SSR) systems, including Mode S surveillance systems shall comply with the Standards and Recommended Practices (SARPs) in ICAO Annex 10, Volume IV Chapters 2 and 3.

**NOTE:** Where the UK has differences filed to SARPs, these will be published in Supplements to the Annexes and in the UK AIP.

### 4 SSR Frequency Requirements

4.1 All SSR systems of Mode A, C and S shall use the 1030 MHz as carrier frequency of the interrogation and control transmissions.

4.2 The carrier frequency of the reply transmission shall be 1 090 MHz.

### 5 Requirements for SSR systems with Mode A and Mode C capability

5.1 SSR systems having Mode A and Mode C capability shall comply with the frequency requirements, polarisation, interrogator modes and transmission characteristics mentioned in ICAO Annex 10 Volume 4 Chapter 3, sections 3.1.1.1 to 3.1.1.5 and 3.1.1.8 to 3.1.1.11.

### 6 Requirements for SSR systems with Mode S capability

6.1 SSR systems having Mode S capability shall comply with the frequency requirements and transmission characteristics mentioned in ICAO Annex 10 Volume 4 Chapter 3, section 3.12, and Mode S air-ground data link requirements in Volume 3 Chapter 5.

6.2 All Mode S systems shall also meet compliance with the applicable sections of Commission Regulation (EC) No. 262/2009 laying down requirements for the co-ordinated allocation and use of Mode S interrogator codes for the Single European Sky.

6.3 SSR interrogators shall be configured to be complied with the requirements and conditions set in the NISC certificate to operate SSR interrogators in the UK. For further details refer to CAP 761 ([www.caa.co.uk/CAP761](http://www.caa.co.uk/CAP761)).

### 7 Performance Monitoring of SSR

#### 7.1 Alignment Checking

7.1.1 All SSR radar systems shall have methods available to determine the correct geographic alignment.

7.1.2 The method of alignment checking, reference points, and the direction to which the system is aligned (e.g. true north) shall be specified.

7.1.3 **Recommendation:** There should be at least one Remote Field Monitor (RFM) to align radar azimuth reference and for integrity monitoring.

## 7.2 General On-going performance Monitoring

7.2.1 As per ICAO Annex 10 Volume 4 Chapter 3, section 3.1.1.10.1, the range and azimuth accuracy of the ground interrogator shall be monitored at sufficiently frequent intervals to ensure system integrity.

7.2.2 Methods used for the pre-operational evaluation of performance and on-going performance measurement of the SSR shall be specified (e.g. Built in test methods, RFM) along with the parameters (e.g. receiver noise level, transmitter output power) subject to monitoring.

### 7.2.3 Receiver Monitoring

7.2.3.1 Receiver sensitivity shall be continuously monitored.

7.2.3.2 **Recommendation:** in receiver systems that employ monopulse and/or RSLs techniques, the sensitivity of all channels should be monitored.

### 7.2.4 Interrogator monitoring

7.2.4.1 The following interrogator characteristics shall be monitored on a continuous or a periodic basis for compliance with the limits specified in ICAO annex 10 Volume 4 Chapter 3:

- a) Pulse Intervals;
- b) Interrogator relative radiated pulse levels;
- c) Interrogator radio frequency;
- d) Interrogator pulse duration;
- e) Radiated Power; and
- f) Spurious radiation.

7.2.4.2 The methods of monitoring shall indicate of any fault of the monitored parameters and the failure of the monitoring equipment itself.

7.2.4.3 **Recommendation:** For Mode S systems, a test target generator should be used in addition to the test transponder to input test video signals to the Mode S system for simulating replies from Mode S equipped aircraft.

## 7.3 Using a Remote Field Monitor (RFM)

7.3.1 All SSR systems shall have a RFM for performance monitoring purposes (522).

7.3.2 The RFM shall have selectable range offset capability.

7.3.3 **Recommendation:** The Mode S RFM used for performance monitoring should be capable of verifying (Refer to ICAO Doc 8071 Volume 3 Manual of Testing Radio Navigation Aids):

- a) Loop tests for all modes of operation used by the interrogator;
- b) Mode A/C surveillance –mode A/C only all-call interrogations;
- c) Successful lock-out transmission;
- d) Reply delay;
- e) Transmitter power;

- f) Continuous wave inhibitor (failure of a continuous transmission of 1090 signal);
- g) Variable minimum Triggering Level;
- h) The ability of the sensor to correctly deliver and receive a Standard Length message;
- i) The ability of the sensor to correctly deliver and receive an Extended Length message;
- j) That Mode A code change is correctly processed by the sensor;
- k) Downlink capability report announcement;
- l) Flight ID change; and
- m) The sensor is working with the correct II/Si codes assigned.

7.3.4 The RFM shall not generate acquisition squitters to eliminate it being acquired by an ACAS unit.

7.3.5 The RFM shall be used by the SSR equipment to continuously monitor those radar parameters which affect detection performance, accuracy or resolution (523)

**NOTE:** This includes parameters such as the following:

- a) Target bearing;
- b) Target range;
- c) Peak power;
- d) Side Lobe Suppression; and
- e) Pulse spacing.

7.3.6 The RFM shall provide accurate reference information to test the transmission, reception and de-coding characteristics of the SSR service in conjunction with the range and azimuth accuracy of the ground interrogator (1710).

#### 7.4 RFM Siting Requirements

7.4.1 The positioning of the RFM will depend on the use of the equipment.

7.4.2 **Recommendation:** Where the controller uses the RFM to assess alignment, the RFM should be sited within the range that the controllers can view. The bearing chosen should correspond to an area of airspace commensurate with the operational situation; the position should not conflict with operationally sensitive areas (524).

**NOTE:** This does not imply that the controller should continuously check the position, but that a suitable Radar Display range setting should be available to the controller to view the RFM.

7.4.3 **Recommendation:** Where an equipment sub-system, under the control of the user, uses the RFM to monitor and assess alignment errors, the RFM shall be within the nominal coverage of the radar. If the equipment sub-system is not monitored directly by the controller, a reporting procedure shall be in place (525).

7.4.4 **Recommendation:** Where a sub-system, not under the control of the user, uses the RFM to monitor and assess alignment errors, the RFM should be within the nominal coverage of the radar. If the RFM position is outside the normal defined area displayed to the remote controller, a reporting procedure should be in place. This procedure should report alarms from the system provider to the service user. The originator of the service, not the remote

user, should identify and notify the remote users of any alignment errors determined (526).

7.4.5 **Recommendation:** The RFM should be located at a range in accordance with manufacturers' requirements.

7.4.6 The monitor shall not be visible from any other operational radar service (528). Where this is not possible a written agreement to the installation shall be obtained from the owners of the affected systems (529).

7.4.7 The Mode A code for the SSR RFM shall be 7777 unless stated otherwise in the SSR approval certificate.

## 8 **SSR performance**

8.1 For all SSR systems, the following performance requirements shall be stated in addition to the generic performance requirements mentioned in SUR 02 of this document. The recommended criteria shall be assessed for suitability for the operational requirement.

### 8.1.1 **Range and Azimuth accuracy**

**Recommendation:** For en-route separation, SSR systems should have a standard deviation of 250 m for range accuracy and 0.15 degrees for azimuth accuracy.

### 8.1.2 **Missing or Invalid Identity and Pressure Altitude Data**

**Recommendation:** The missing or invalid Identity and Pressure Altitude Data should be less than 5% probability in any one scan.

### 8.1.3 **Reports with corrupted Identity and Pressure Altitude Data**

**Recommendation:** Reports with corrupted identity and pressure altitude information should occur with less than 2% probability at any one scan.

### 8.1.4 **False targets**

**Recommendation:** In a full SSR Mode S environment there should be no persistent false targets.

## **SUR06 Requirements for Multilateration Systems**

### **Part 1 Preliminary Material**

#### **1 Introduction**

- 1.1 Multilateration is a form of co-operative and independent surveillance system like SSR. Multilateration (MLAT) systems use the time difference of arrival (TDOA) of the existing 1090 MHz transmissions from aircraft, between several ground receivers to determine the position of the aircraft. An MLAT system can be active, passive or both.
- 1.2 Standards have already been specified for the existing 1090 MHz and 1030 MHz transmissions in ICAO SARPS Annex 10 Volume 4, hence derivation of further Standards will not be pursued with respect to them. However setting requirements for MLAT systems is necessary to ensure that the MLAT systems are compatible with the existing systems, formats and protocols.
- 1.3 This document sets national regulatory requirements specific for MLAT systems.

#### **2 Scope**

- 2.1 The requirements in this document apply to all MLAT systems in general. However application specific guidance is provided where possible.
- 2.2 The Generic requirements in SUR 02 are applicable to all systems including MLAT. The requirements and guidance included in this document are specific to multilateration system implementations. Although multilateration can be applied to many signal types transmitted by aircraft, this document refers to multilateration using 1090 MHz signals.

## Part 2 Requirements

### 3 ICAO SARPS

In addition to the requirements below, all Multilateration systems shall comply with the Standards and Recommended Practices (SARPs) in ICAO Annex 10, Volume 4 Chapter 6.

### 4 Performance Requirements

- 4.1 MLAT systems used for air traffic surveillance shall have performance to meet the Required Surveillance Performance defined for the operational services supported.
- 4.2 Where the MLAT system is used as a replacement to radar, the MLAT system shall meet at least the same performance criteria met by the radar system subject to replacement.

### 5 Active MLAT System Transmitter Requirements

- 5.1 The interrogator capability shall be identified and justified with respect to the current and planned aircraft equipage requirements.
- 5.2 **Recommendation:** Measures should be taken to minimise the effect of active MLAT operation on the 1030/1090 MHz radio frequency environment.
- 5.3 Selective interrogations from multilateration systems shall not set “lockout” on any targets.
- 5.4 The Interrogation rate shall be configurable depending on the operational requirement.
- 5.5 All interrogation types used by the MLAT system shall be defined.
- 5.6 All active MLAT systems must transmit in accordance with National IFF/SSR Committee (NISC) requirements and conditions specified in the relevant Interrogator Approval certificate.

### 6 Active MLAT Systems Capable of Mode-S Interrogation

- 6.1 Commission Regulation (EC) No. 262/2009: Laying down requirements for the co-ordinated allocation and use of Mode S interrogator codes for SES ([www.eurocontrol.int/ses/gallery/content/public/docs/pdf/ses/sk\\_msipdf.pdf](http://www.eurocontrol.int/ses/gallery/content/public/docs/pdf/ses/sk_msipdf.pdf)) shall apply to all active MLAT systems which have a Mode S interrogator for which at least one of the following conditions is satisfied:
  - a) the interrogator relies, at least partly, on Mode S all call interrogations and replies for Mode S targets acquisition; or
  - b) the interrogator locks out acquired Mode S targets in reply to Mode S all call interrogations, permanently or intermittently, in part or totality of its coverage; or
  - c) the interrogator uses multisite communications protocols for data link applications.

### 7 ADS-B capable MLAT systems

- 7.1 MLAT systems capable of receiving ADS-B messages using Mode S Extended Squitter shall comply with the system characteristics stated in ICAO SARPS ICAO Annex 10, Volume 4 Chapter 5.
- 7.2 Where an ANSP intends to use ADS-B positional data or other data items transmitted in ADS-B messages, such data items shall be identified with their intended use.

- 7.3 The ability to de-code ADS-B messages shall be demonstrated as part of commissioning trials. These requirements are identified in SUR 12.
- 7.4 Where the MLAT system is implemented to detect ADS-B targets, the requirements mentioned in SUR 07 for ADS-B ground systems shall apply to the MLAT ground system capable of receiving ADS-B messages.
- 7.5 **Recommendation:** It is recommended for all MLAT systems to have the ADS-B message decoding capability.

## 8 Receiver Synchronisation

- 8.1 The receiver synchronisation method shall be defined and justified as appropriate to the operational requirement.
- 8.2 **Recommendation:** The synchronisation method should incorporate sufficient degree of redundancy.
- 8.3 For transponder synchronised systems, the loss of one transponder shall not cause the loss of the entire MLAT system due to synchronisation failure.

## 9 Receiver Geographical Distribution

- 9.1 The geographic distribution of sensor locations shall be such that the required probability of detection and coverage can be obtained at all levels where the service will be provided.
- 9.2 The system should be installed and optimised such that the loss of data from any single receiver or interrogator does not cause a loss of the required coverage.
- 9.3 The antennas associated with the sensors shall have a clear line of sight to the targets in order to be able to derive the 2D or 3D position information required.
- 9.4 The sensor antennas shall be sited such that at least 4 sensors to have clear line-of-sight simultaneously to the target in the operationally significant coverage area.

## 10 Link Performance

- 10.1 The data transmission links used between the sensors and the central processing system shall be identified along with entities that have operational responsibility.
- NOTE:** Various communication links including RF links, satellite links, copper wire links and fibre optics may be used for communications between sensors and the central processing system within the same MLAT system.
- 10.2 The data link requirements listed in SUR 03 paragraph 3 shall be applicable to all data transmission links used in the MLAT system.
- 10.3 The suitability of the data transmission links chosen shall be justified in terms of reliability, availability, continuity and integrity.
- 10.4 Where such data transmission links are operated by third parties, ANSPs shall have appropriate service level agreements in place for repair, maintenance, accessibility and the performance of the links.

## 11 Redundant Sensor Configuration

- 11.1 The system shall comprise of at least one additional sensor to the minimum number of sensors required for obtaining a 2D or 3D solution throughout the required coverage area.

**NOTE:** This additional sensor may be used at all times for improved accuracy, although its use will be essential for deriving position information during a failure of a single sensor.

- 11.2 The impact on coverage and accuracy in failure of each individual sensor shall be determined through n-1 analysis and shall be demonstrated as acceptable to continue the intended operation.

**NOTE:** 'n' is the total number of sensors. This has to be demonstrated via modelling and simulation and during performance assessment trials.

- 11.4 In the case of more than one sensor failure, the suitability of the system to continue operation shall be decided based upon the achievable coverage and the accuracy levels. The operational strategy in such situations shall be defined including operational procedures.

- 11.5 The procedures in such situations shall be clearly documented and the controllers shall be fully trained to handle such event.

## 12 MLAT Performance Monitoring

- 12.1 The MLAT system shall use a test transponder (site monitor/RFM) for on-going system integrity and end-to-end performance monitoring.

- 12.2 The performance monitoring mechanisms shall be clearly defined with the parameters subject to monitoring by all monitoring mechanisms.

**NOTE:** These must include any in-built status monitoring and external monitoring mechanisms.

- 12.3 The system shall be capable of indicating to controllers when the MLAT system performance is suitable for operational use and when the system performance does not permit its use for providing the intended service.

**NOTE:** These may include visual and audible means or both.

- 12.4 The system shall indicate to the controllers when the system is operating under redundant conditions, if this is deemed necessary.

- 12.5 The system shall be capable of indicating to the engineering staff the current operational status of the sensor network and any failures.

- 12.6 Where one or more RFMs are also used for time synchronisation purposes, the impact of the loss of those RFMs to the time synchronisation function as well as to the system status monitoring function shall be assessed and indicated in design assurance documentation.

## 13 Sensor Siting Requirements

- 13.1 The structure upon which the receivers/transmitters, antennas are mounted shall be of sufficient stability to withstand all expected weather conditions in the operational environment, especially with respect to maximum wind speed and icing.

- 13.2 The maximum wind speed, ice loading, temperature and humidity conditions expected in the operational environment shall be identified.

**NOTE:** Typical values for ice loading conditions are up to 10 mm thick, maximum wind speeds during a 3 second period for operation to be no less than 80 knots and 120 knots for survival of the outdoor equipment.

## 14 System Interfaces

- 14.1 The output of the MLAT system shall be a digital data output, using standard communication protocols (e.g. ASTERIX).

## 15 MLAT Output and Processing

- 15.1 The data output rate shall be identified and the MLAT system shall use the best data output mechanism that gives the highest quality and positional accuracy of data.

- 15.2 The processing and tracking system shall be capable of handling the data received by the MLAT receivers and outputting the data at the required rate.

**NOTE:** MLAT system may receive a large amount of data depending on the amount of data transmissions occurring on the 1090 MHz frequency at any given time, however the required data rate may be much slower than this (e.g. 4s in a busy terminal environment) depending on the application. Hence the system has to accommodate a processing mechanism that delivers data of best quality and accuracy.

## 16 Power Supply

- 16.1 The stability of the power supply to the system shall be consistent with the availability and continuity of service requirements.

## 17 Low level coverage

- 17.1 The coverage and the probably of detection in the low levels of altitude shall meet the performance requirements necessary for the intended application in the lower levels of the defined coverage area.

**NOTE:** Unlike radar systems, MLAT system coverage and probability of detection can significantly vary across vertical levels. The probability of detection may be lower than the required criteria at lower altitudes.

## 18 MLAT Performance

### 18.1 Probability of Detection

- 181.1 **Recommendation:** The Pd should be at least 97% for the MLAT system.

### 18.2 False Targets

- 18.2.1 **Recommendation:** Number of false targets during any update should be less than 1.

## **SUR07 Requirements for ADS-B Systems**

### **Part 1 Preliminary Material**

#### **1 Introduction**

- 1.1 ADS-B is a form of co-operative and dependent surveillance system. The ADS-B system broadcasts aircraft position and other information to be received by an “ADS-B In” capable ground based receiver. The aircraft position, velocity and associated data quality indicators are usually obtained from an on-board GNSS.
- 1.2 ADS-B messages can be down linked using Mode S Extended Squitter, Universal Access Transceiver or VHF digital link Mode 4. The data link type used in Europe is the Mode S ES using 1090 MHz.
- 1.3 This document sets national regulatory requirements specific for ADS-B systems.

#### **2 Scope**

- 2.1 The requirements in this document apply to all ADS-B systems in general. Airborne surveillance using ADS-B IN capability is out of scope of this document.

## Part 2 Requirements

### 3 ICAO SARPS

- 3.1 The ground surveillance systems utilising Mode S Extended Squitter capability ADS-B) shall comply with the requirements contained in Annex 10 Volume 4 Chapter 5 (the formats and data sources for the squitter messages are defined in ICAO Annex 10 volume III Part 1, Appendix to Chapter 5).

### 4 ADS-B Receiver Requirements

- 4.1 All ADS-B receiver stations shall be capable of receiving ADS-B messages transmitted via version 2 of the Mode S Extended Squitter message transmission protocol.
- 4.2 The ADS-B ground receive sub system shall be capable of receiving, decoding, packaging and time stamping the ADS-B messages on the supported data links in the operational environment.

**NOTE 1:** If the implementer expect to provide ADS-B surveillance to aircraft that support data links other than Mode S ES (e.g. UAT or VDL), the ground surveillance receivers shall have the capability to support them.

**NOTE 2:** In the unlikely event of using data links other than Mode S ES in the UK, additional requirements should be discussed on a case by case basis. In such situations, compliance with the ICAO provisions relevant to UAT and VDL will be expected.

### 5 Safety Assessment

- 5.1 The ANSP shall define the required data items and the specific purpose for which the ADS-B data items will be used.

**NOTE 1:** The ADS-B data may be used as the sole means of surveillance, or as the main co-operative surveillance feed, as replacement to existing SSR or as a redundant system.

**NOTE 2:** ADS-B ES aircraft equipage requirements are specified in Article 5 of the SPI IR. Annex 10 Part B of the SPI IR specifies the data items that shall be transmitted by the ADS-B Mode S –ES transponders.

**NOTE 3:** Mode S-ES transmitting system characteristics can be found in ICAO Annex 10 Volume 4 Chapter 5 section 5.1.

- 5.2 A comprehensive system safety assessment shall be performed prior to the introduction of ADS-B including identification of failure modes and the probabilities of the ADS-B ground system, and airborne sources providing each required data item to be transmitted in the ADS-B message.
- 5.3 For all ADS-B ground systems, the requirements for the following shall be derived by conducting hazard identification and risk assessment process:
- The likelihood that the ADS-B receive sub-system corrupts the ADS-B data;
  - The ADS-B receive sub system does not provide updated ADS-B reports for 1 or more aircraft;
  - The undetected error rates in the ground-ground transmission of ADS-B reports;

- d) The rates of undetected errors in the ADS-B messages by the air-ground link;
  - e) The probability that the ground system creates an undetected error in the vertical position;
  - f) The probabilities that the ground domain creates an undetected error for each of the Mode A code, Aircraft identification, and ICAO 24 bit address;
  - g) The probability that the ground domain creates an undetected error in the SPI information;
  - h) The probability that the ground domain creates an undetected error in the Emergency indicators;
  - i) The rate of false ADS-B position reports from the ground processing (i.e. false report ratio).
- 5.4 The ground functions shall detect the loss of data within a period of one refresh cycle (i.e. within the duration of one update period).
- 5.5 For the airborne system elements from which ADS-B data items are sourced, the following requirements shall be defined:
- The data items and their quality indicator data items;
  - The sources providing each data item;
  - Data integrity requirements;
  - System integrity requirements for sources providing data;
  - Continuity;
  - Availability.
- 5.6 The data integrity requirements and system integrity levels for the data sources connected to the transponder shall be in accordance with requirements specified in Annex 2 Part B of the SPI IR.
- 5.7 The safety assessment for the airborne system elements providing each data item shall include the impact of all elements that interface with the sources providing the data items.
- NOTE:** The CAA monitors the GPS performance in support of the aviation applications and some safety critical air traffic services that are based on GPS. The performance data can be accessed via [www.caa.co.uk/ATSRequirementsOverview](http://www.caa.co.uk/ATSRequirementsOverview) and clicking on 'GNSS Supported Services'.
- 5.8 The ADS-B transponder shall comply with the performance and integrity requirements specified in Annex 2 Part B of the SPI IR.

## 6 ADS-B based surveillance services

- 6.1 ADS-B based surveillance service shall only be provided to targets having certified ADS-B equipment that meet the required performance criteria.
- 6.2 The suitability of ADS-B surveillance system to be used for the intended purpose shall be assessed and justified taking the following into account:
- the certified equipage levels;

- the quality of data items;
- ability to meet the required performance criteria.

**NOTE:** A pre-operational trial period may be necessary to confirm the equipage levels, and for ensuring the performance of the data transmitted by the ADS-B equipment meet the required criteria.

- 6.3 Where ADS-B is used to support an application that is supported by radar the ADS-B technical performance characteristics shall meet the equivalent radar performance criteria.
- 6.4 The evidence shall demonstrate the level of equipage, transmitting equipment certification standards, suitability of sources providing data items critical for a safe operation, the performance of the data and the transmitting equipment.
- 6.5 ADS-B may be used alone as the only co-operative means of surveillance, including in the provision of separation between aircraft, provided that the factors identified in paragraph 6.1 are adequate to support the separation minimum.

## 7 Update Rate

- 7.1 The ADS-B system shall maintain a reporting rate that ensures at least an equivalent degree of accuracy, integrity and availability as for a radar system that is used to provide a similar ATC service.

**NOTE:** The typical reporting rate from the aircraft is 0.5 seconds, however the rate provided to the situation display may be less than aircraft reported rate provided that the required performance is still met.

## 8 Safety Nets

- 8.1 All safety net features should possess the same responsiveness as equivalent radar safety net features.

## 9 Position Accuracy and Integrity Requirements

- 9.1 The acceptable criteria for the accuracy and integrity of the ADS-B messages required by the ground system shall be determined and justified for the intended application. The accuracy and integrity indicators transmitted by the ADS-B report may consist of:

- a) NIC : Navigation Integrity Category
- b) NACp: Navigation Accuracy Category for Position
- c) NUC: Navigation Uncertainty Category
- d) SIL: Surveillance Integrity Level

**NOTE:** The types of indicators included may vary depending on the avionics types. The accuracy and integrity indicators above are defined for systems using GNSS as the positional information source.

- 9.2 The navigation source(s) (e.g. GNSS) that will be used for reporting of aircraft position shall be identified.

**NOTE:** The aircraft sending position reports to the ground ADS-B receivers may use GNSS

as their positional information source or other sources (such as inertial navigation system).

- 9.3 An assessment shall determine the likelihood that the position information will not meet the accepted accuracy and integrity criteria for the intended application.
- 9.4 The availability of the airborne positional data shall be equivalent to that of the radar.
- 9.5 An analysis shall determine the likelihood that the data of aircraft participating in ADS-B surveillance become unavailable during operation or the aircraft sub-system corrupt the ADS-B information.
- 9.6 For environments expected to receive ADS-B messages from avionics that have not compensated for latency, the determination of required accuracy and integrity criteria shall take the uncompensated latency into account.

#### 9.7 **Vertical Position**

- 9.7.1 The minimum accuracy of the altitude information transmitted by the ADS-B message shall be equivalent to that of the radar.
- 9.7.2 The vertical tolerances for ADS-B level information should be consistent with those applied to Mode C level information.
- 9.7.3 The ADS-B surveillance report presented to the controller shall clearly identify if the vertical position information is coming from a geometric source or barometric source.

**NOTE:** Some avionics may allow aircraft to transmit geometric height in the ADS-B message although only the barometric altitude is allowed to be used for ATS applications.

### 10 **ADS-B Ground Processing System Requirements**

- 10.1 The availability/continuity of the ADS-B receiving and processing system shall meet the availability/continuity requirements for the provision of intended service.
- 10.2 The likelihood that the ADS-B ground processing system corrupts information in the airborne ADS-B report shall be determined and justified for the intended service.
- 10.3 The likelihood that the ADS-B ground processing system does not deliver the ADS-B positional data received from an aircraft shall be determined and justified.
- 10.4 The ADS-B receive sub-system shall reference all velocity elements to the WGS-84 ellipsoid.
- 10.5 The ground domain shall not degrade the horizontal position accuracy through loss of resolution, uncompensated latency or other means.
- 10.6 The resolution of the barometric altitude shall be specified.
- 10.7 The ground domain shall not degrade altitude resolution to worse than 100 ft.
- 10.8 Time of applicability in the surveillance report presented to the controller shall have an absolute accuracy of +/- 0.2 seconds or less relative to UTC.
- 10.9 All types of ADS-B surveillance reports shall contain a time of applicability.
- 10.10 The ADS-B receive sub system shall provide a time field in each ADS-B report, that is translatable to the time of applicability of the data contained in the report.

- 10.11 The ADS-B receive sub system shall distinctly mark in the surveillance Report whether the altitude/height information contained in the message is derived from a barometric or geometric source.
- 10.12 The pressure altitude shall be interpreted by the ground domain relative to a standard pressure of 1013.25 hectopascals.

## 11 Quality Indicators

- 11.1 The quality indicators used/supported by the ground system for determining the suitability of the positional information transmitted by aircraft shall be identified.
- 11.2 These shall include accuracy and integrity containment parameters and their associated quality indicators from all aircraft using GNSS or non GNSS positional information involved in the ADS-B surveillance application.

**NOTE:** GNSS based systems use HPL (Horizontal Protection Limit) or HFOM (Horizontal Figure of Merit) as integrity and accuracy containment parameters. Non-GNSS systems may use equivalent accuracy and integrity containment parameters for the derivation of associated quality indicators.

- 11.3 For aircraft using non-GNSS systems as the source of positional information, the ground systems shall expect an equivalent criteria to that of the GNSS for the accuracy and integrity quality indicators. The accuracy and integrity containment parameters and their associated probabilities shall also be consistent with the HPL/HFOM used in GNSS systems.
- 11.4 Prior to accepting aircraft with various ADS-B avionics for the provision of ADS-B surveillance, a safety analysis shall be carried out to determine if the risk level is acceptable in the event of unavailability of an integrity containment parameter from aircraft.
- 11.5 The analysis shall determine the requirement for other means of verifying accuracy and integrity of data by ground monitoring or a strategy to handle such aircraft in a safe manner if additional means of verifying is not provided.
- 11.6 The ground system shall only use the ADS-B data for the provision of an ATC service if the quality indicators from the participating aircraft meet the required criteria.

**NOTE:** See Surveillance Performance and Interoperability Implementing Rule Articles 5, 8 and 11 for the ADS-B equipage requirements imposed under the SES Interoperability regulations and Annex 4 Part B for the list of data items that shall be transmitted by ADS-B transponders to the ground.

- 11.7 An indication shall be provided to the controller on the display, whether the surveillance quality of a particular aircraft is acceptable for the application, the data is being used.
- 11.8 The display system shall also indicate whenever the quality of the surveillance data falls below the acceptable criteria for the application.
- 11.9 Indication that an aircraft is transmitting an emergency status shall be displayed to the controller in a clear and efficient manner.

## 12 System Performance Monitoring

- 12.1 The system shall clearly indicate to the controller if an aircraft fails to meet the required accuracy and integrity criteria during operation (i.e. an aircraft of which initial ADS-B messages were acceptable and used for the provision of service)
- 12.2 Ground ADS-B receivers shall be subject to status monitoring. The system shall immediately indicate the controller of any failed receivers.
- 12.3 **Recommendation:** Apart from the quality indicators included in the ADS-B reports, mechanisms should be in place to monitor and verify the accuracy and integrity of ADS-B data.

## 13 Degraded Conditions

- 13.1 In the event of one or more ADS-B receiver failures, a strategy shall be in place either to handle the traffic with back up or additional surveillance data sources, or to reduce coverage where ADS-B based surveillance is provided or to safe transition to procedural control.
- 13.2 Procedures shall be in place to handle such aircraft that fail to meet the required criteria.

## **SUR08 Use of Surveillance Data for Aerodrome Traffic Monitoring**

### **Part 1 Preliminary Material**

#### **1 Introduction**

The Aerodrome Traffic Monitor (ATM) equipment must be approved by the CAA under Article 205 of the ANO (612). The Aerodrome Traffic Monitor may use surveillance data from local or remote surveillance sensors or both. The functions of the ATM are described in CAP 493 Manual of Air Traffic Services Part 1 Section 2 Chapter 1.

#### **2 Scope**

This document applies to all surveillance sensor equipment providing data in aid of functions performed using the Aerodrome Traffic Monitor. It also contains requirements for the Aerodrome Traffic Monitor processing and display equipment.

## Part 2 Requirements

### 3 Safety Objective

The ATM shall provide accurate and uncorrupted data suitable for all the functionalities that will be performed using the Aerodrome Traffic Monitor.

### 4 General Requirements

4.1 The exact functions for which the Aerodrome Traffic Monitor is used shall be identified as per the description of ATM functionalities contained in CAP 493 MATS Part 1.

**NOTE:** ATM must not be used to provide Approach Radar Services.

4.2 In addition to the special requirements that are listed below, the display system requirements and related ergonomic aspects of display systems described in SUR 11 shall apply to ATM display equipment.

### 5 Surveillance Sensor Performance Requirements

#### 5.1 Accuracy

5.1.1 The sensors providing data to the ATM shall detect the position of the aircraft with an accuracy sufficient to discriminate between two targets that are separated by the minimum separation distance allowed between aircraft within the area of interest.

**NOTE:** The ATM may be used for Air Control Service which includes control over aircraft flying in, and in the vicinity of the ATZ, aircraft taking-off and landing, all movements on active runways and their access points.

#### 5.2 Coverage

5.2.1 The surveillance sensors that provide data for the Aerodrome Traffic Monitor shall be capable of detecting all targets within a range of 20 NM from runway threshold.

### 6 Recording of ATM

6.1 Refer to SUR 10 for ATM recording and replay requirements.

### 7 ATM Processing and Display System Requirements

#### 7.1 Displayed Range

7.1.1 In normal operation the ATM shall only display targets within a range in which the functions of the ATM described in CAP 493 are applicable.

**NOTE:** A range greater than the required range for normal operation may be available for display as and when necessary as a quick look function.

## 7.2 Display Size

- 7.2.1 The display shall have a size suitable such that it presents clear unambiguous information of all aircraft within the range of interest to the controllers suitable to perform all functions for which the ATM will be used.

## 7.3 Runway Selection

- 7.3.1 The system shall be capable of automatic adjustment of range and centre on runway change (616).

## 7.4 Display Maps

- 7.4.1 The display shall show the runway centreline (617).

- 7.4.2 **Recommendation:** The system should indicate ranges from the touchdown point in 1 NM increments (618).

**NOTE:** See SUR 04 for a definition of the touchdown point. The displayed range may also be measured with respect to the runway threshold. The reference point for the displayed range and that used in the controllers' procedures shall be consistent.

- 7.4.3 The display map shall indicate the relevant reference point (i.e. threshold/touchdown point) (619).

- 7.4.5 **Recommendation:** If a labelled aerodrome traffic monitor is provided, handover procedures should positively identify all targets (620).

## 7.5 Resolution

- 7.5.1 The equipment shall resolve two targets at the closest separation distance applicable between two targets within the area of interest.

### 7.5.2 Track Guidance

**Recommendation:** Prediction vectors or trail dots should be used to indicate approach speed (623).

## 7.6 Display Orientation

**NOTE 1:** The orientation of the picture in relation to the view from the VCR will depend on the complexity of the aerodrome layout and the controller responsibilities.

At aerodromes (where practically possible) the orientation is to be such that the runway on the aerodrome traffic monitor is aligned with the view of the runway, from the control position (632). In such cases where this is not possible, Human Factors risks that this may pose shall be addressed in the supporting Safety Assurance Documentation.

## **SUR09 Surveillance Systems for Airport Surface Surveillance**

### **Part 1 Preliminary Material**

#### **1 Introduction**

- 1.1 Surveillance sensors play a crucial role in systems used for airport surface surveillance such as SMGCS and A-SMGCS. The surveillance sensors providing data for these systems may comprise of a single non-co-operative sensor such as a Surface Movement Radar (SMR) or a combination of a non-co-operative and multiple co-operative sensors. While ADS-B can be used as a form of surveillance technique for detecting co-operative targets, local area multilateration is a popular form of surveillance in surface movement surveillance systems for detecting co-operative targets in the airport environment.

#### **2 Scope**

- 2.1 According to ICAO SARPS Annex 14 Chapter 9, a surface movement guidance and control system shall be provided at an aerodrome. However, SMR systems and other forms of surveillance sensors may not necessarily be a component in all Surface Movement Guidance and Control Systems (SMGCS).
- 2.2 The requirements in this document are specially concerning the performance of the surveillance sensors, processing and display of surveillance data, where SMR or other form of surveillance sensors form part of the SMGC system at an aerodrome.
- 2.3 The requirements in this document apply to all co-operative and non-co-operative surveillance sensors providing data for an airport surface surveillance system. Where possible, special requirements applicable for SMR and co-operative sensors have been identified separately.

## Part 2 Requirements

### 3 Safety Objective

To provide clear and unambiguous surveillance data to aid the guidance, movement and control of airport surface traffic.

### 4 Existing Standards

4.1 The following ETSI standards exist for Advanced Surface Movement Guidance Control Systems which have been identified as "Community Specifications" for application under the Single European Sky Interoperability Regulation (EC) No. 552/2004.

Part 1: ETSI EN 303 213-1: "Community Specification for application under the Single European Sky Interoperability Regulation (EC) No. 552/2004 for A-SMGCS Level 1 including external interfaces";

Part 2: ETSI EN 303 213-2 "Community Specification for application under the Single European Sky Interoperability Regulation (EC) No. 552/2004 for A-SMGCS Level 2 including external interfaces";

Part 3: ETSI EN 303 213-3:"Community Specification for application under the Single European Sky Interoperability Regulation (EC) No. 552/2004 for a deployed co-operative sensor including its interfaces";

Part 4: ETSI EN 303 213-4:"Community Specification for application under the Single European Sky Interoperability Regulation (EC) No. 552/2004 for a deployed non-co-operative sensor including its interfaces";

Part 5: "Harmonised EN covering the essential requirements of article 3.2 of the R&TTE Directive for transmitter used in multilateration equipment";

Part 6: "Harmonised EN covering the essential requirements of article 3.2 of the R&TTE Directive for deployed surface movement radar sensors".

**NOTE:** Compliance with the Community Specifications presumes compliance with the Essential Requirements of the SES Interoperability Regulation.

### 5 General Requirements

5.1 Where surveillance data from SMR and/or other surveillance sensors are required to support the surface movement surveillance of an aerodrome, the required performance criteria shall be identified based up on the following factors:

- a) The minimum visibility conditions the airport normally operates;
- b) The traffic density and complexity of the movements;
- c) The design and layout of the aerodrome.

5.2 **Recommendation:** The system should be designed to be capable of expansion to accommodate complex operations, larger coverage area and various sizes of aircraft and vehicles that may operate in the aerodrome in future.

### 5.3 Coverage

- 5.3.1 The areas of aerodrome surface for which surveillance coverage using SMR or other sensor equipment is required shall be defined.
- 5.3.2 The horizontal coverage of the sensor(s) shall extend over the required area of coverage.
- 5.3.3 The vertical coverage shall be suitable for monitoring all traffic on the airport surface in the required area of vertical coverage.
- 5.3.4 **Recommendation:** The vertical coverage should be at least 60 m above surface level.
- 5.3.5 Where the sensors are only required for partial coverage of the aerodrome surface, visible or other means of surveillance shall be in place to monitor traffic on the areas not monitored by surveillance sensor equipment.

### 5.4 Detectability under Adverse Weather

- 5.4.1 The Surveillance sensor(s) shall be capable of detecting all surface traffic in the required area of coverage under the worst weather conditions including lowest visibility under which the aerodrome operations shall continue.

**NOTE:** All surface traffic shall mean all aircraft and vehicle for a non-co-operative sensor and all co-operative traffic for other means of surveillance such as MLAT and ADS-B.

### 5.5 Mixed Equipage Environment

- 5.5.1 Where both co-operative and non-co-operative traffic operate in the required coverage area, sensors shall be implemented to detect both co-operative and non-co-operative targets throughout the coverage.

### 5.6 Resolution

- 5.6.1 The horizontal resolution of the sensor equipment shall be suitable to resolve the smallest distance between targets (including aircraft and vehicles) and stationary objects within the operating area.

### 5.7 Accuracy

- 5.7.1 The accuracy requirement for surface surveillance systems shall be determined by a safety assessment for the specific aerodrome.

### 5.8 Update Rate

- 5.8.1 The update rate shall be at least once per second.
- 5.8.2 The update rate required shall be decided taking into account the speed of movements between aircraft and vehicles and their dimensions.

## 6 Requirements Specific to SMR

- 6.1 Where SMR is used for airport surface surveillance, SMR shall to the extent possible enable the detection and display of the movement of all aircraft and vehicles on the manoeuvring area in a clear and unambiguous manner.

**NOTE:** ICAO Annex 14 Chapter 9 recommends that surface movement radar for the manoeuvring area should be provided at an aerodrome intended for use in runway visual range conditions less than a value of 350 m. In addition, Surface movement radar for the manoeuvring area should be provided at an aerodrome when traffic density and operating conditions are such that regularity of traffic flow cannot be maintained by alternative procedures and facilities.

- 6.2 Aircraft and vehicle position indications may be displayed in symbolic or non-symbolic form. Where labels are available for display, the capability should be provided for inclusion of aircraft and vehicle identification by manual or automated means.
- 6.3 The probability of detection for SMR shall be at least 90% for all target sizes expected on the required coverage area.
- 6.4 Typical performance requirements for a SMR can be found in ICAO Doc 9476 Appendix F. However it should be noted that the required performance from a SMR depends on whether the SMR is used as part of a simple SMGCS or an A-SMGCS in which the requirements may be more stringent.

## **7 Requirements Specific to MLAT implementations**

- 7.1 Where multilateration sensors are used in aid of airport surface surveillance, the loss of any one MLAT receiver or interrogator shall not cause a loss of the required coverage.
- 7.2 The MLAT antennas shall be mounted on strategic locations where each antenna has a clear line of sight to transponder antennas of aircraft or vehicles.

**NOTE:** In addition to the requirements listed above, general requirements described in SUR 06 of this document for MLAT systems shall apply to the MLAT systems used for surface surveillance.

## **8 Requirements Specific to ADS-B implementations**

- 8.1 Where ADS-B receivers are used in aid of airport surface surveillance, the loss of any one ADS-B receiver shall not cause a loss of the required coverage.
- 8.2 The ADS-B receiver antenna/s shall be mounted on strategic locations where each antenna has a clear line of sight to transponder antennas of aircraft or vehicles.

## **9 SMGCS Requirements**

- 9.1 An SMGCS shall be designed with due consideration to all of its functional domains. A local safety assessment shall determine the safety impact in the event of failure of any element of the system and confirm the suitability of the functional and performance requirements.

**NOTE:** General requirements and guidance on Surface Movement Guidance and Control Systems are given in ICAO Doc 9476 - Manual of Surface Movement Guidance and Control Systems.

## 10 A-SMGCS Requirements

- 10.1 Surveillance sensors used for A-SMGCS shall have a vertical coverage up to an altitude to detect missed approaches and where appropriate, low-level helicopter operations.
- 10.2 The sensors providing data to the A-SMGCS shall detect aircraft from a suitable distance that aircraft approaching to all active runways can be integrated to the ground movements detected and displayed on the A-SMGCS.
- 10.3 The distance from which it is required to detect approaching aircraft shall be identified.
- 10.4 The surveillance sensors shall detect any obstacles, and vehicles in the required coverage area and any designated protected areas.
- 10.5 The A-SMGCS shall be referenced to the World Geodetic System (WGS-84).
- 10.6 An A-SMGCS shall be designed and operated with due consideration to all of its functional domains. A local safety assessment shall determine the safety impact in the event of failure of any element of the system and confirm the suitability of the functional and performance requirements to the local operational context.

**NOTE:** ICAO Document 9830 Advanced Surface Movement and Guidance Control Systems manual contains performance requirements for surveillance, guidance, and control functions for a typical A-SMGCS system. Eurocontrol has also published “operational Concept and Requirements document for A-SMGCS Level1 and Level 2 Implementations.

## 11 Monitoring and Alerting

- 11.1 The performance of the surveillance sensors shall be monitored.
- 11.2 Alerts shall be provided to the users of the system in the following situations;
- a) Complete failure of a sensor;
  - b) Failure of one or more sensors resulting in reduced vertical or horizontal coverage;
  - c) System malfunction resulting in degraded performance and below the minimum required performance criteria.

## 12 Display Requirements for A-SMGCS

- 12.1 The A-SMGCS shall provide identification and labelling to all authorised aircraft and vehicles on the movement area required.
- 12.2 The response time to issue alerts, alarms, or automatically generated instructions shall be suitable such that necessary precautions can be applied to avoid conflicts taking to account:
- The minimum separations between aerodrome movements (aircraft and vehicles);
  - The separations between movements from obstacles (ex: buildings, hangers etc.).
- 12.3 All critical elements of the system shall be provided with timely audio and visual indications of failure.
- 12.4 Upon re-starting, the system recovery time shall be no longer than 10 seconds. Upon re-starting, the system shall restore the information on current traffic and system performance.

- 12.5 Input devices for the controllers shall be functionally simple such that a minimum number of input actions are required from the controllers.
- 12.6 The display and all the indicators shall be viewable in all ambient light levels in the aerodrome control tower environment.

### **13 Processing System**

- 13.1 The processing system shall have sufficient capacity to handle and process the surveillance data at the maximum movement rate at the relevant airfield.
- 13.2 **Recommendation:** The processing system should have capacity sufficient to process requested movements for a period of up to 1 hour.
- 13.3 The allowable error in the reported position shall be consistent with the requirements set by the guidance and control functions.

### **14 Recording**

- 14.1 Refer to SUR 10 for recording requirements of surface movement surveillance data.

# **SUR10 Requirements for the Recording, Retention and Replay of ATS Surveillance Data**

## **Part 1 Preliminary Material**

### **1 Introduction**

- 1.1 The ability to replay recordings of ATS surveillance data is a vital aid to post accident or post incident investigation and to provide location data in the event of search and rescue operations.
- 1.2 Replayed data can also be used to evaluate and maintain the performance of surveillance systems used to aid the provision of an air traffic service.

### **2 Scope**

- 2.1 The term “surveillance data” mentioned in this document refers to all surveillance data obtained from third party providers, en-route or airfield sensors (including approach and surface movement sensors) by radar or other surveillance techniques such as Automatic Dependent Surveillance (ADS) or multi-lateration and wherever such data is used as an aid to air traffic services.

**NOTE 1:** The ICAO Standard for “Automatic recording of surveillance data”, set out in paragraph 6.4.1 of Chapter 6 in Annex 11 “Air Traffic Services” (Thirteenth Edition, Amendment 43), requires the automatic recording of “surveillance data from primary and secondary radar equipment or other systems (e.g. ADS-B, ADS-C) used as an aid to air traffic services”.

**NOTE 2:** Surveillance data used “as an aid to air traffic services” shall mean all surveillance data displayed to the controllers either as part of a surveillance display or safety nets for which visual indications will be provided to controllers on screen, derived from surveillance data.

### **3 General Requirements**

- 3.1 With effect from 31 December 2012 it shall be mandatory for all ATS Units which use surveillance data as an aid to air traffic services to have in place surveillance data recording systems for recording operational screens at the glass (ATG) and surveillance data obtained through the wall (TTW) together with the ability to provide a time synchronised replay of voice and surveillance data.

## Part 2 General Requirements

### 4 Safety Objective

**To provide data for use in accident and incident investigations either by the Air Accidents Investigation Branch (AAIB) or CAA, and to support search and rescue, air traffic control and surveillance systems evaluation and training (1716).**

### 5 Functional Requirements

- 5.1 All surveillance data used by an ANSP for the purposes of providing an air traffic service shall be automatically recorded and retained by the surveillance data recording system.
- 5.2 Surveillance data used as an aid to air traffic services shall normally be recorded at two points in the path between the surveillance sensor(s) and the display system with the only exceptions being those described in Section 7 of this document.
- a) Through the Wall (TTW): Data obtained from remote or on site sensors or networks.
  - b) Operational Screens recorded “At the Glass” (ATG): From a connection (or “tap”) as close to each operational display as is practicable.
- 5.3 The surveillance data obtained ATG shall preferably be recorded using a lossless compression technique with no loss of accuracy or detail. The recording system shall be capable of recording data at a rate (which may be adaptive) sufficient to ensure the successful capture of any changes that occur to the surveillance data displayed to the controller and any system input change made by the controller such as any entries made via either keyboard or mouse/rolling ball..
- 5.4 The surveillance data recording system deployed at an ATS Unit shall not degrade or otherwise adversely affect the performance of the surveillance processing and display systems employed at that ATS Unit.
- 5.5 The surveillance data recording system and power supply configuration shall ensure the continued availability of the recording process, without interruption, whenever the ATS Unit is using surveillance data as an aid to air traffic services (see paragraph 11).
- 5.6 Surveillance data recorded either at the ATS Unit or by a third party provider (see paragraph 7) shall be retained in secure storage for a minimum period of thirty days or longer if the recordings are pertinent to the investigation of an air accident or incident (see paragraph 14).
- 5.7 The surveillance recording and replay system at the ANSP facility shall be capable of supporting the time-synchronised replay of voice and surveillance data used by that ATS Unit for the provision of air traffic services.

## Part 3 Specific Requirements

### 6 “Through the Wall” (TTW) Recording

- 6.1 “Through the Wall” recording includes any surveillance data used by an ANSP as an aid for providing an air traffic service that is either obtained from on site surveillance sensors or in the form of remote surveillance feeds (e.g. ORRDs) provided by a third party (e.g. NATS or MOD). TTW recording shall be recorded at any point in the path between the surveillance sensor(s) and the data processing system and may consist of combined or uncombined feeds or processed or unprocessed surveillance data feeds.
- 6.2 All surveillance data stated in paragraph 6.1 shall be recorded TTW with the exception of data used in the circumstances mentioned in paragraph 7 which only require recording ATG.
- 6.2. In circumstances where surveillance data is sourced from a third party (e.g. NATS or the MoD), the remote surveillance data feeds shall be recorded either by the ANSP at the ANSP unit, or by the third party provider of the data. However where such remote surveillance data feeds are not recorded by the ANSP on their premises, ATS Units shall obtain and submit to the relevant CAA Regional Office evidence that the surveillance data will be recorded and retained by the provider of such data.

**NOTE:** This evidence should be in the form of a written agreement between the provider of the surveillance data and the ATS Unit.

### 7 Circumstances which only require ATG Recording

#### 7.1 Analogue Primary Radar Systems

- 7.1.1 Data from an analogue primary radar sensor presents an impractical recording requirement as regards bandwidth and subsequent storage of the recorded data.
- 7.1.2 In circumstances where the analogue radar data are displayed to the controller in the form of a processed and plot extracted signal, surveillance data shall be recorded from each operational screen ATG.

#### 7.2 Surface Movement Surveillance Systems

- 7.2.1 Surface Movement control systems including SMR displays and A-SMGCS displays shall be recorded ATG where the information presented on these displays is used by the controllers to provide guidance, information or instructions either by visual or non-visual means that would lead to any movement action of an aircraft or vehicle receiving the service.

#### 7.3 Recording of Aerodrome Traffic Monitor (ATM) Displays

- 7.3.1 The Aerodrome Traffic Monitor displays shall be recorded ATG at all times where the ATM display is used to perform any functions listed in paragraph 17.2 of CAP 493 (MATS Part 1) Section 2 Chapter 1, subject to the conditions listed therein.

## 7.4 Recording of Spare Positions, Duplicate Positions and Surveillance Data in Contingency Visual Control (CVCR) Rooms

- 7.4.1 Surveillance data provided for any spare positions, duplicate positions including those positions of any contingency visual control rooms shall be recorded ATG for the entire duration of the event where such positions were used in support of air traffic services including approach or aerodrome control functions.

## 8 Accurate and Consistent Timing

- 8.1 The surveillance recording system shall incorporate time-recording devices or techniques to ensure the accurate “time-stamping” of ATS data.
- 8.2 Time-recording devices or techniques shall use Co-ordinated Universal Time (UTC) and shall express each time-stamp in hours, minutes and seconds of the 24-hour day beginning at midnight (712).
- 8.3 A common time-source shall be used to ensure that all recordings made at an ATS Unit or those retained by a third party provider can be time-synchronised in accordance with the minimum requirements set out in paragraph 5.8 of this document.
- 8.4 The recorder time-source shall be automatically updated by reference to an international time standard such as the MSF signal radiated from Anthorn in Cumbria or be subject to regular and documented checks to ensure that the time-stamps are maintained within a tolerance of less than  $\pm 2$  seconds of UTC (713).

## 9 Data Integrity and Continuity of Recording

- 9.1 Surveillance recording must be maintained during operational hours and measures shall be in place in the event of a loss of a single ATG or TTW data recording capability to restore recording in a relatively short time (e.g. a spare screen capture device or moving to a spare position).

**NOTE:** It is likely that the provision of dual-redundant equipment or systems which contain multiple hard disc drives (HDD) or solid state drives (SSD), configured as Redundant Array of Independent Discs (RAID) will be necessary to achieve the required availability.

- 9.2 In the event of a total loss of ATG or TTW recording, the ANSP shall inform the appropriate CAA Regional Office of the situation and take measures to re-instate the recording capability as soon as practicable.
- 9.3 The provision of a back-up power supply from either a central battery system or individual Un-interruptible Power Supply (UPS) unit shall ensure the continued availability of power to the surveillance recording system and other essential equipment during all operational hours in the event of an interruption to the main electrical supply (2261).

## 10 Recording System requirements

- 10.1 The recording system shall be capable of recording all TTW surveillance data formats (e.g. ASTERIX, RDIF) used by the surveillance systems at the ANSP unit.
- 10.2 The recording system shall have the capability to simultaneously record all controller working positions (that use surveillance data) used during all operational hours where air traffic services are provided.

- 10.3 The recording system shall have the capability to record ATG data at a suitable refresh rate and display resolution and shall faithfully record all the features displayed to the controller with no degradation of the clarity, brightness, color and contrast displayed at the time on the controller's displays.
- 10.4 The recording system shall have the capability to record TTW data at the same link speed and format as the original data source
- 10.5 Archiving of the recorded surveillance data for the minimum 30 day period shall be an automated process (or with minimal human intervention).
- 10.6 The system shall have the capability to indicate the failure of the archiving function to ensure no recorded data will be lost during archiving process.
- 10.7 The ANSP shall be able to demonstrate sufficient storage capacity exists for the storage of surveillance data recorded over a period of 30 days.

## 11 Alarm/Status Indications

- 11.1 Local and remote alarm/status indications of the surveillance recording system, including any additional hardware associated with "screen capture" (ATG), shall be provided to alert Air Traffic Control and/or Engineering personnel to take such actions as are necessary to ensure the continued operation of the surveillance recording at the ATS Unit (985).
- 11.2 Remote alarm indications shall be "latching" so that they require positive intervention by ATC or Engineering staff and confirmation of the status of the surveillance recording system by those staff before the alarms are cancelled.
- 11.3 **Guidance:** Whilst it may be appropriate to be able to cancel an audible alarm, another independent visual signal or lamp should continue to alert ATC or Engineering staff until the necessary restorative action has been taken by these staff.

## 12 Serviceability and Recording Function Check

- 12.1 A daily check shall be made of the surveillance recording function. Alternatively the recording system shall contain automatic monitoring to alert the failure of the recording system by visual or audible alarms or indications.
- 12.2 **Guidance:** Use can be made of any devices or facilities incorporated into the recording equipment to perform automatic checks of the recording function but unless this check is made directly from the hard drive (or drives), a separate replay of pre-recorded data must be made (as determined by local procedures) and the result recorded in the Engineering log book.

## 13 Surveillance Data Storage Procedures

- 13.1 The recorded data shall be retained in secure storage and protected from being erased, corrupted or deleted for a period of at least thirty days.

**NOTE:** When the recordings are pertinent to accident and incident investigations, they shall be retained for longer periods until it is evident that they are no longer required (see paragraph 15).

- 13.2 Suitable measures and procedures at each ATS Unit shall ensure:
- a) All access to the stored data is recorded (728);
  - b) Authority under which any recorded radar data leaves the site for replay or duplication is recorded (729); and
  - c) The identity of the person or organisation taking charge of the recorded radar data is recorded (730).

## **14 Impounding the Recorded Data**

- 14.1 On receiving a detailed request concerning recorded transmissions from either the CAA SRG Transcription Unit or the AAIB, normally within the 30 day retention period, archived data containing the specific recorded data shall be removed from normal storage or extracted from HDD/SDD and placed in a separate and secure quarantine area pending further instructions.
- 14.2 If the Surveillance data is recorded on the same system as the audio channels and the system has the capability then the ANSP shall impound a minimum of 4 hours of data either side of the occurrence time, i.e. 8 hours in total. Otherwise surveillance data can be quarantined locally and made available to produce recordings as required by the CAA or the AAIB. See also CAP 670 COM 01.
- 14.4 The impounding process of the selected data shall not cause any interruptions to the recording and archiving process.
- 14.3 The ATS Unit, or third party provider of surveillance data, will be permitted to retain one copy of the quarantined data for local use but data retained in the “quarantine” area of the surveillance data recorder must not be replayed, deleted or over-written until written permission for the release of such data is received from the CAA (725).

## **15 Access to Original Records**

- 15.1 In the event that the AAIB request a visual replay of the recorded data (at either the ATS unit or third party provider), the ANSP must be able to provide that visual replay within 24 hours of receiving the request.
- 15.2 The ANSP shall ensure that appropriate requirements and guidance for ATS personnel are contained in their Manual of Air Traffic Services Part 2.

## **16 Replay Functions and Facilities**

### **16.1 Replay System Requirements at the ANSP facility**

- 16.1.1 The recorded data shall be available for replay at a separate (non-operational) position either “on-demand”, or as soon as possible, in the case of a replay required to support “search and rescue” at the ANSP facility.
- 16.1.2 The use of replay and duplication functions of the replaying system shall not cause a break in the recording function (742).
- 16.1.3 It shall be possible to replay audio and TTW or ATG recordings simultaneously in a synchronised manner at the ANSP replay station for any controller position of interest.

- 16.1.4 Replay of the surveillance data recorded ATG shall faithfully and correctly identify all of the features displayed at the relevant operational position at the time of screen capture.
- 16.1.5 Replay of surveillance data recorded TTW shall faithfully and correctly identify the complete data recorded TTW with no discrepancies to the data recorded TTW.
- 16.1.6 The replay system shall have the capability to extract the recorded data for the requested duration by the CAA or the AAIB, in to a suitable removable media (e.g. CD/DVD/memory stick).
- 16.1.7 Individual frames/screenshots, from a replay of data recorded ATG shall also be capable of being output as a printed copy when required.

## 16.2 Requirements for Providing Recorded Data by ANSPs to the CAA or the AAIB

- 16.2.1 ATS Units and third party providers shall be capable of providing a copy of the surveillance data recorded ATG/TTW for specified dates and times upon request by either the AAIB or the CAA along with the audio recordings for the same time period(as requested).
- 16.2.2 The ATS unit shall provide the copied ATG or TTW recorded surveillance data as soon as possible but no later than 72 hours following the arrival of the request.
- 16.2.3 It shall be possible to copy the ATG or TTW recording data on to a removal media such as a CD, DVD or memory stick or for the recording to be sent via e-mail as an electronic file which can be replayed to form the air situation picture.

**NOTE:** The most appropriate form of receiving these files will be liaised by the CAA or the AAIB.

- 16.2.4 TTW or ATG recording data copied to removable media or sent as electronic files ( to be replayed to form an air situation picture) shall be produced in a format compatible with the replaying systems used by the CAA and the AAIB (or in the case of ATG recording, standard media player software such as Windows Media Player). If this is not possible, an appropriate replay tool shall be provided with the data.

**NOTE:** The types of replaying systems and their capabilities available at the CAA /AAIB may expand, with future upgrades and possible implementation of new systems. It is advised the ANSP check with the CAA /AAIB which types of files are acceptable.

- 16.2.5 In addition, a function shall exist to export data from an individual aircraft track of interest, derived from the TTW recording to a text-based file (.TXT or Comma Delimited (.CSV)). The data shall consist of 2D positional data (e.g. radar range and bearing, or latitude/longitude) and time relative to UTC as a minimum, plus any other available data (SIC, SAC, altitude, squawk code, speed, validity etc).

# **SUR 11 Display System Requirements for Surveillance Systems**

## **Part 1 Preliminary Material**

### **1 Introduction**

- 1.1 When a surveillance data display is intended for use for the provision of Air Traffic Services it must comply with safety standards.
- 1.2 This document sets out the technical requirements relating to those safety standards that are concerned with the approved use of surveillance data displays by Air Traffic Service units.
- 1.3 Guidance material on issues to consider when changing display technology is available at the following link: [www.caa.co.uk/ATSDocuments](http://www.caa.co.uk/ATSDocuments).

### **2 Scope**

- 2.1 This document applies to all types of display equipment used for processing and presenting Air Traffic Services (ATS) surveillance data and is subject to approval under Air Navigation Order Article 205.
- 2.2 Part 2 identifies requirements for display system technical characteristics.
- 2.3 Part 3 sets out requirements on ergonomic aspects of the display systems including a suitable method of specifying and testing the adequacy of the Human Machine Interface (HMI) and its operation.
- 2.4 The requirements in part 4 apply to display map generation equipment which is used to produce the fixed display map. These include overhead projection, etched plates, independent display map generators or on-system display maps.

## Part 2 Requirements – Display System Technical Characteristics

### 3 Safety Objective

The display system shall preserve the accuracy, availability and integrity of the input data and reproduce it to present in an unambiguous and clear manner (1712).

### 4 General Requirements

4.1 The environmental requirements for which the display system is designed to operate shall be identified.

**NOTE:** These requirements include temperate, humidity, vibration etc.

4.2 System inputs and the data display formats shall be identified.

4.3 Where dual channel systems are used, there shall be no single point of failure in the display system architecture that will result in the loss of the entire system.

4.4 Processing of co-operative and non-co-operative surveillance data shall be designed to minimise the risk of single failure resulting in the loss of both co-operative and non-co-operative surveillance data.

4.5 The presence of co-operative and non-co-operative surveillance input signals and CCDS signals shall be continuously monitored by the system.

4.6 Operators shall be alerted to any detected fault condition of the above.

4.7 System throughput delays shall be minimised.

4.8 The display specification shall be related to the operational requirement both in functional and performance terms (575).

4.9 The display system power supply methods in normal operation and in the event of normal power supply failure shall be identified and justified.

### 5 Display of QNH

5.1 The display shall be capable of displaying QNH values (595).

5.2 QNH value input mechanisms shall be identified.

5.3 Manual entry and changes to this value shall be validated by double entry (596).

5.4 When it is possible to change the QNH value automatically, the equipment shall require the change to be drawn to the controller's attention and confirmed on all other displays (597).

### 6 Display configuration Files

6.1 The display configuration files shall be password-protected.

6.2 A rigorous configuration management mechanism of the configuration files shall be in place.

## 7 Key display technical features

The following shall be assessed to determine suitability/appropriateness for the operational requirement;

- a) Screen area and corresponding displayed range (553).
- b) The number of display lines (554).

**Recommendation:** The number of lines should be greater than 1000\*1000 (555).

- c) Linearity and screen astigmatism (556).
- d) Frame refresh rate (557).

**Recommendation:** Frame refresh should be 75 Hz (or greater), non-interlaced (558).

- e) Ability to display system status information (560).
- f) The chosen display brightness (561).
- g) The ambient lighting (562).
- h) Maximum response time
- i) Maximum number of targets that can be processed and displayed at a given time/capacity
- j) Display system typical latency
- k) Viewing Angle
- l) Matrix type
- m) Contrast ratio and luminance

## 8 System Parameters

8.1 The following parameters shall be specified and justified in relation to the OR, technical specification and hazard analysis, as appropriate:

- a) Resolution (577).
- b) Accuracy (578).
- c) Precision (579).
- d) Max/Min ranges (580).
- e) Data load ('analogue' plus 'synthetic') and processing time. If the equipment is subjected to a high data load the operator shall be given a warning of the data that shed (581).

**Recommendation:** For systems using remote surveillance data for overlay, data discard should take place progressively from long range (582).

- f) The required MTBF (583).
- g) Required MTTR (584).
- h) Input type. Analogue, data formats, data transmission rates (585).
- i) Environmental performance (586).
- j) EMC performance (587).

- k) Quality standards applicable to equipment design (both hardware and software) shall be stated (588).
- l) Correct identification of radar source by validating radar source code (589).
- m) Identification of appropriate data input faults. This information shall be indicated within one update interval (590).

## 9 Display Range and resolution

- 9.1 The maximum and the minimum display ranges shall be suitable for the operational requirement.
- 9.2 The display system shall have capability to display coverage diagrams for each surveillance sensor and resultant coverage diagram for all ground based surveillance sensors presented in a specific colour.
- 9.3 The Surveillance Display shall have the capability to select a specific range for each surveillance workstation.
- 9.4 The display resolution at the maximum and minimum range shall be suitable for the operational requirement.
- 9.5 Allowable error budgets for the display system shall be calculated and justified in the manufacturers design assurance documentation (576) (e.g. Pixel errors, map projection errors, allowable sensor errors).

## 10 Brightness

- 10.1 The brightness range, both overall and for individual screen elements, shall be restricted to the range determined in the colour assessment trial (600).

**NOTE:** It should not be possible to delete radar targets completely by use of this control.

- 10.2 **Recommendation:** Target and map brightness should be independently variable (601).

## 11 Electro Magnetic Performance

- 11.1 The system shall not malfunction from the electromagnetic interference from the other equipment in the operating environment.
- 11.2 The system shall not emit electro-magnetic interference which will result in malfunction of the other equipment in the operating environment.
- 11.3 The system shall comply with the European Union Low-Voltage Directive.

## 12 Display symbols

- 12.1 The display symbols used for primary only plots, combined plots etc shall enable the controller to discriminate between various types of target reports, i.e. PSR plots, combined plots etc.
- 12.2 The symbology set selected shall be assessed for suitability to the OR (567).

**NOTE:** The on-screen positioning of menu selection and video map symbology is of particular importance.

12.3 **Recommendation:** The equipment should not display any symbol indicating the position of particular filtered targets (568).

#### 12.4 **Special Purpose Codes**

12.4.1 The equipment shall draw the attention of the controller by flashing the associate label if it detects one of the emergency codes listed below (569):

7700 : SOS

7600 : RT FAIL

7500 : HIJACK

12.4.2 **Recommendation:** An audible alarm should also be sounded (570).

Any audible alarms shall be assessed for distraction and suitability for purpose.

12.4.3 **Recommendation:** The equipment should display both the emergency code and the previous callsign or code if unconverted (571).

#### 12.5 **Symbol Size**

12.5.1 **Recommendation:** The symbol size should not vary with displayed range (572).

**NOTE:** Some features, map features for example, will be scaled according to their significance on the displayed ranges.

### 13 **Leader Lines**

13.1 Where the display automatically moves the labels to various positions (to prevent label overlapping) the equipment shall provide leader lines (573).

### 14 **Contrast Control**

14.1 **Recommendation:** The ATC staff shall not change the contrast levels set within the system by the engineering staff.

### 15 **Colour Assessment and Calibration**

15.1 Colour calibration checks shall be carried out at intervals appropriate to the system stability (566).

15.2 The colour set shall be assessed as appropriate for the operational requirement (563).

15.3 **Recommendation:** Some colours should be reserved for future requirements (564).

15.4 A system shall be in place that allows the colour set to be calibrated (565).

## 16 Readability

- 16.1 The display shall be readable in all ambient light conditions (625).
- 16.2 The display shall be readable over a range of viewing angles, both vertically and horizontally (626).
- 16.3 **Recommendation:** Displays requiring viewing hoods should not be used (627)
- NOTE:** High intensity daylight viewing displays and/or brightness controls fitted to the equipment can achieve the same effect.

## 17 Colour Display

- 17.1 Colour shall not be used for information coding (628).
- NOTE:** Displays may use colour but only in conjunction with brightness and symbology to aid de-cluttering of screen information.
- 17.2 **Recommendation:** Where displays use colour for decluttering, it should be ensured that the contrast control is not available in normal use (629)

## 18 Map data accuracy

- 18.1 The accuracy which the features are mapped to the system shall be defined.

## 19 Functional Parameters

### 19.1 Input Selection

- 19.1.1 The system shall be capable of showing the source of all data that the controller has selected for display on the radar display (591).
- 19.2 **Recommendation:** If a remote SSR data source is used the radar identification code should be decoded and displayed on the screen (592).
- 19.3 Return to default settings shall be achievable via the 'top level' menu (593).
- 19.4 The region of the boundary where composite picture processing is being used shall be indicated (594).
- NOTE:** This is to indicate the area where track wander may occur.
- 19.5 The system shall have the capability for entering annotations for display. Each annotation will have a specific text and colour.
- 19.6 The system shall display activation of SPI using a unique indication.
- 19.7 The following elements shall be available for display:
- a) Map information;
  - b) Range rings;
  - c) Time;

- d) Selected Surveillance Display range;
- e) Selected height filter;
- f) Controller jurisdiction indicator;
- g) Handoff indication;
- h) Range/bearing line (cursor);
- i) Indication when the Air Situation Display is not being updated;
- j) Selected track presentation mode/surveillance sensor;
- k) Special codes;
- l) Safety Nets;
- m) Track information, including Position symbols, Track history information;
- n) Label information.

## 20 Target Filtering

- 20.1 When the display equipment can filter out targets from the situation display, the equipment shall be capable of displaying the parameters of such filters (598).
- 20.2 **Recommendation:** Display equipment should be fitted with a filter override allowing all targets to be displayed quickly (599).

**NOTE:** Target filtering on the display may be based on different criteria including height, area, type, SSR code and other Flight Plan derived data. The requirements and recommendations above apply to all such filtering.

## 21 Operator Functions

- 21.1 **Recommendation:** The equipment should have the following operator functions:
- a) Selection of display ranges (602).
  - b) Display off centre (603).
  - c) Choice of maps (604).
  - d) Range rings on/off (605).
  - e) Choice of leader line length, SSR label block rotation and positioning (606).
  - f) Prediction data, code/call sign selectivity (607).
  - g) Choice of character size (608).
  - h) Menu selection/positioning (609).
  - i) Acceptance of error/alert messages (610).
- 21.2 ADS-B, ADS-C, PSR, SSR, and PSR/SSR plot presentation shall be available as a selectable function.
- 21.3 Display system shall have the capability to enable or disable track history information in each position.
- 21.4 The surveillance workstation shall have a capability to select the number of track history positions using a specific symbol.

- 21.5 The system shall have the capability to re-position any label relative to the position symbol, manually or using an automatic algorithm.
- 21.6 The system shall have a capability to select and present map data in each surveillance workstation.
- 21.7 The main surveillance window shall have the capability to display geo-referenced images representing meteorological information as an overlay under operator control.
- 21.8 The system shall have the capability of manually enable or disable the presentation of plot data besides the presentation of tracked targets.
- 21.9 The system shall have the capability to calculate and display the predicted position of any track as designated by a controller input action.
- 21.10 The system shall have the capability to process and display alphanumerically the ground speed and heading (track) of any track designated by the controller.

## 22 Derived Warning or Alerting Information (Safety Nets)

- 22.1 ATC Service Providers shall assess the risks to aircraft that can be addressed by deriving warning or alert information from available surveillance data and, where appropriate, incorporating facilities into surveillance display (or associated) systems (2316).

Typical warning systems, known as safety nets, include:

MSAW - Minimum Safe Altitude Warning

STCA - Short Term Conflict Alert

APM - Approach Path Monitor

APW – Airspace/Area Proximity Warning

RIMCAS - Runway Incursion Monitoring and Collision Alerting System

**NOTE 1:** Where safety net systems such as STCA, MSAW, APM and/or APW are deployed, ANSPs shall consider the ATC Contingency Procedures defined in Section 15.7 of ICAO Doc 4444 PANS-ATM in devising procedures applicable to each associated safety net.

**NOTE 2:** The effect and contribution of ground based safety nets may be taken into account when an ANSP determines the achieved level of safety. Further information on Safety Nets can be accessed via the Eurocontrol Safety Net web pages:

[http://www.eurocontrol.int/safety-nets/public/subsite\\_homepage/homepage.html](http://www.eurocontrol.int/safety-nets/public/subsite_homepage/homepage.html)

- 22.2 **Recommendation:** Where installing an STCA, MSAW, APW or APM system it should comply with the Relevant Eurocontrol Specification accessible via the link given above.
- 22.3 Where a Service Provider chooses not to install warning facilities where a risk that could be addressed by the use of safety nets is identified (such as Controlled Flight Into Terrain), it is expected that clear evidence that it is impractical to install the system will be provided (2317).

- 22.4 Where the ground based safety net contribution is necessary in achieving the acceptable level of safety:
- a) the integrity, reliability and continuity of the safety net shall ensure that it is capable of supporting the achievement of the acceptable level of safety;
  - b) measures shall be in place to ensure the safety of traffic in the event of a complete failure of the safety net.
- 22.5 Permanent or temporary withdrawal of such a safety net shall only be permitted provided that alternative measures are in place and capable of mitigating the risk to an acceptable level at all times.
- 22.6 Appropriate training shall be provided to controllers to ensure the safe handling of traffic in the event of failure, withdrawal or limitations of all safety nets.
- 22.7 Any warning and alerting information derived from surveillance data shall be presented to the controller in a manner (visual or audible) that does not result in any detrimental impact to the routine provision of air traffic control services (2318).
- 22.8 Measures shall be taken to minimise the presentation of 'nuisance' alerts (2319).
- 22.9 It shall be possible to silence an audible alert, whilst continuing to present visible information for as long as a hazard exists, so as to avoid any detrimental impact to the routine provision of air traffic control services (2320).
- 23 Data Recording Facilities**
- 23.1 See SUR 10 for surveillance data recording requirements.

## Part 3 Requirements – Ergonomic Aspects

### 24 Safety Objective

To ensure the operation of surveillance data displays is unambiguous and does not compromise the safety of the Air Traffic Service (1714).

### 25 The Specification of the Display HMI

#### 25.1 Operational Requirement

The specific operational requirement (OR) for the equipment shall be defined (636).

#### 25.2 Evaluation

25.2.1 A formal ergonomic evaluation shall be carried out to ensure that the safety of the ATS is not compromised (637).

### 26 HMI Definition

26.1 The following stages are recommended in the definition of an HMI. In each case, the impact on ATC should be assessed and justified with respect to the OR and the Safety Objective (638).

26.1.1 **Recommendation:** The activities that the system should perform should be defined (639).

26.1.2 **Recommendation:** The events that can occur that require a cognitive or perceptive response should be defined (640).

26.1.3 **Recommendation:** The tasks that the system should accomplish in order to respond to the events and activities should be defined (641).

26.1.4 **Recommendation:** The tasks should be ranked in order of priority according to the OR (642).

**NOTE:** As referred to in CAP 760 ([www.caa.co.uk/CAP760](http://www.caa.co.uk/CAP760)), adequate attention must be made to Human Factors, in assessing HMI. The link below provides a list of useful ICAO documents, including Doc. 9758 Human Factor Guidelines for Air Traffic Management (ATM) Systems.

<http://www.icao.int/anb/humanfactors/Documents.html>

### 27 Functional and Performance Requirements

#### 27.1 Confirmation of Activation

27.1.1 The input device shall give immediate confirmation of selection (643).

**NOTE:** This does not mean that the equipment shall carry out the function selected immediately.

## 28 Selection Time

28.1 The selection time shall correlate with the priority level (644).

**NOTE:** This is defined as the time between first confirmation of activation and function available.

28.2 **Recommendation:** The following are recommended:

- a) Less than 1 sec for high priority (645).
- b) Less than 5 sec for medium priority (646).
- c) Not defined for low priority (647).

**NOTE:** Other times may be justified as appropriate to the specific OR.

## 29 Wait Indication

29.1 The system shall indicate its indeterminate state during the time between confirmation of activation and function available (648).

29.2 **Recommendation:** All input should be prohibited, except cancellation, during this wait period (649).

## 30 Traceability of Device Specification

30.1 **Recommendation:** The mechanical performance of all input devices should be specified to a recognised test standard (650).

## 31 Input Devices Technical Requirements

### 31.1 Safety Objective

**The input devices shall not mislead or hinder the operator or be capable of unintended action (651).**

### 31.2 General

The following requirements and recommendations are made in respect to specific input devices. These devices shall be appropriate to the task, have consistent performance characteristics and facilitate ease of use (652).

31.3 **Recommendation:** All input devices on the workstation should have appropriate characteristics. Specific regard should be made to the following:

- a) Size of input device (653).
- b) Separation between input devices (654).
- c) Feedback method – aural, tactile or visual, as appropriate (655).
- d) Displacement, e.g. push distance (656).
- e) Labelling (657).
- f) Actuating force (658).

- g) Suitability to task (659).
- h) Response time (660).

31.4 **Recommendation:** The equipment should not use rotary selection switches to select more than 10 discrete positions (661).

31.5 **Recommendation:** The equipment should not use thumbwheels for high or medium priority controls (662).

31.6 **Recommendation:** Non-tactile switches should activate on the first activation. This is equivalent to the down stroke (663).

**NOTE:** Non-tactile switches that have no displacement feedback: Examples include infra-red touch-panels, magnetic pick-up, capacitive pick up etc.

31.7 **Recommendation:** Equipment should not use lever switches to select more than 3 discrete positions (664).

## 32 Menus

32.1 All menus shall be appropriately positioned (665).

32.2 **Recommendation:** Menus should not impede the primary task (666).

32.3 **Recommendation:** Equipment should locate each high priority function not lower than the second page of any menu (667).

32.4 **Recommendation:** Equipment should locate each medium priority function not lower than the third page of any menu (668).

32.5 **Recommendation:** Each page should have an available selection to return up one level, return to top level and exit (669).

32.6 **Recommendation:** All functions should be by positive selection (670).

## 33 Compliance with Standards

33.1 The relevant ergonomic standards for which the display system has been designed shall be identified.

33.2 **Recommendation:** All display systems used for display of air traffic surveillance data should comply with ISO 9241 standard for display systems.

## Part 4 Requirements for Surveillance Display Map Generation

### 34 Safety Objective

The process of surveillance display map generation shall provide complete and accurate reference data for ATS (1715).

### 35 Procedure for Production and Update of Display Maps

- 35.1 Display map generation shall be subject to formal configuration management (671).
- 35.2 Each map or generation of map shall be given a unique identifying label (672).
- 35.3 The map as displayed on the equipment shall display this label (673).
- 35.4 In addition, documentation shall use this label to show the origin and contents of the information used on the map (674).
- 35.5 The individual elements to be included on the map shall be identified and documented in the Operational Requirement (676).
- 35.6 **Recommendation:** The definition of such elements should be in terms of ATS requirements. These elements should include the following:
- a) Visual reporting points (677).
  - b) Adjacent airfields (678).
  - c) Adjacent areas of flying activity. For example, hang gliding sites, parachuting sites, etc. (679).
  - d) Danger areas, prohibited areas etc (680).
  - e) Limits of controlled airspace (681).
  - f) Runway extended centrelines (682).
  - g) Map north marker (683).

**NOTE:** For certain ATS units additional points may be required.

- 35.7 **Recommendation:** A member of the ATC Department should carry out Step 35.5 and 35.6 (684).
- 35.8 The map presented shall have specific graphic representation for the following entities:
- a) FIR/UIR borders
  - b) Lateral limits of sectors
  - c) Terminal control areas
  - d) Control zones
  - e) Traffic information zones
  - f) Airways and ATS routes
  - g) Restricted areas

35.9 The identified features shall be referenced to defined geodetic co-ordinates (685). In addition, the procedure shall state the geodetic system used to define these geographical locations (686).

35.10 **Recommendation:** The procedure should define the conversion of the geographical co-ordinates to the system geometry. It should also state the algorithms or processes used to convert this data (687).

### **36 Verification**

36.1 Provisions shall be made to check the displayed data for accuracy and completeness (689).

36.2 The original production or change request shall be compared with the resulting map information (690).

36.3 **Recommendation:** This should include a procedure for checking the absolute accuracy of the displayed maps (691).

36.4 **Recommendation:** A member of the ATC Department should carry out the verification (692).

### **37 Validation**

37.1 The final user shall evaluate the whole map prior to introduction to service (693).

37.2 **Recommendation:** A member of the ATC Department should carry out the validation (694).

37.3 A procedure shall exist to ensure that the map always contains all operationally significant information (695).

### **38 Responsibilities for Control of Surveillance Display Maps**

38.1 The display map documentation shall identify all posts responsible for the control of the video maps (696).

### **39 Tolerances on Display Map features**

39.1 For a display used for SRA, all features used in the SRA zone shall be accurate to within 5% of range scale +55 metres (180 feet) in range and within 1 degree measured from the airfield reference point (697).

39.2 **Recommendation:** For raster scan display systems, all features should be accurate to within the resolution of the display (698).

39.3 For all other features accuracy shall be within 450 metres (0.25 NM) (699).

### **40 Changes to Surveillance Display Maps or SRA Maps**

40.1 **Recommendation:** Methods independent of the original source should be used for proof of changes which are independent of the original source (708).

## 41 Consideration on Mapping Co-ordinate System

**NOTE:** When producing display maps the aim is to place the feature at the position where the radar sensor would place a co-located target. However, as the radar calculates by range and angle, this will not account for the change in angle between grid north and magnetic north. In addition all systems use published geographical co-ordinates to derive the feature position in range angle. Use of a different system to convert the geographical co-ordinates from that used to derive the original geographical co-ordinates will produce an error. The procedures in Sections 4, 6 and 7 will evaluate these errors.

41.1 **Recommendation:** The display maps should be in WGS84 format (709).

# **SUR 12 Performance Assessment of Surveillance Systems**

## **Part 1 Preliminary Material**

### **1 Introduction**

Surveillance systems require performance assessments to be carried out prior to an Air Navigation Order (ANO) Article 205 Approval can be granted (803) including flight trials where necessary. Performance assessment may comprise of flight trials, targets of opportunity traffic analysis using both manual and automated means of assessment. It is also necessary to assess the on-going performance of surveillance systems once commissioned and put into service, and when changes are introduced into existing systems.

The following document details the requirements for such performance assessments and verification tests.

### **2 Scope**

This document applies to all surveillance sensor equipment providing data for an Air Traffic Service (ATS) and requiring approval under Article 205 of the ANO.

Although some requirements in the document commonly apply to any test of a similar nature, it does not specify the requirements concerning tests conducted to assess performance of surveillance systems to address a specific problem, e.g Wind turbine interference, Interference testing.

## Part 2 Requirements

### 3 Safety Objective

To test in a practical manner that the ground based surveillance system meets its Operational Requirement (OR) (1719) on commissioning and during its operational lifetime.

### 4 General Requirements

- 4.1 In accordance with the SPI IR Article 7, ANSPs shall assess the level of performance of ground based surveillance chain before putting them into service as well as regularly during the service, in accordance with the requirements set out in Annex V of that regulation.

**NOTE:** It is not mandatory to conduct trials or tests to assess system performance for every safety related change to surveillance systems and their constituents. The need for the performance assessment trials upon a safety related change will depend on the nature of the change and the system constituents subject to change (e.g. implementation of an entire surveillance system will require performance assessment trials to be carried out prior to entering operational service, while a replacement of part of a display system may only require a relatively simple performance assessment to be carried out).

- 4.2 Performance of the surveillance system shall be verified by the ANSP by actual measurement (i.e. not by simulation models) using the data available at the output of the surveillance system.

**NOTE:** Refer to Annex A for a schematic diagram of a surveillance system.

- 4.3 The performance assessment of the surveillance systems shall include performance of all elements in the ground based surveillance chain, i.e. transmitters, receivers, data transmission links, data processing systems, data fusion systems and display systems.

**NOTE:** Where an HMI is used, the HMI ideal settings (i.e. display settings such as font style, contrast etc) may be analysed separately following a Human Factors Assessment.

- 4.4 Where the HMI performance contributes to the number of hazards or the probabilities at which the hazards occur, the HMI performance shall be justified as suitable for the intended use. This should include where possible, testing and verification of the performance aspects of the HMI that could be tested in a practical manner.

**NOTE:** Performance of the HMI can affect the integrity of the data being presented, or to the continuity, reliability, availability of the overall ground based surveillance chain (i.e. integrity safety requirements), hence must be included in the analysis of failure modes.

- 4.5 Any testing and performance assessment carried out by an ANSP during the performance assessments could only demonstrate a limited range of performance parameters defined in the required performance stated in paragraph 6.4 in SUR 02. These can comprise of parameters such as accuracy, resolution, false target rates, processing delays etc. The performance parameters that will be tested during the ANSP performance assessment shall be defined. These must include testing data items critical for safe operation.

**NOTE:** Evidence gathering to demonstrate that the system supports the integrity requirements of the ground based surveillance chain via ANSP performance verification testing becomes impractical due to the limited duration and the limited number of circumstances within which the system can be tested in a practical manner. The evidence

supporting that a system meets with the integrity requirements must be provided, this may comprise of historical performance data, or based on assurance and evidence provided by the manufacturer regarding the system integrity performance. The ANSP shall seek evidence or choose sample tests to validate a performance prediction model which the manufacturer applied in order to provide performance assurance data.

4.6 Where performance is measured for the complete end-to-end surveillance chain (i.e. including airborne and ground sub systems), it shall be possible to distinguish the performance level attributable to the ground based surveillance chain.

4.7 Where an ANSP relies on airborne systems to provide data items necessary to provide the air traffic services, the suitability of the onboard transmitting equipment and sub systems providing each data item, shall be justified.

**NOTE:** The onboard transmitting equipment (e.g. transponder) and other airborne systems providing surveillance data (e.g. GPS signal) may be safety assessed under existing airborne system certification processes.

4.8 The continuity, reliability and availability of such data items transmitted by onboard systems, received by the ground based system shall be safety assessed and justified as suitable for provision of service.

**NOTE:** Aircraft manoeuvres, jamming or interference effects can cause loss or corruption of the signal received by the ground surveillance sensor.

## 5 Test Targets

5.1 All methods used for test target generation for the purpose of performance assessment shall be specified.

**NOTE:** Targets for test purposes could be provided by using a dedicated test flight, Targets of Opportunity Traffic (ToP), In-built test target generators or injected test targets.

5.2 Where, a dedicated test target is used, the target shall have an RCS of approximately  $1\text{m}^2$  or alternatively be representative of the size of the smallest target likely to operate in the ANSPs operational environment.

5.3 Where ToP traffic is used for performance analysis, the approximate target sizes shall be known for those tests used for probability of detection analysis.

5.4 The suitability of test target type used for the test for assessing the parameter(s) shall be justified.

5.5 Where injected test targets are used evidence shall be provided of the measured target parameters, e.g. Power level.

## 6 Performance Assessment Methodology and Techniques

6.1 All techniques and methodologies (both manual and automatic) used for performance analysis shall be specified along with the parameters assessed by each methodology.

**NOTE:** Performance assessment could be performed with target counting software, manual observation, manual calculation, or by using special software tools such as SASS.

6.2 Suitability of the performance assessment methodology for assessing the performance of the parameters of interest shall be justified.

6.3 Where results are assessed by manual observation, assessment shall be performed by suitable personnel, and the results shall be logged with time of applicability.

## 7 Test Environment

7.1 Where ToP or Flight Trials are used for assessing performance of a surveillance system, the performance shall be assessed within the coverage volume where the service is provided using the data from the surveillance system.

7.2 In uncontrolled airspace where services are provided only for the participating aircraft and it is necessary to assess performance parameters involving more than one aircraft, the results shall be verified between aircraft to which the service is provided.

7.3 Performance parameters likely to be affected by the following shall be identified with respect to following in an ANSP specific operational environment:

- Aircraft behaviours (e.g. special manoeuvres, velocity, direction etc)
- Weather Effects (e.g. Rain, snow, wind etc)
- External Interference sources (e.g. phone masts, other radar like transmitters)
- Terrain Effects (e.g. mountains, sea)
- Other noise, clutter or interference sources likely to affect performance (e.g. wind turbines)

**NOTE:** The impact these may cause may depend on the specific surveillance equipment used by an ANSP to provide services. Although an ANSP may not have identified all current or future sources that may exist in its environment that affect the performance of their surveillance equipment, any prominent features listed in categories above should be accurately identified. When establishing performance of a surveillance system, it is important to know the exact conditions in which the surveillance system delivered the measured performance.

## 8 Tests for Confirming Performance using Performance Prediction Models

8.1 Where simulated tests are used to assess performance, ANSPs shall ensure the input parameters and assumptions used in the simulated model are valid for the test and the operational context.

8.2 Simulated tests shall be as close an approximation to the real environment as possible in terms of target model, target behaviour, surveillance system, ANSP operational context, weather, terrain etc.

8.3 ANSPs shall identify which specific practical scenarios are used for verifying the prediction model, along with all the parameter settings.

**NOTE:** ANSPs may conduct tests for chosen scenarios, to confirm performance predicted based on a prediction model, where testing all such scenarios become impractical or cannot be tested within a practical duration.

## 9 Performance Assessment Duration

- 9.1 The test periodicity or duration shall be justified as adequate to test the parameters subject to assessment.

## 10 Positional Accuracy Assessment

- 10.1 Where accuracy is assessed in comparison to a second surveillance system with a known accuracy, the accuracy of the system used for comparative assessment shall be justified.
- 10.2 Where accuracy is assessed independently of another surveillance system, the position of the test target shall be recorded by independent and suitable means.
- 10.3 Positional accuracy assessment shall assess the accuracy of the system in the areas of operational significance.

## 11 Coverage Analysis

- 11.1 Tests shall be conducted to prove the required level of detection within the coverage volume defined by the operational requirement.
- 11.2 As the system provides a large coverage volume and it might be impractical to conduct practical tests throughout the coverage volume, tests shall at least cover detailed analysis into operationally significant areas.

**NOTE:** Such significant areas will include, as appropriate:

- a) Handover areas.
  - b) Holding areas.
  - c) Typical airway routes.
  - d) Areas with clutter or reflection problems.
  - e) Upper and lower boundaries of operational cover.
  - f) The approach
  - g) For mode S systems requiring a discrete IC code operation, the validity of the assigned coverage map
- 11.3 Tests shall contain scenarios to demonstrate:
- a) lower vertical boundaries
  - b) upper vertical boundaries
  - c) maximum range
  - d) establish cone of silence area (where applicable) or boundaries of areas of non detection
- 11.4 Detection at the edge of coverage shall be confirmed with a target of 1 m<sup>2</sup> RCS or the smallest target size likely to operate in the service area.
- 11.5 Coverage analysis shall contain an appropriate series of vertical levels to demonstrate that the surveillance sensors provide adequate coverage in the required coverage volume both in horizontal and vertical dimensions.

- 11.6 **Recommendation:** The test should include slices at 1,000, 2,000, 4,000, 6,000, 10,000, and 20,000 ft above the aerodrome reference point and as appropriate to the OR (811).
- 11.7 Test scenarios shall include target motion in inwards (centripetal) and outwards (centrifugal) directions from any system based on detection by a single sensor (e.g. radar/ADS-B) and scenarios including tangential motion.
- 11.8 In addition test scenarios shall also include at least one climb and/or descend scenarios ideally from the bottom of coverage through to the top of coverage volume.
- 11.9 A suitable horizontal test profile covering 360° horizontal coverage of the sensor or the sensor network shall be performed at a level equivalent to the base of the required coverage, the top of the required coverage and at a suitable medium level in between.
- 11.10 Standard manoeuvres, manoeuvres to test the boundaries of flight path defined by operational procedures, and any special manoeuvres of aircraft operating in the airspace shall be included in the accuracy analysis.

## 12 Resolution Check

- 12.1 The performance assessment shall include tests to check the resolution capability of the system in terms of the minimum separation standards or deconfliction minima as required in the OR (831).
- 12.2 The resolution capability of the system shall be evaluated in both 'standard' areas and areas of clutter and reflections (832).

## 13 False Targets and False Tracks

- 13.1 The overall system performance assessment calculations shall exclude false targets as much as practically achievable.

**NOTE:** False target report is defined as a target report that does not correspond to the actual position of a real aircraft target at the time it was presented to the user, which contains as the minimum the 2D positional data and the time of applicability of 2D positional data.

- 13.2 The method of identifying false target for manual or automated calculation processes shall be justifiable (e.g. well known clutter areas, reflections etc).

## 14 Latency Checks

- 14.1 The latency introduced by the ground based surveillance system shall be verified during performance assessment tests.
- 14.2 Total end-to-end delay shall be justified as acceptable and shall be tested as part of a dedicated flight test.
- 14.2 The delay to the GNSS positional data and other airborne data items including Special Position Indicator, Emergency Indicator and Pressure Altitude shall be tested as part of the dedicated flight trial, where such data items are applicable to the service.

## 15 Testing Down-linked Aircraft Parameters

- 15.1 Performance assessment shall consist of tests to demonstrate successful receipt and decoding of Down-linked Aircraft parameters.
- 15.2 Any loss, or corruption introduced by the ground system shall be verified through a practical test.

## 16 Recording Test Results

- 16.1 Where the results are not assessed in real time the surveillance data resulted from testing shall be recorded by suitable recording equipment.
- 16.2 The recording equipment shall meet the recording equipment requirements stated in SUR 10 paragraphs 5, 8 and 10.
- 16.3 The errors in the collection and recording of data shall be calculated and justified.

**NOTE:** This may include:

- a) The resolution error in any recording devices.
  - b) The error in the equipment used to determine the aircraft position.
- 16.4 **Recommendation:** Target returns registered in each block of airspace should be recorded and analysed in order to identify areas of anomalous replies (813).

## 17 Tracking Performance

- 17.1 The performance assessment shall determine the following:
- a) Missed detections (individual updates)
  - b) Duration and number of consecutive missed detections
  - c) Track discontinuities
  - d) Track seduction
  - e) Track initiation
  - f) Track deviations
  - g) False tracks
- 17.2 The number of consecutive missed detections that can be tolerated shall be justified.
- 17.3 The maximum error of the deviated tracks shall not exceed the maximum horizontal position error defined in the required performance criteria.
- 17.4 Any track initiation problems, track seduction or discontinuities shall be further investigated and shall be justified as acceptable for safe operation.
- 17.5 For non-plot extracted systems, any track fading effects must be assessed.

## 18 Surveillance System Test Configuration

- 18.1 Where service will be provided with one surveillance technique alone, performance of each surveillance technique operating alone shall be performance assessed for the operational service provided.

**NOTE:** For example in normal operation WAM and PSR may be used as the main sources of surveillance data. However PSR alone may be used in WAM failure.

- 18.2 Where the service is provided by simultaneously using multiple surveillance sources operating as combines or in parallel the simultaneous configuration shall be performance assessed.

- 18.3 The performance assessment shall assess the surveillance sensor in all the configurations intended for operational use (807).

**NOTE:** Such configurations may include multiple PRFs, polarisation settings, interrogation patterns etc.

- 18.4 In situations where the OR requires ground based surveillance sensor to detect replies/squitters of more than one type of co-operative aircraft surveillance equipment, the performance assessment shall demonstrate ability to provide surveillance data from each type.

**NOTE:** Some sensors are expected to receive and decode signals from multiple surveillance sources onboard aircraft (e.g. an MLAT system can detect Mode A/C targets as well as ADS-B targets in an SSR and ADS-B mixed environment).

## 19 Performance Assessment for SRA

### 19.1 Accuracy Assessment for SRA Procedures

#### 19.1.1 SRAs terminating at 0.5 NM or 1 NM from touchdown point

- 19.1.2 The following accuracy assessment is required for any surveillance system, intended for use for such procedures:

- 19.1.3 For each SRA procedure intended, a minimum of 3 aircraft or helicopter tracked approaches shall be carried out (822).

- 19.1.4 Where 0.5 NM SRA is proposed, for each approach the target position shall be recorded at threshold, 0.5 NM, 1 NM, 2 NM and 3 NM from touchdown and compared against the controller reported position (823).

- 19.1.5 **Recommendation:** For SRAs terminating at 1NM or less from touchdown point, for each approach the target position should be recorded at 0.5 NM, 1 NM, 2 NM and 3 NM from touchdown and compared against the controller reported position (824).

**NOTE 1:** To assist in the selection of appropriate range points these ranges can be  $\pm 0.25$  NM.

**NOTE 2:** The following is a suitable method for obtaining the aircraft position:

- a) Bearing by use of theodolite tracking of a suitably equipped aircraft using trained operators from an approved flight check organisation.

- b) Range checking by use of visual reporting points.

## 19.2 Coverage Assessment for SRA

- 19.2.1 If SRAs are provided using the surveillance sensors, a dedicated flight trial shall demonstrate the accuracy and Pd, of the surveillance sensor as appropriate, over the SRA approach path up to the SRA terminating distance.

## 20 Surface Movement Control Applications

- 20.1 Surveillance systems implemented for surface movement applications such as SMGCS or ASMGCS, the tests shall demonstrate adequate vertical and horizontal coverage, accuracy and resolution.
- 20.2 The critical areas shall be identified (e.g.: manoeuvring area on the runway) and the tests shall demonstrate that the system is capable of achieving the required coverage, accuracy and resolution over these areas.
- 20.3 Where the surface movement application also requires coverage over the aerodrome surrounding airspace (ex: for A-SMGCS) tests (dedicated flying or ToP) shall demonstrate the surveillance system achieves the required vertical and horizontal coverage according to the operational requirement.

## 21 Systems using ADS-B data

- 21.1 For systems using ADS-B position data the positional accuracy can only be affected by the on-board latency, data link latency, and during ground system processing and transmission.
- 21.2 The performance assessment shall demonstrate the range performance (vertical and horizontal coverage) of the ADS-B ground station is adequate to the required operational coverage.

**NOTE:** The ADS-B receiver sensitivity and the power of the transmitted signal by the airborne equipment are key to the range performance.

- 21.3 A flight trial may be necessary to demonstrate the coverage of the ADS-B ground station (e.g. Mode S ES) depending on whether or not the coverage of the ADS-B receiver station has been demonstrated previously over the required coverage area (e.g. If the coverage of MLAT receivers capable of receiving ADS-B reports is already proven over the required coverage area, it is not necessary to trial its range performance again.).
- 21.4 The ground system processing and transmission performance's effect on the accuracy of the positional information can occur by delays, losing or corrupting data. Where the ADS-B receiver ground station coverage has already been demonstrated, the performance of the ground system processing and transmission can be demonstrated by simple trials based on the ground or by simulation.

## 22 Systems using MLAT data

- 22.1 For Multilateration systems that are implemented for applications other than surface movement applications, flight trials shall demonstrate that the system is capable of achieving required coverage in the required operational levels.

**NOTE:** MLAT systems providing data for an A-SMGCS where detection is necessary in the

aerodrome surrounding airspace (e.g. within 5 NM), a flight trial shall be necessary to demonstrate the coverage and accuracy.

22.2 Any areas with lack of detection and/or degraded accuracy within the operationally required area of coverage shall be identified.

22.3 The flight trials shall comprise of a flight flying over the lower vertical and horizontal boundaries of the expected coverage area to determine accuracy and coverage.

#### 22.4 **N-1 Analysis**

22.4.1 MLAT performance assessment trials shall also comprise of trials to demonstrate the achievable coverage upon failure of a receiver in the system covering multiple scenarios.

22.4.2 In a system with many receivers it may be impractical to trial every scenario of a failure of each receiver. In such cases the most critical scenarios shall be trialled.

22.4.3 Where the implementer has decided to continue service upon failure of 2 or multiple receivers, the trials shall demonstrate that the system is capable of achieving the required accuracy and coverage upon failure of the receivers.

#### 22.5 **Detection of Mode A, C, S and ADS-B Targets**

22.5.1 MLAT systems that are expected to receive and process Modes A/C, S and ADS-B positional information, the performance assessment trials shall demonstrate that the system is capable of receiving and processing targets having Mode A/C, S SSR transponder types and ADS-B targets.

22.5.2 Trials shall also demonstrate that in a mixed environment where targets with varying cooperative techniques are expected, the system is capable of receiving and processing them simultaneously and presented to the user in a standard update rate.

**NOTE:** Various techniques may have differing rates of update, e.g. ADS-B may send information every 0.5 seconds while a radar may update information every 4 seconds only. The trial should demonstrate that the targets received at varying update rates are presented to the user in a correct and a usable manner according to the required update rate.

### 23 **Assessment of Maps and Remote Field Monitors**

23.1 As part of the performance assessment tests the accuracy of the display maps shall be confirmed (825).

23.2 A number of significant map features shall be chosen and a suitable reference shall be determined for each feature (826).

#### 23.3 **Surveillance Display Maps**

23.3.1 Where new RDP and display systems are implemented, at least three features of new display maps shall have the accuracy assessed as part of the flight trial for the equipment (700). The tolerance on this accuracy shall be better than 900 metres (0.5 NM) (701).

23.3.2 **Recommendation:** These features should, wherever possible, be in three quadrants of the display (702).

**NOTE:** A new video map has no predecessor. Sites which have new radar or map generation equipment produce new maps.

23.3.3 **Recommendation:** The accuracy assessment should ensure that the features shown correspond identically to those displayed at adjacent ATC units (703).

**NOTE:** Co-ordination between adjacent units is an important ATC function.

23.3.4 **Recommendation:** Co-ordination should be evaluated whenever opportunity occurs (704).

#### 23.4 **New Surveillance Radar Approach (SRA) Maps**

23.4.1 New SRA maps shall be assessed for bearing and range error at 6 NM, 3 NM, 2 NM, 1 NM and 0.5 NM as appropriate to the intended SRA termination range (705). The assessment shall be by use of an aircraft with independent positioning equipment on board an aircraft or fixed ground mounted reflection sources (706).

23.4.2 **Recommendation:** Internal or external positioning equipment may be used to determine aircraft position, for example, theodolite or INS etc (707).

23.5 The trials shall also include the verification of performance of the remote monitors such as Permanent echoes and Test Transponders.

23.6 The assessment of Remote monitors shall include as a minimum the verification of horizontal position information accuracy and end-to-end system delay.

### 24 **Ongoing Performance Analysis and Verification**

24.1 Measurements shall be in place to ensure continued satisfaction of the system performance.

24.2 All types of techniques including Remote Field Monitors, BITE, external monitoring methods, employed for on-going performance monitoring shall be identified with the distinct purpose of each type of monitoring mechanism.

24.3 Any partial or complete reliance on external monitoring mechanisms for on-going performance monitoring shall be identified.

24.4 Any dependency on other surveillance systems being available for on-going performance monitoring shall be identified.

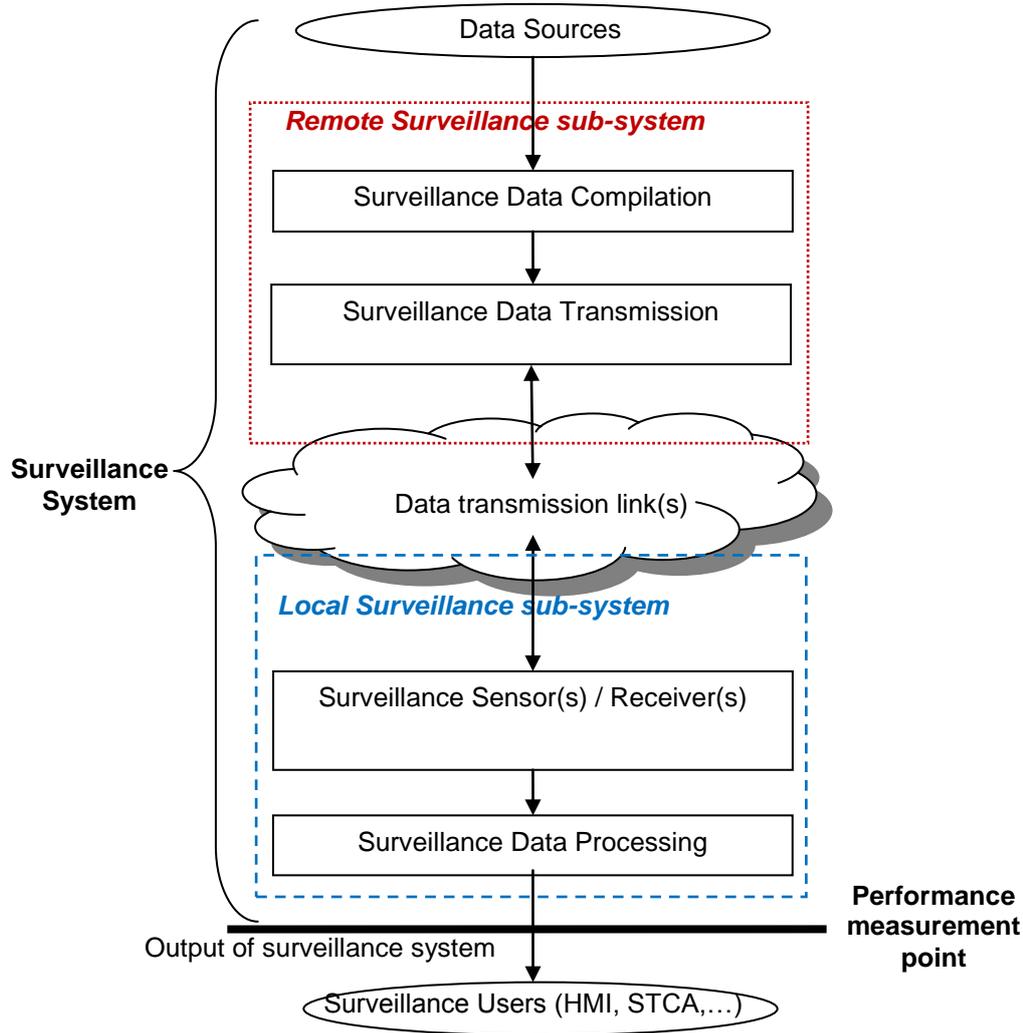
24.5 Any system status indications provided to controller by means of visual or audible means shall be clearly defined.

24.6 Any instances of failures to meet the required performance criteria determined via the on-going performance monitoring mechanisms or by controller observation shall be recorded.

**NOTE:** Such instances may be either recorded in monitoring systems and retrievable when necessary or shall be logged in written form in the case of controller observations.

- 24.7 Complete loss or failure of the surveillance sensors, ground-based data transmission links, processing systems, display systems, HMIs, recording systems and ground based system components such as power supply units, vehicle identification units, external monitoring devices shall be logged/recorded.
- 24.8 **Recommendation:** Where practicable a SASS-type performance analysis should be performed at sufficient intervals to assess that the system meets the operational requirements during its operational lifetime.
- 24.9 Where such on-going performance assessment determines that required performance is not met for a safe operation, the relevant Regional Office Inspector shall be informed and appropriate course of action shall be agreed.

# Annex A A Schematic Diagram of a Surveillance System



## **Annex B Guidance for the use of Multistatic Radar Systems in ATS Applications**

### **1 Introduction**

- 1.1 Multistatic is an emerging concept that is becoming an increasingly popular method of providing surveillance data for Air Traffic Service applications. It is being trialled in several European countries to prove the concept and ANSPs are becoming increasingly enthusiastic on multistatic techniques as it provides an alternative to traditional PSR for the detection of non-co-operative targets.
- 1.2 These systems may use transmitters of opportunity like radio and television broadcast stations and mobile telephone base stations. Alternatively, dedicated transmitters can be specially deployed to avoid relying on third party illuminators. The signal received via the reflected path is cross correlated with the direct signal from the transmitters in order to locate the position of the target reflecting the signals which is the same principle used in multilateration systems. Similar to MLAT systems, MSPSR systems can also be active or passive depending on whether or not the system uses dedicated transmitters.

### **2 Active Multistatic Systems**

- 2.1 Where the existing level of transmissions do not meet the required performance or are not sufficient to achieve coverage over the entire coverage area required by the operational requirements, transmitters may be added to achieve the level of coverage and to ensure the required performance is met by the multistatic surveillance system.
- 2.2 The active Multistatic systems shall be subject to frequency licensing and transmitter requirements.
- 2.3 The amount of transmissions shall be kept to the minimum possible level. Such transmissions shall be subject to spectrum protection requirements in Article 5 of the SES Surveillance Performance Interoperability regulation mentioned in SUR 01 paragraph 5.1.

### **3 Performance Requirements**

- 3.1 Where a multistatic system is used to replace an existing PSR, the multistatic system shall as a minimum demonstrate to meet the equivalent radar performance.
- 3.2 The requirements in SUR 06 "Requirements for Multilateration Systems" paragraphs 4 to 15 shall be applicable to the Multistatic systems.

### **4 Pre-operational Trials**

- 4.1 Prior to entering operational service the system shall be subject to a period of pre-operational trial which tests and verifies the overall system performance throughout the required area of coverage.

## Annex C Introduction to Surveillance Applications and Services in the UK

The purpose of this Annex is to introduce the Current Surveillance Based Air Traffic Services in the UK and explain the terms “Services”, “Applications” and “Functions” used in the scope of CAP 670 SUR section.

### 1 General

- 1.1 Surveillance is used in civil aviation for many purposes, including ATM, weather reporting, terrain avoidance, and search and rescue.
- 1.2 Data derived from surveillance systems/equipment can be used directly or as an aid for the provision of various air traffic services defined for inside the controlled airspace and for those in uncontrolled airspace known as ATSOAS services.

### 2 Air Traffic Services based on Surveillance Data

- 2.1 In the UK, traditionally the type of surveillance based Air Traffic Services are as follows:

Type of Airspace	Surveillance Service
Controlled Airspace Radar Control Service	Radar Control Service
Outside Controlled Airspace	Deconfliction Service or Traffic Service

- 2.2 Surveillance services provided outside controlled airspace (Deconfliction Service and Traffic Service) are detailed in Section 1 Chapter 11 of CAP 774 UK Flight Information Services.

### 3 Applications based on Surveillance Data

The term application is used to define a specific use for which surveillance data is used. Whilst the Air Traffic Service officially declared can be categorised as a Radar Control Service, or a Traffic Service, surveillance data can be used for a specific utilisation that directly or indirectly supports the provision of the Air Traffic Service.

For example, Radar Control service can be provided in en-route airspace or in an approach environment for the purpose of separation. In the en-route airspace this may be 10NM distance based separation or a time based separation. In the approach environment this may be 5 NM or 3 NM distance based separation.

Following are some examples of such applications:

#### In an approach environment

- 3 NM distance base separation
- Surveillance Radar Approaches

**On an Aerodrome environment**

- For Air Traffic Monitor (ATM) which is a supporting tool
- For Surface Movement Guidance and Control System (SMGCS), or an Advanced SMGCS which is a tool used for providing aerodrome control service

**4 Surveillance data related functions**

A function describes a specific task that can be performed using surveillance data. There are many functions for which surveillance data can be used for. The systems designed for various applications described above may have one or more specific functions that use surveillance data:

- Separation of arriving, departing and en route traffic;
- Vectoring;
- Flight path monitoring;
- Position information to assist in the navigation of aircraft;
- Monitoring traffic to provide information to the procedural controller;
- Assistance to aircraft crossing controlled airspace;
- Information on the position of aircraft likely to constitute a hazard;
- Avoiding action;
- Information about observed weather for pilots and other controllers;
- Assistance to aircraft in emergency;
- Surface surveillance;
- Detection of foreign object debris;
- Safety Nets e.g. Short Term Conflict Alert (STCA/RIMCAS/APM).

## **Annex D List of useful ICAO Documents on Ground Based Surveillance Systems**

The following ICAO Documents and circulars are useful sources of information for the planning and implementation of various surveillance techniques.

### **1 Documents**

- a) ICAO Doc 9924 - Aeronautical Surveillance Manual
- b) ICAO Doc 9871 - Technical Provisions for Mode S Services and Extended Squitter
- c) ICAO Doc 9861 - Manual on the Universal Access Transceiver (UAT)
- d) ICAO Doc 9830- Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual
- e) ICAO Doc 9694 - Manual of Air Traffic Services Data Link Applications
- f) ICAO Doc 9688 - Manual on Mode S Specific Services
- g) ICAO Doc 9684 - Manual on the Secondary Surveillance Radar (SSR) Systems
- h) ICAO Doc 9476 - Manual of Surface Movement Guidance and Control Systems (SMGCS)
- i) ICAO Doc 8071- Manual on Testing of Radio Navigation Aids Volume 3 (Testing of Surveillance Radar systems)

### **2 Circulars**

- a) ICAO advisory circular 174: Secondary Surveillance Radar Mode S
- b) ICAO Circular 212 Secondary Surveillance Radar Mode S Data Link
- c) ICAO Circular 226 Automatic Dependent Surveillance
- d) ICAO Circular 256 - Automatic Dependent Surveillance (ADS) and Air Traffic Services (ATS) Data Link Applications
- e) ICAO Circular 326- Guidelines for Implementation of ADS-B and Multilateration Systems
- f) ICAO Circular 21 - Timed Approaches and Utilisation of Radar in Spacing of Aircraft on Final Approach

## Annex E UK Approach for Provision of Surveillance for ATS

- 1.1 The purpose of this Annex is to make ANSPs aware of the regulatory approach the CAA, as the National Regulator, has taken regarding the approval of Air Traffic Surveillance Systems, and regarding the ongoing activities concerning the future of surveillance infrastructure in the UK.
- 1.2 The UK surveillance infrastructure has been mainly based on PSR and SSR to date and these techniques were included as mandatory requirements in CAP 670 SUR sections. The national airborne equipage carriage requirements are published in the UK AIP GEN1-5 section 5.3 and is currently limited to SSR transponder Equipment.
- 1.3 There is increasing interest in other co-operative systems such as Multilateration, ADS-B and ADS-C and non-co-operative techniques such as Multistatic radar amongst countries worldwide including the UK. Standards such as SARPS have already been developed for such systems.
- 1.4 As a member state of the European Union, the UK must comply with the European law mandated by the European Commission, in the form of regulations such as SES Interoperability IRs. As such any provisions mandating specific technologies for airborne equipment and ground surveillance systems must be complied with.
- 1.5 In addition to technologies prescribed by the European law, the National Supervisory authorities can impose national requirements in terms of airspace, airborne equipage and ground surveillance infrastructure. The CAA has initiated work reflecting the Future Airspace Strategy (FAS) and other related Government imperatives to determine the best options for the surveillance infrastructure within the UK. Cost efficiency, energy efficiency and spectrum efficiency are some of the important factors that are key to this decision making process.
- 1.6 In recent years both the ICAO and Eurocontrol approach has been focused on developing standards based on the required performance instead of the conventional approach of defining prescriptive standards specific for each surveillance technology.
- 1.7 As such the CAA recognises the benefits of adopting an approach that provides greater flexibility to ANSPs on the choice of surveillance technologies to be implemented provided that safety standards are not compromised.
- 1.8 Whilst prescriptive requirements may still be necessary to address security and safety concerns in certain types of airspace, the CAA views that the deployment of surveillance systems/equipment will be predominantly based on the required surveillance performance that is a technology independent approach that encourages the adoption of emerging new surveillance technologies.
- 1.9 Work has begun both by ICAO and Eurocontrol to define required surveillance performance standards. Under the performance-based approach, the technical performance parameters are defined specific to each application for which the surveillance data is used.