**EUROPEAN ORGANISATION
FOR THE SAFETY OF AIR NAVIGATION**

EUROCONTROL

Mode S Elementary Surveillance (ELS)
Operations Manual

DIRECTORATE NETWORK MANAGEMENT

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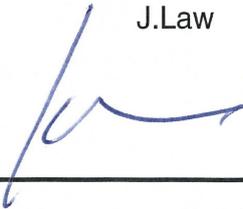
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0.11	27/05/2010	Addition of airspace/aerodrome definitions and contingency planning aspects.	10, 20, 21
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Contents

EXECUTIVE SUMMARY

The operational introduction of SSR Mode S Elementary Surveillance requires the compilation of essential operational information so that the appropriate organisations in the States concerned are able to introduce the planned improvements to SSR based air traffic services (ATS) in a safe, efficient and coordinated manner.

The material in this Operations Manual has been developed from previous guidance material[1] by the Mode S Elementary Surveillance Operational Introduction (ELS-OPS) Task Force, a group of civil and military operational and procedure specialists, tasked through the Aircraft Identification Implementation Support Group (AIISG). The mission of the AIISG is to provide a single stakeholder forum for the successful implementation of the Aircraft Identification Programme in accordance with the aircraft identification strategy established by the Air Navigation Service Board (ANSB).

In compiling this material, account has been taken of the Mode S Flight Data Processing (MOFR) Task Force's deliverable - *Functional Requirements for Mode A Assignment and Correlation*, as approved by the EUROCONTROL Operational Requirements and ATM Data Processing Team (ODT) on 14 November 2001. Account has also been taken of current ATC operational procedures and flight plan processing systems, and the need for modification to cater both for the improved surveillance functionality and for the maintenance of interoperability between Mode S equipped and non-Mode S equipped ground stations.

Where it has been found that no previously documented information exists concerning specific aspects pertinent to the operational introduction of Mode S, the Task Force has endeavoured to formulate the operational principles considered to be necessary. This Operations Manual has been developed as guidance to assist States and Air Navigation Service Providers (ANSPs) to produce unit level instructions and, where necessary, Letters of Agreement with adjacent States/ANSPs. Certain procedures specific to Mode S already exist in ICAO documentation. Where the Task Force has considered that these suffice, it has restated or made reference to them.

This Operations Manual supersedes the document Guidance for the Operational Introduction of SSR Mode S, Volume 1 Elementary Surveillance, edition 1.0, dated 17 Dec. 2003.

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[1] Guidance for the Operational Introduction of SSR Mode S, Volume 1 Elementary Surveillance.

GLOSSARY

ACID	(Downlink) Aircraft Identification
AD	Air Defence
ADS-B	Automatic Dependent Surveillance-Broadcast
AEW	Airborne Early Warning
AIC	Aeronautical Information Circular
ANSB	Air Navigation Services Board
ANSP	Air Navigation Service Provider
A-SMGCS	Advanced Surface Movement Guidance and Control Systems
ATC	Air Traffic Control
ATM	Air Traffic Management
ATS	Air Traffic Service
ATSU	Air Traffic Service Unit
CFMU	*EUROCONTROL* Central Flow Management Unit
CND	Cooperative Network Design
CONOPS	Concept of Operations
EATMP	European Air Traffic Management Programme
ECAC	European Civil Aviation Conference
ELS-OPS	*Mode S* Elementary Surveillance Operational Introduction *Task Force*
FPL	Filed Flight Plan *ICAO format*
GAT	General Air Traffic
GICB	Ground Initiated Comm B Protocol
HMI	Human Machine Interface
IC	Interrogator Code (amalgamation of II and SI codes)
ICAO	International Civil Aviation Organisation
II Code	Interrogator Identifier Code
IFF	Identification Friend or Foe
IOC	(ACID) Initial Operating Capability
IR	(EU) Implementing Rule
ITU	International Telecommunications Union
LoA	Letter of Agreement
Mode S	Mode Select
MSOps-TF	Mode S Operational Introduction Task Force
MSSR	Monopulse Secondary Surveillance Radar
NATO	North Atlantic Treaty Organisation
OAT	Operational Air Traffic
ORCAM	Originating Region Code Assignment Method
OLDI	On-Line Data Interchange
RAP	Recognised Air Picture
RASP	Recognised Air and Surface Picture
RF	Radio Frequency
RNAV	Area Navigation
SARPs	*ICAO* Standards and Recommended Practices
SI Code	Surveillance Identifier Code
SPI	Special Pulse (Position) Identification

SSR	Secondary Surveillance Radar
TMA	Terminal Control Area
VHF	Very High Frequency

1.   INTRODUCTION

1.1   Operational Introduction of SSR Mode S ELS

Aircraft compliant with Mode S ELS provide the following functionality (this has also been referred to as "Basic Functionality"):

- **Automatic Reporting of Aircraft Identification.** This is compatible with the callsign used in flight, which is automatically presented to the controller.

- **Transponder Capability Report.** A technical function to enable ground systems to identify the data link capability of the transponder.

- **Altitude Reporting in 25ft Intervals** (subject to aircraft capability).

- **Flight Status** (airborne/on the ground). A technical function, which inhibits the transponder from replying to All Call interrogations when the aircraft is on the ground.

- **SI Code Capability.** A technical function to identify transponders capable of operating within a Surveillance Identifier (SI) code ground environment (which permits a reduction in ground infrastructure complexity). Basic functionality with SI code capability is the minimum level permitted for operations in European airspace.

The operational introduction of SSR Mode S ELS and, in particular, the use of the downlink aircraft identification feature in Europe began in Spring 2008, although operational use of the Mode S Conspicuity Code, Mode A code 1000 was not introduced until early 2009.

The guidance on operational procedures contained in this Manual is primarily aimed at facilitating ATC operations with respect to civil and military Mode S and Mode A/C ground and airborne systems as the European Mode S infrastructure is being established and extended. It is recognised that, in some areas, Mode A/C facilities (particularly at regional and military aerodromes) will remain in use for an appreciable period following the introduction of Mode S ELS in the Terminal Control Area (TMA) and en-route environment. In some portions of the airspace, use of Mode A/C may continue, or will need to co-exist according to the Air Navigation Services Board (ANSB), until at least 2025[2]. States should consider the contents of this Operations Manual when developing procedures to facilitate the inter-operation of their Mode S network with remaining Mode A/C facilities.

1.2   Scope

This Operations Manual extends to the development of operational procedures and is relevant to all current and future users of SSR, including military Identification Friend or Foe (IFF) systems operating in 1030/1090 MHz. In particular, it applies to the organisations, people, automated systems, infrastructure and existing rules concerned in the operation of IFF/SSR and the data derived from the ground and airborne elements involved.

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[2] Prediction from the ANSB Strategy for Continuous and Unambiguous Aircraft Identification, precursor to the EUROCONTROL Aircraft Identification Programme to implement the 2012 Initial Operating Capability (IOC).

1.3 Development of Operational Arrangements

1.3.1 In formulating arrangements for the introduction of Mode S ELS, account has been taken of existing ATC operational procedures as well as the need for modification to cater both for the improved surveillance functionality and for the maintenance of interoperability between Mode S equipped and non-Mode S equipped aircraft and ground stations. It is particularly important to accommodate the requirements of aerodromes and other airspace user interests within the developing Mode S infrastructure. Furthermore, procedures need to be established, by the appropriate authorities, to ensure safe and effective coordination between the ANSPs involved. Local arrangements may need to be agreed and specified in Letters of Agreement (LoAs).

1.3.2 The process also takes account of the need to obtain the earliest possible benefit from the operational employment of Mode S ELS, whilst at the same time avoiding the possibility of increased controller and flight crew workload. This applies particularly to the continued employment of Mode A codes. In addition, care needs to be taken in the establishment of new procedures, by the authorities concerned, to ensure that no service provider or user is unduly disadvantaged during the course of these changes in operational arrangements.

1.3.3 This Operations Manual should be read in conjunction with the Data Processing of Mode S ELS Eligible Flights – User Requirements Document (URD), Edition 1.0, dated 29 September 2010, which has been formulated specifically to meet the needs of the current Aircraft Identification Programme. In this respect, the URD does not necessarily supersede the Transition to Elementary Mode S Surveillance – Functional Requirements for Mode A Assignment and Correlation Document (FRD), Edition 1.0, dated 20 November 2001. In particular, the mandatory requirements in the FRD pertaining to the assignment of Mode A discrete codes remain extant.

1.4 Operational Use of Downlink Aircraft Identification

Mode S ELS exploits the Mode S downlink aircraft identification feature for the correlation and radar identification of flights and enables such flights to be assigned the Mode S conspicuity code (A1000) in place of a discrete Mode A code. To accomplish this, however, the airspace within which Mode S ELS operations take place must be defined within the CFMU environment database (ENV), and eligible flights clearly flagged "MODESASP" to the ANSP user.

1.4.1 Mode S Declared Aerodromes and Airspace

1.4.1.1 For the purpose of IFPS flagging, a **Mode S Declared Aerodrome** is an aerodrome declared by an ANSP to the CFMU, at which the ANSP intends to assign and/or use A1000 in place of a discrete SSR code, to support the use of downlink ACID. In such cases:

- *The downlink aircraft ID of departure aircraft to be assigned A1000 is to be verified at the earliest opportunity.*

- *A Mode S Declared Aerodrome may only be created or modified on an AIRAC date. Such aerodromes are static ENV data.*

- *A Mode S Declared Aerodrome may be deactivated or (re)activated as a Mode S Declared Aerodrome on-line. The Mode S attribute of an aerodrome is dynamic ENV data.*

1.4.1.2   For the purposes of IFPS flagging, **Mode S Declared Airspace is** airspace declared by an ANSP to the CFMU, within which the ANSP intends to assign and/or use A1000 in place of a discrete SSR code, to support the use of downlink ACID. In such cases:

- *Mode S Declared Airspace shall consist only of the following types of airspaces or a vertical portion thereof: Control Zone (CTR), Terminal Area (TMA), Control Area (CTA), sector, merged sector. A vertical portion of an airspace is the airspace that retains the original horizontal boundaries but is contained between a defined lower and upper level.*

- *The original airspace, including its horizontal and vertical boundaries, may only be created or modified on an AIRAC date. Mode S Declared Airspaces are static ENV data.*

- *An airspace may only be deactivated or (re)activated as Mode S Declared Airspace on an AIRAC date.*

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2.   AIRBORNE SYSTEMS

2.1   Compliance

The term compliance refers to the airborne equipment requirements that support Mode S ELS as promulgated through regulations enacted by participating States in accordance with the guidance provided by EUROCONTROL Specimen AICs. Airborne equipment requirements pertaining to Mode S ELS are at Annex A.

2.2   ICAO 24-Bit Aircraft Address

SSR Mode S relies on a unique ICAO 24-bit aircraft address for selective interrogation of an individual aircraft. 16,777,214 aircraft addresses are allocated in blocks by ICAO to the State of Registry or common mark registering authority for assignment as prescribed in Annex 10, Volume III, Appendix to Chapter 9, Part I.

A EUROCONTROL Specimen AIC that focuses attention on adherence to the worldwide scheme for aircraft address assignment, together with the correct reporting of aircraft identification (see 2.6) is at Annex B.

2.3   Backwards Compatibility

When compliant with ICAO SARPs, a Mode S transponder will always reply to SSR Mode 3/A interrogators and thus only one type of transponder needs to be carried by an aircraft[3]. This is pertinent to aircraft, mandated to equip with Mode S transponders, which still need to operate in non-Mode S airspace.

2.4   Transponder Interrogator Code Supportability

Mode S transponders are to be capable of supporting both Interrogator Identifier (II) and Surveillance Identifier (SI) codes in accordance with ICAO SARPs[4]

2.5   Antenna Diversity

Mode S transponders installed on aircraft with gross mass in excess of 5,700 kg or a maximum cruising true airspeed capability in excess of 463 km/h (250 kt) shall operate with antenna diversity[5]. This is an ICAO standard, which applies when the aircraft individual certificate of airworthiness is first issued on or after 1 January 1990, or when Mode S transponder carriage is required on the basis of a regional air navigation agreement, specifying the airspace and airborne implementation timescales.

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[3]. ICAO Annex 10, Volume IV, 3.1.2.4.1.1

[4] ICAO Annex 10, Volume IV, 2.1.5.1.7

[5] ICAO Annex 10, Volume IV, 2.1.5.3

2.6   Aircraft Identification Feature

To comply with airborne equipment requirements, Mode S transponder equipped aircraft must incorporate an aircraft identification feature[6]. Flight crew are required to set the aircraft identification for transmission by the transponder to correspond with the aircraft identification specified in item 7[7] of the ICAO flight plan. If no flight plan has been filed, the transponder is required to report the aircraft registration, which may be pre-set. Procedures for the correct setting of Aircraft Identification are set out in the EUROCONTROL Specimen AIC reproduced at Annex B.

To ensure that airspace users are familiar with the requirements of Mode S ELS, a EUROCONTROL leaflet has been produced to enable aircraft operators, flight crews and operations staff to complete flight plans correctly and operate Mode S transponders in the approved manner. This leaflet, entitled 'Mode S – Flight Plans and Transponders', illustrates the accurate completion of flight plan Items 7 (Identification) and 10 (Equipment), and the correct setting of Aircraft Identification to be downlinked.

A copy of this leaflet is at Annex C.

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[6] Annex 10, Volume IV, 3.1.2.9 refers.

[7] ICAO Doc 8168, PANS-OPS, Vol I, Part III, Section 3, 1.3

3.   GROUND SYSTEMS

3.1   Sensors

3.1.1   Interrogator Description

The performance requirements for Mode S ground sensors in terms of target detection and quality are considered to be not less than those values recommended for monopulse SSR systems[8]. Designed coverage is for a range from 0.5-256 nm and heights up to 66,000 ft. The sensor uses monopulse detection techniques but, use of a unique ICAO 24-bit aircraft address and provision of all the required aircraft data in one reply, reduces interrogation rates. Each aircraft can be interrogated selectively, needing only one or two 'hits' per aircraft per scan and minimising interference problems associated with SSR Mode A/C.

In particular:

-       The operation of a Mode S interrogator will not interfere with the SSR performance of any aircraft equipped with a Mode A/C transponder.

-       A Mode S interrogator is capable of performing the conventional surveillance function with Mode A/C transponders.

3.1.2   Interrogator Codes

The Mode S system requires each interrogator to have an Interrogator Code (IC), which can be carried within the uplink and downlink transmissions. Responding aircraft transponder identification is achieved by acquiring the unique ICAO 24-bit aircraft address. Originally ICAO SARPs provided for a 4-bit Interrogator Identifier (II) Code. This permitted only 15 II Codes to be available for operational use. However, amendment change 73 to ICAO Annex 10 resulted in an additional 63 codes being made available in the form of Surveillance Identifier (SI) Codes. It is essential in Europe, particularly for the maintenance of civil/military interoperability, for aircraft to be equipped with Mode S transponders that support both II and SI code functionality. An explanation, in a simplified form, of Mode S Interrogation Principles and Interrogator Codes is at Annex D.

3.1.3   Interrogator Code Allocation

A scheme for the central allocation of Interrogator Codes is administered by EUROCONTROL on behalf of the ICAO European and North Atlantic Office. The process, which is overseen by a Civil/Military European Mode S IC Allocation Coordination Group (MICoG) is incorporated within the ICAO EUR-Region Air Navigation Plan and the scheme has been embedded, separately, in EU Law, by means of an Implementing Rule (IR).

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[8]   EUROCONTROL Standard for Radar Surveillance in En-Route Airspace and Major Terminal Areas, Section 6.3
    See also Draft Implementing Rule on Surveillance Performance and Interoperability (SPI IR)

3.1.4 Interrogation Methods

3.1.4.1 A Mode S sensor has two methods of interrogation: All-Call and Selective. All-call interrogations are transmitted regularly at a steady rate in a similar way to conventional SSR. Any Mode S transponder that is not 'locked out' will reply to an all-call interrogation transmitting its unique ICAO 24-bit aircraft address. In this way, the interrogator acquires targets not previously detected. Once a transponder is known to the interrogator and its track has been established, it can be 'locked out'. This prevents the transponder from replying to any more all-call interrogations from that or any other Mode S sensor with the same interrogator code for a period of 18 seconds during which it will only respond to Selective interrogations from that interrogator. However, it will continue to respond to allcall interrogations from other Mode S sensors with a dissimilar identifier code and also to Mode A/C sensors.

3.1.4.2 Lockout is a new concept for SSR and is one of the major factors in radically reducing reply rates and thus reducing interference. To prevent the potential for undesirable, uncontrolled lockout of targets, a number of safeguards have been built into the international standards[9] for both interrogator and transponder to ensure that lockout is handled in a fail-safe manner.

3.1.4.3 Selective interrogations make use of the unique 24-bit aircraft address and can be sent out close to the azimuth where the aircraft is expected to be. No other aircraft that happens to be in the radar beam at that time will reply. The aircraft addressed will reply with its Mode A code, aircraft identification and altitude. The type of reply is controlled by the interrogator, but in either case only a single reply is required because there is no ambiguity as to which aircraft the reply belongs. Extra interrogations can be made to ensure that at least one reply is received and that the azimuth performance is maintained.

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[9] ICAO Annex 10, Volume IV, 3.1.2.6.9

4. OPERATING ENVIRONMENT

4.1 General

Mode S has been developed as a natural and logical extension to the application of radar services using SSR Mode A/C. Thus from the radar controller's view point, the fundamental elements upon which aircraft identification, application of separation minima and coordination are based remain largely unchanged. However, in the mixed Mode S/non-Mode S environment, which will exist following Mode S implementation, there is a need to ensure that both systems can operate harmoniously. It is necessary, therefore, to examine existing procedures to ascertain where additional or modified provisions might be required.

4.2 Identification of Aircraft

In accordance with ICAO Doc 4444 direct recognition of the aircraft identification of a Mode S equipped aircraft in a radar label may be used to establish surveillance identification, supplemented by local instructions, as required.

> e.g. where no flight plan is available, or, one might not have been filed, an ATSU could be required, when observing a downlinked aircraft Identification that is either identical to, or the coded equivalent of the R/T callsign, to assign a Mode A discrete code in accordance with the established SSR radar identification procedures.

4.2.1 Verification of Downlink Aircraft Identification

4.2.1.1 Where circumstances permit, the downlinked Aircraft ID of Mode S ELS eligible flights should be verified at the earliest opportunity, preferably on the ground prior to departure, and A1000 assigned accordingly. This would normally apply at an aerodrome where a Mode S ELS service is operational and the aerodrome has been declared as such to the CFMU by the responsible ANSP.

4.2.1.2 Aerodromes that are not Mode S ELS capable might still be declared to the CFMU for the flagging of eligible flights providing that downlink aircraft identification can be verified by means other than Mode S ELS.

4.2.1.3 In other circumstances, an aerodrome, which lacks sufficient Mode S radar cover, or other means to verify downlink aircraft identification, might be declared to the CFMU for the flagging of eligible flights, providing a mechanism has been established by the responsible ANSP for verification to take place at the earliest opportunity after departure.

4.2.2 Transfer of Identification

4.2.2.1 Transfer of identification using the notification that the information transmitted by the Mode S Aircraft Identification feature is correct relies on both units having appropriate Mode S ELS capability; therefore, it must only be conducted in accordance with bilateral agreed arrangements.

4.2.2.2 Transfer of identification by means of notification of the ICAO 24-bit aircraft address is not a recommended procedure to be employed in Mode S ELS operations.

4.3 Incorrect Downlinked Aircraft Identification

Should it be observed by ATS operators that the aircraft identification transmitted by the aircraft is different from that expected, the pilot is to be instructed to "re-enter Mode S aircraft identification"[10]. If, following confirmation by the pilot that the correct identification has been set on the Mode S identification feature, the discrepancy continues to exist, or, if the aircraft identification being transmitted by the aircraft cannot be rectified by the flight crew, then control staff are to take the following actions:

a. inform the pilot of the persistent discrepancy;

b. Assign a discrete Mode A code; and

c. notify the erroneous aircraft identification transmitted by the aircraft to the next control position and any other interested unit using Mode S for identification purposes. (e.g. a Mode S 'flagged' flight squawking a discrete SSR code might be an indication of an incorrect downlink Aircraft Identification and as such may serve as notification in such circumstances).

4.4 Failure of Mode S Airborne Equipment

In the event of an apparent transponder failure, control staff should instruct the pilot to check transponder and squawk ident[11].

4.4.1 Complete Transponder Failure

In the event of a complete transponder failure after departure, existing procedures for SSR transponder failure should be followed.

4.4.2 Partial Failure

An aircraft may experience a partial or intermittent failure of Mode S airborne equipment, whereby the transponder might still respond to interrogations, either in Mode S or Mode A, but not be capable of reporting the correct aircraft identification continuously. This may be due to an error in the flight management system or in transferring data to the transponder from elsewhere. A partial failure may not be apparent to the ground system for a period of time and might first be detected by the next ATSU.

In such cases ANSPs may be obliged to revert to fallback procedures (e.g. Mode A/C and discrete SSR codes).

4.5 Correlation Processes

There are two methods by which aircraft may be correlated with their stored flight plan data.

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[10] ICAO Doc 4444 (PANS-ATM); 12.4.3.5

[11] Once the pilot has checked the transponder, if the Mode A code and/or the Aircraft Identification have not changed during the past 18 seconds, no updated data may be extracted. This can be remedied by instructing the pilot to "squawk IDENT", which will enable the ground station to re-extract all static parameters when a Special Pulse [position] Identification (SPI) is announced.

4.5.1 Use of Mode S Aircraft Identification Feature

4.5.1.1 Correlation between the flight plan and the aircraft radar return is established and maintained based on a match between the downlinked Mode S Aircraft ID and the aircraft identification derived from Item 7 of the flight plan. Other factors, such as filtering related to the predicted position, may be applied. Thus, where the Mode S reported aircraft identification is available on the radar label (see 3.2.1), unless a discrete SSR code needs to be assigned for other reasons, A1000 may be assigned by the correlating ATSU. For example, A1000 may be assigned to suitably equipped flights departing directly into Mode S airspace, or entering Mode S airspace with a non-retainable discrete SSR code.

> Note
>
> 1. A1000 is reserved for assignment by ATC according to procedures defined for operations in Mode S designated airspace, unless the conditions for the use of codes: 7000, 7500, 7600 and 7700 apply[12].
>
> 2. Some ground systems need to trigger a change from a discrete code to A1000 before the Mode S downlinked Aircraft ID is used for correlation purposes. Systems will be programmed to trigger such code changes only for those flights that require a Mode A code change at specific airspace/regional boundaries (i.e. if a flight is planned to retain a discrete Mode A code, then correlation will be achieved by means of this code, and not the downlinked Aircraft ID).

4.5.1.2 The assignment of A1000 is subject to the arrangements agreed by the Mode S implementing ANSPs for the 'flagging' of Mode S compliant flights by the CFMU (see 4.6).

4.5.1.3 Not all ANSPs will use this correlation method at the outset of operational introduction. However, it is the option favoured by all administrations for the long term.

4.5.2 Use of Discrete Mode A Code and Mode S in Combination[13]

4.5.2.1 Correlation may be effected, in accordance with current procedures, by assigning a discrete Mode A code in compliance with the Code Management Plan. In such circumstances, the Mode S capability of the flight will be systematically detected and correlation maintained by Mode S.

4.5.2.2 When appropriate, once correlation has been achieved and providing that the aircraft concerned is downlinking the correct Aircraft ID, the discrete Mode A code used for this purpose can be released at an early stage and A1000 assigned.

4.6. HMI Adaptation

The operational introduction of SSR Mode S surveillance services requires some adjustment to controller Human Machine Interface (HMI). In terms of Mode S Elementary Surveillance, some adaptation is needed to the controller display of radar labels and, where required, the provision of a Vertical View Display (see Annex E).

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[12] ICAO SSR Code Allocation List for the EUR Region.

[13] Formerly Correlation Method 2 as defined by the Mode S Flight Data Processing (MOFR) Task Force in the document - *Functional Requirements for Mode A Assignment and Correlation.*

4.6.1 Radar Labels

4.6.1.1   In general terms, when a flight has been correlated (which may have been established by either of the methods explained in 4.5), then the identity of the flight in the radar label will be acquired from the associated stored flight plan data.

4.6.1.2   When track/flight plan data correlation is not achieved (e.g. downlink aircraft identification does not match item 7 of the flight plan), or when correlation is lost, it is essential that appropriate data is displayed to control staff.

4.7   CFMU 'Flagging' of Mode S ELS Eligible Flights

Where applicable, and to facilitate the automatic assignment of A1000 to Mode S ELS compliant aircraft, the EUROCONTROL CFMU IFPS will 'flag' eligible flights by inserting the annotation "IFP/MODESASP" at Item 18 of the flight plan. To ensure a graduated and controlled introduction of ELS services, the Mode S ELS 'flagging' process will be introduced in two phases, as detailed in the sub paragraphs below.

4.7.1   Mode S ELS 'Flagging' Phase 1

4.7.1.1   During Phase 1 of the introduction of Mode S ELS services, Mode S 'flagging' will only be applicable for aircraft conducting an entire flight, from take-off until landing, within Mode S Declared Airspace. ANSPs may elect to provide Mode S ELS services for nominated aircraft operators only during the initial period of introduction, to check and confirm the integrity of ground infrastructures and operational procedures.

4.7.1.2   Where A1000 is to be used in the context of gate-to-gate Mode S operations, such aircraft will be required to transmit the assigned code throughout the flight, commencing from the flight crew request for push back or taxi (whichever occurs earlier) until the aircraft is parked at its stand. A Specimen AIC on Mode S Multilateration in association with Advanced Surface Movement Guidance and Control Systems (A-SMGCS) covering the operation of Mode S transponders at such aerodromes is at Annex F.

4.7.2   Mode S ELS 'Flagging' Phase 2

4.7.2.1   During Phase 2 of the introduction of Mode S ELS services, Mode S 'flagging' will also be applied to eligible flights that are planned to enter Mode S Declared Airspace during the flight, and remain within Mode S Declared Airspace continuously thereafter until the flight has landed. Mode S ELS 'flagging' Phase 2 will only be introduced once Phase 1 'flagging' is firmly established and the ANSPs involved are fully prepared to expand Mode S ELS operations. **Phase 2 flagging will not occur before the ACID Programme's Initial Operating Capability (IOC) date of 9 February 2012.**

> Note   Mode S 'flagging will not be applied to flights that enter and leave Mode S Declared Airspace, and then re-enter and continue within Mode S Declared Airspace for the remainder of the flight.

4.7.2.2   Where flights are transferred from a non-Mode S equipped ATSU in circumstances where the assigned discrete Mode A code would normally be changed, A1000 may be assigned in accordance with the correlation method described in 4.5.1.

Note   In these circumstances, the installation of a system-generated reminder should be considered to prompt control staff accordingly (see also 4.6 - HMI Adaptation).

4.8   Contingency Planning

4.8.1   In the event of a system failure that prevents use of the ACID within Declared Airspace, ANSPs will need to manage those aircraft that are airborne and have been assigned A1000.   ANSPs must also have in place contingency plans to suspend the automatic assignment of A1000 to eligible Mode S ELS flights that have been 'flagged' and are within the flight planning system. Moreover, ANSPs must take appropriate action with the CFMU to deactivate the relevant aerodrome(s) during the course of the Mode S radar outage. A more detailed overview of the declaration of Mode S Airspace/Aerodrome and the CFMU IFPS 'flagging' process is at Enclosure 1.

4.8.2   The following points need to be taken into account by ANSPs when preparing appropriate contingency plans:

- The telephone number(s) of the applicable CFMU personnel should be readily available. Short notice deactivation must be initiated via telephone contact, rather that e-mail or other commercial messaging network.

- The CFMU holds the names and telephone numbers of all relevant supervisors. For security reasons, the CFMU will not act on instructions received directly over the telephone, but will call the appropriate supervisor back for confirmation of the instruction before acting.

- Once a Mode S Declared Aerodrome has been temporarily deactivated, the CFMU will no longer 'flag' flights to and from that aerodrome. However, flight plans processed prior to the deactivation will retain the IFPS assigned 'flags' which will, in turn' trigger FDPSs to assign A1000 to such flights. 'Flagged' flights may appear up to 5 days after the time of deactivation (limit to how far in advance a flight plan can be filed). Contingency plans must include procedures to mitigate this.

4.9   Coordination with Adjacent Non-Mode S Equipped ANSPs

Letters of agreements between adjacent units should include any procedures and accords that are appropriate to ensure the coordination of any adjacent ELS/non-ELS operations.

4.10   Mode A Code Saving Measures

Mode S, in association with an appropriate Mode A code management process (Enhanced ORCAM or CCAMS), will help alleviate the inherent limitations of Mode 3/A whilst providing the means to benefit from an improved ATC surveillance capability with a corresponding augmentation in safety. This, in turn, facilitates the process towards easing controller workload and increasing system capacity.

4.10.1   General Principle

4.10.1.1   The general principle with respect to striking an acceptable balance between SSR code saving vis-à-vis controller workload is as follows:

> ➢ **The operational use of Mode S should not itself require the assignment of an additional code where otherwise an existing code would have been retained**.

4.10.1.2   The general principle is applicable to both flights entering Mode S Declared Airspace which do not have a retainable discrete SSR code. As outlined in previous paragraphs, flights entering Mode S airspace displaying a retainable code will normally continue to operate using that code.

4.11   Verification of Altitude / Level Information

The existing ICAO requirements of ICAO Doc 4444; 8.5.5, concerning 'Level information based on the use of pressure-altitude information (Mode C) will continue to apply following the introduction of SSR Mode S and until such time as any changes to ICAO SARPs may be promulgated. It is therefore incumbent on ANSPs to ensure compliance with the procedures as set out in the ICAO Doc 4444 (8.5.5.1 & 8.5.5.2) for the verification and determination of level accuracy and occupancy.

4.12   Continued Use of Mode A Special Purpose Codes

In addition to the employment of special purpose SSR codes detailed below, other Mode 3/A codes, e.g. 2000 and 7000 denoting particular air activities, play an important role in day-to-day ATM. In particular A1000 (see Note 1 to 4.5.1) is reserved for Mode S conspicuity within the ICAO EUR-Region.

Mode 3/A special purpose codes will need to remain in use until such time that an alternative method is developed to convey the specific information displayed,

4.13   Unlawful Interference with Aircraft in Flight

Existing procedures[14] pertaining to the use of Mode A Code 7500 remain unchanged by the introduction of Mode S Elementary Surveillance.

4.14   Communications Failure

Existing procedures[15] pertaining to the use of Mode A Code 7600 remain unchanged by the introduction of Mode S Elementary Surveillance.

4.15   Emergency

Existing procedures[16] pertaining to the use of Mode A Code 7700 remain unchanged by the introduction of Mode S Elementary Surveillance.

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[14] ICAO Doc 8168, PANS-OPS, Volume I, Part III, Section 3, Chapter 1, 1.6

[15] ICAO Doc 8168, PANS-OPS, Volume I, Part III, Section 3, Chapter 1, 1.5

[16] ICAO Doc 8168, PANS-OPS, Volume I, Part III, Section 3, Chapter 1, 1.4

5. CIVIL / MILITARY INTERFACE

5.1 Interoperability Issues

5.1.1 Background

Use of the 1030/1090 MHz frequencies is reserved, under an International Telecommunications Union (ITU) agreement, for the provision of Aeronautical Radio Navigation Services. In addition to civil SSR systems, military IFF systems use the same two frequencies, a consequence of which is the interoperability of IFF Mode 3 and SSR Mode A. Military SSR Mode 3 is fully interoperable with civil Mode A, enabling military systems to identify civil aircraft and vice versa. This interoperability is based on joint coordination procedures which exist in many of the States between civil and military aircraft controlling agencies. It is essential to maintain this civil/military interoperability with the operational introduction of Mode S Elementary Surveillance.

5.1.2 Operational Considerations

Military authorities strongly recognise the need for civil/military interoperability. Although Mode S provides no military utility per se, it is recognised that the carriage and operation of Mode S airborne equipment by military aircraft will facilitate handling in the airspace in which air traffic services based on SSR Mode S are provided by civil ATS units and allow military flying operations with minimal or no restrictions at all. Therefore, the military need for the acquisition and distribution of Mode S data for the safe coordination and control of aircraft and, in an Air Defence context, to assist in the compilation of the Recognised Air Picture is acknowledged.

5.2 Air Defence Operations

The use of SSR in Air Defence (AD) operations encompasses ground, maritime and airborne platforms and contributes to the fulfilment of the requirements of aircraft identification to aid Recognised Air Picture (RAP) compilation and for the provision of an ATS to assigned assets. Traditionally, this function has been met through the interoperability of Mode 3/A inherent within IFF and SSR. Notwithstanding the backwards compatibility of Mode S and Mode 3/A, the operational capability of non-Mode S capable/equipped AD platforms in a mixed SSR environment will be determined by the procedures introduced by civil authorities concerning the continued use of Mode 3/A codes.

It should be noted that there are two distinct operational requirements for the use of SSR in military air operations, ATS provision and AD activities, which also includes RAP compilation. The practical application of these requirements covers a wide range of diverse interrogation platforms including ground-based radars (static and mobile), aircraft, ships and surface-to-air missile (SAM) systems. Moreover, military platforms will continue to employ specific IFF Modes 1, 2 and 4 and any additional mode under development.

5.3 Ground-based Air Defence Operations

Until such time that ground-based AD systems are Mode S capable, interrogation will continue to be based on military IFF modes supported by SSR Modes 3/A and C.

Although it may be possible for Mode S data to be derived from civil Mode S interrogators, it is likely that a stand-alone Mode S interrogation capability will be required in many platforms, As a result, II and SI code allocation will need to be closely coordinated and interrogation techniques adopted which are harmonised with peacetime civil ATS requirements. Furthermore, the techniques proposed will be subject to close scrutiny by national frequency clearance authorities to ensure that they do not undermine the integrity of the overall RF environment. However, the same authorities will need to be cognisant of the military requirement to test and train utilising those capabilities, which would be needed in times of crisis and conflict.

5.4   Airborne Air Defence Operations

Changes in military doctrine and strategy over the years have led to an increased airborne IFF/SSR interrogation capability which, in the classical SSR environment, has been accommodated and managed without detriment to civil operations. However, as these particular platforms develop a Mode S interrogation capability, the need for more stringent coordination and controls, in the peacetime situation, become increasingly apparent. It will be necessary for the appropriate national authorities to devise updated arrangements so as to ensure that airborne platforms such as Airborne Early Warning (AEW) can fulfil their operational tasks in a way that does not interfere with other users or add to the pressure exerted on the RF environment[17].

It is likely that airborne platforms will need to employ stand-alone interrogation capabilities that could potentially have an effect within high traffic density airspace subject to regulation by several different States. In addition, the operational nature of these platforms is such that rapid tactical redeployment within a Mode S region is likely to be a regular occurrence. Therefore, it is essential, that in developing a Mode S interrogation capability, civil and military authorities, both nationally and internationally, must define common and agreed procedures with respect to matters such as II and SI code allocation, interrogation techniques and frequency clearances in order that the disparate requirements can be met in a coordinated and harmonised manner.

5.5   Maritime Air Operations

5.5.1   Aircraft Identification

Warships require SSR data to provide safe separation of aircraft under their control from other air traffic and to assist in the compilation of a Recognised Air and Surface Picture (RASP). Many ships will not have the capability to utilise RASP data relayed from shore-based AD systems and will have to preserve the ability to operate independently for deployment outside such cover or in advance of it being provided in theatre. An accurate and comprehensive RASP is of particular importance when platforms are deployed to counter potential hostilities in an area where normal peacetime ATM procedures remain in place.

5.5.2   Use of SSR

The identification and correct threat assessment of air contacts relies in part on the use of SSR. Its importance in this respect is recognised by ICAO[18]. Whilst a

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[17] Advice can be obtained and harmonisation measures undertaken within the EUROCONTROL Civil/Military SSR Environment Liaison (CIMSEL) Group.

[18] ICAO Doc 9554 Manual Concerning Safety measures Relating to Military Activities Potentially Hazardous to Civil Aircraft Operations.

variety of sensors will be employed, SSR in many cases provides the earliest detection of cooperative targets. Assessment is facilitated through knowledge of the international Mode A Code Plan and, where rules of engagement permit, by the direct challenge by voice on VHF, addressing the aircraft by SSR code. Mode C information and conformity to published air routes also greatly assist in threat assessment. With the future proliferation of Area Navigation (RNAV) routing, the importance of SSR will increase.

5.5.3   Mode S Data Acquisition

The methods to acquire Mode S data will depend on the nature of on-going operations, the area of these operations and the extent to which extended squitter[19] is employed. If the latter is widely implemented and used, passive receivers might be used for short range RASP compilation in support of primary radar and other sensors. This solution may be employed where, for instance, peacetime rules restrict mobile interrogators, which, although employing II or SI codes may pose a greater interference threat than fixed MSSR units. However, warships will always require an active Mode S interrogation capability, including during testing and training, in peacetime, on the basis of tolerable interference to civil ATM systems. In times and areas of crisis, active interrogation will be necessary and may vary from target-specific in support of other sensors to continuous All Call where early track detection and assessment is crucial.

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[19] Mode S transponders transmit an unsolicited squitter comprising a specially designed three-dimensional position report for the purpose of passive detection and tracking by ground sensors and ACAS systems. Extended squitter, which provides more data, is designed to support the broadcast of aircraft-derived position as a form of automatic dependent surveillance (ADS), known as ADS-broadcast (ADS-B). *ICAO Annex 10 Volume IV, 3.1.2.8.6 refers.*

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Annex A : Airborne Equipment Requirements for Mode S Elementary Surveillance

1. Background

1.1 Since 1997, there have been several Aeronautical Information Circulars (AICs) issued by many ECAC member States concerning the carriage and operation of Mode S airborne equipment in European airspace. The information below provides a summary of the requirements and regulation for Mode S Elementary Surveillance as agreed within EUROCONTROL and coordinated with the implementing States, namely Belgium, France, Germany, Luxembourg, the Netherlands and Switzerland. The United Kingdom intends to regulate separately for Mode S Enhanced Surveillance, within which Elementary Surveillance is an intrinsic function.

1.2 Additional material can be found in the Joint Aviation Authorities (JAA) Administrative and Guidance Material, Leaflet N° 13, Revision 1, Certification of Mode S Transponder Systems for Elementary Surveillance[20].

2 Airborne Equipment Regulation

2.1 The carriage and operation of Mode S airborne equipment with Elementary Surveillance functionality shall be mandatory in airspace designated by the appropriate ATS authorities as follows:

a. For IFR flights, as General Air Traffic (GAT), a level 2 transponder, as a minimum, with Elementary Surveillance functionality with effect from **(State to insert date)**.

b. For VFR flights, conducted in airspace where the carriage and operation of SSR transponders is already mandatory, a level 2 transponder, as a minimum, with Elementary Surveillance functionality with effect from **(State to insert date)**.

> *Note* *Individual State requirements for the mandatory carriage and operation of SSR Mode S airborne equipment may differ from 2.1a & b*

These statements may be too simplistic for the current UK regulation. It might be easier to say that ELS carriage requirements in UK airspace are given in UK AIP GEN 1.5.

2.2 Mode S Elementary Surveillance functionality shall constitute the following transponder parameters and data formats for Ground Initiated Comm-B (GICB) protocols as defined in ICAO Annex 10 Volume III and the ICAO Manual of Mode S Specific Services (Doc 9688-AN952):

➢ ICAO 24-bit aircraft address aircraft address
➢ SSR Mode 3/A
➢ Altitude reporting in 25ft increments, or, at least 100ft increments (subject to airframe source) [ICAO Annex 10, Vol. IV, 2.1.3].
➢ Flight Status (airborne/on the ground) [ICAO Annex 10, Vol. IV, 3.1.2.8.6.7].
➢ Data Link Capability Report (BDS 10hex).
➢ Common Usage GICB Capability Report. (BDS 17hex).
➢ Aircraft Identification (BDS 20hex).
➢ ACAS Active Resolution Advisory (BDS 30hex).

> *Note 1* *The aircraft operator has to ensure that the aircraft reports a unique 24-bit aircraft address as assigned by the appropriate State authorities.*

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[20] This document will be fully revised and replaced by EASA AMC (Acceptable Means of Compliance) 20-18 during the course of 2012.

Note 2   *Automatic reporting of aircraft identification is not provided by the ICAO 24-bit aircraft address aircraft address.*

Note 3   *Provision of Flight Status may not be practical for helicopters with skids or for aircraft with fixed landing gear and the operator may need to seek a derogation to this requirement.*

Note 4   *An acceptable equipment Minimum Operational Performance Standard for the transponder is given by EUROCAE document ED-73B.*

Note 5   *Reference should be made to the applicable certification requirements for the airborne system.*

2.3   The functionality of Mode S airborne equipment shall comply, as a minimum, with the provisions of ICAO Annex 10, in particular, Vol. III and IV as standardised in Amendment 77 and with the appropriate technical standards.

2.4   The installed equipment must be an approved Level 2, as a minimum, Mode S transponder compliant with EASA Technical Standard Order ETSO-2C112c, or an equivalent standard that is acceptable to the certification authority.

Note   *ETSO-2C112c is based on EUROCAE document ED-73C, which takes account of Amendment 77 to ICAO Annex 10.*

2.5   Mode S equipped aircraft with gross mass in excess of 5700kg or a maximum true cruising airspeed in excess of 250 kt (463 km/h) shall be operated with antenna diversity as prescribed in ICAO Annex 10, Vol. IV, 3.1.2.10.4.

Note   *Where it is impractical to provide antenna diversity on a particular airframe, a derogation may be considered.*

2.6   Mode S equipped aircraft shall be operated with the appropriate transponder peak pulse power as prescribed in ICAO Annex 10, Vol. IV, 3.1.2.10.2.

2.7   Mode S transponders shall have the ability to process Surveillance Identifier (SI) codes in addition to Interrogator Identifier (II) codes as prescribed in ICAO Annex10, Vol. IV, 2.1.5.1.7.1.

2.8   To comply with Mode S Elementary Surveillance airborne equipment requirements, the Mode S transponder must be connected to the appropriate data sources on board the aircraft (e.g. as described in ARINC 718A).

Annex B : Specimen AIC on ICAO 24-Bit Aircraft Addresses and Aircraft Identification Reporting

Recommended Text of State AIC Released 26/06/2003:

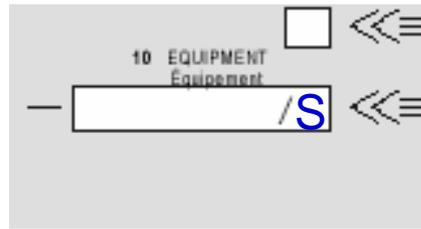| Notes		ICAO 24-Bit Aircraft Addresses and Aircraft Identification Reporting
1. State to insert date and reference of last circular issued for Mode S Elementary Surveillance, if applicable.		**1 INTRODUCTION** 1.1 The provision of air traffic services (ATS) using SSR Mode S, initially in a central area of European airspace, will rely on a unique ICAO 24-bit aircraft address for selective interrogation of individual aircraft. The ICAO 24-bit aircraft address is also an essential element of the airborne collision and avoidance system, ACAS II. In addition, Mode S surveillance requires the reporting of aircraft identification as stated in previous circulars concerning Mode S airborne equipment requirements. (note 1). 1.2 The aircraft address shall be one of 16 777 214 twenty-four-bit aircraft addresses allocated by ICAO to the State of Registry or common mark registering authority and assigned as prescribed in the Appendix to Chapter 9, Part I, Volume III, ICAO Annex 10. 1.3 All Mode S equipped aircraft engaged in international civil aviation are required to have an aircraft identification feature as prescribed in ICAO Annex 10, Volume IV, Chapter 2, 2.1.5.2. 1.4 This circular provides guidance to ensure consistency regarding 24-bit aircraft addresses and the reporting of aircraft identification relevant to the operational introduction of Mode S Elementary and Enhanced Surveillance. In particular: a) Adherence to the worldwide scheme for assignment of ICAO 24-bit aircraft addresses. b) Correct setting of Aircraft Identification by flight crew.
2. Insert name of State and title of applicable organisation responsible for 24-bit aircraft address		**2 THE ICAO 24-BIT AIRCRAFT ADDRESS** 2.1 Instances occur of incorrect ICAO 24-bit aircraft addresses being installed/hard-wired on individual aircraft. This has happened not only on first installation of a Mode S transponder but also when a major modification has been made to the Mode S equipment, and following a change of State of Registration. Incorrect installation, such as setting the address to all zeros, or, inadvertent duplication of an address can pose a severe risk to flight safety. In particular, the airborne collision avoidance system, ACAS II, performs on the assumption that only a single, unique ICAO 24-bit aircraft address per airframe exists. The performance of ACAS II can be seriously degraded and in some instances <u>disabled</u> if an incorrect or duplicate address is installed on an aircraft. 2.2 Incorrect or duplicated ICAO 24-bit aircraft addresses will also undermine the effectiveness of surveillance services based on SSR Mode S. 2.3 It is essential that aircraft operators comply with the aircraft address assignment procedures of the State regulatory authority to which blocks of addresses have been allocated by ICAO (note 2).

assignment		

| | | 2.4 | The worldwide addressing scheme has been designed so that, at any one time, no address is assigned to more than one aircraft. Only one address can be assigned to an aircraft and it cannot be changed except under exceptional circumstances authorised by the State regulatory authority concerned. |

2.5 When an aircraft changes its State of Registry, the previously assigned address is to be relinquished and a new address assigned by the new registering authority.

2.6 It is essential that the aircraft address is periodically verified using ramp tests. Such checks must also be conducted when a major maintenance check has taken place and when the aircraft has changed registration, to ensure that a newly assigned address has been properly set.

3 CORRECT SETTING OF AIRCRAFT IDENTIFICATION

3.1 To comply with European airborne equipment requirements, Mode S transponder equipped aircraft must incorporate an Aircraft Identification Feature. Correct setting of aircraft identification is essential for the correlation of radar tracks with flight plan data in the ATM and Airport Operator ground systems. Initial operational trials using SSR Mode S have shown that many aircraft are transmitting incorrect aircraft identification, e.g. BC_1234 instead of ABC1234. Such erroneous settings of aircraft identification prohibit automatic track correlation and, if perpetuated, will severely limit the effectiveness of Mode S to relieve the shortage of SSR codes.

3.2 In accordance with ICAO Doc 8168 *[PANS-OPS]* Vol.I, Part VIII, 1.3, flight crew of aircraft equipped with Mode S having an aircraft identification feature shall set the aircraft identification in the transponder. This setting shall correspond to the aircraft identification specified in item 7 of the ICAO flight plan, or, if no flight plan has been filed, the aircraft registration.

3.3 Aircraft Identification, not exceeding 7 characters is to be entered in item 7 of the flight plan **and** set in the aircraft as follows:
Either,
a) The ICAO three-letter designator for the aircraft operating agency followed by the flight identification (e.g. KLM511, BAW213, JTR25), when:
in radiotelephony the callsign used consists of the ICAO telephony designator for the operating agency followed by the flight identification (e.g. KLM 511, SPEEDBIRD 213, HERBIE 25).
Or,
b) The registration marking of the aircraft (e.g. EIAKO, 4XBCD, OOTEK), when:
1) in radiotelephony the callsign used consists of the registration marking alone (e.g. EIAKO), or preceded by the ICAO telephony designator for the operating agency (e.g. SVENAIR EIAKO),
2) the aircraft is not equipped with radio.

Note 1 No zeros, dashes or spaces are to be added when the Aircraft Identification consists of less than 7 characters.

Note 2 Appendix 2 to ICAO Doc 4444 *[PANS-ATM]*, refers. ICAO designators and telephony designators for aircraft operating agencies are contained in ICAO Doc 8585.

3. State to insert local points of contact		**4 FURTHER INFORMATION** Further information or guidance may be obtained from: (Note 3) More general information concerning SSR Mode S in the context of the European Air traffic Management Programme (EATMP) is available at the EUROCONTROL Web Site Address: http://www.eurocontrol.int/modes/

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Annex C : Mode S – Flight Plans and Transponders

European States have introduced Mode S Elementary Surveillance (ELS) services and it is now essential that flight crews and aircraft operations staff accurately complete flight plans and operate Mode S transponders in the approved manner.

The following, simple steps (as detailed in ICAO Doc 4444 – Procedures for Air Navigation Services: Air Traffic Management and ICAO Doc 8168 - Procedures for Air Navigation Services: Aircraft Operations) must be followed precisely:

FLIGHT PLANS

Item 7 – Aircraft Identification

Here you must enter either:

the three letter ICAO designator for the aircraft operating agency, followed by the flight identification (e.g. BAW123)

When this is entered at Item 7, the R/T call sign used will consist of the ICAO telephony designator for the operating agency followed by the flight identification (in this example: "Speedbird 123").

[*See ICAO Doc 8585 - "Designators for Aircraft Operating Agencies, Aeronautical Authorities and Services", for code/de-code information*]

or/

the Registration Marking of the aircraft (e.g. FGZCF)

When this is entered, the R/T call sign to be used will consist of this identification alone (e.g. "FGZCF"), or proceeded by the ICAO telephony designator for the aircraft operating agency (e.g. "Airfrans FGZCF").

NOTE: What is entered at Item 7 **must** match exactly what is entered in the Mode S Aircraft Identification (also known as Flight ID) input device in the cockpit. If it does not, then the aircraft will not be correlated with its stored flight plan and delays will ensue.

There must be no spaces ahead of or between the designator letters and flight number, nor any additional/superfluous zeros. If the input device requires all character boxes to be filled, enter spaces after the flight number.

Item 10 – Equipment (Surveillance Equipment / SSR Equipment)

In the Surveillance Equipment / SSR Equipment element of Item 10, you must enter the <u>correct letter</u> denoting the type of transponder fitted to your aircraft:

Most likely, it will be

'**S**', which specifies:

Transponder - Mode S, including both pressure altitude and **aircraft identification** transmission.

Other letters available specify:

'**N**' Nil

'**A**' Transponder - Mode A (4 digits - 4096 codes)

'**C**' Transponder - Mode A (4 digits - 4096 codes) and Mode C

'**X**' Transponder - Mode S without both aircraft identification and pressure-altitude transmission

'**P**' Transponder - Mode S, including pressure-altitude transmission, but no aircraft identification transmission

'**I**' Transponder - Mode S, including aircraft identification transmission, but no pressure-altitude transmission

<u>TRANSPONDERS</u>

The Aircraft ID (also known as the Flight ID) is to be entered through the FMS or transponder control panel (depending upon aircraft equipment).

NOTE: What is entered at Item 7 **must** match exactly what is entered in the Mode S Aircraft Identification (also known as Flight ID) input device in the cockpit. If it does not, then the aircraft will not be correlated with its stored flight plan and delays will ensue.

There must be no spaces ahead of or between the designator letters and flight number, nor any additional/superfluous zeros. If the input device requires all character boxes to be filled, enter spaces <u>after</u> the flight number.

Annex D : Explanation of Interrogator Codes

1   Interrogation Principles

1.1   The default mode of operation of Mode S ground interrogators is:

- To acquire new aircraft within the radar coverage of the ground station by transmitting specific interrogations sent to all aircraft (like Mode A/C interrogations) in order to acquire their ICAO 24-bit aircraft addresses and their positions. These interrogations are known as 'all-call' interrogations and the replies to such interrogations are known as all-call replies.

- To selectively interrogate individual aircraft (by using their ICAO 24-bit aircraft addresses and an estimation of their position) for the rest of their trajectory within the coverage of the ground station.

1.2   Once an aircraft has been acquired, a Mode S ground station no longer needs to receive all-call replies (which only increase RF pollution without any benefit to the system). Therefore, in its default mode of operation, a Mode S interrogator will 'lock out' an aircraft to all-call interrogations once this aircraft is acquired. When an aircraft is locked out, it does not reply to all-call interrogations.

2   Interrogator Codes

2.1   The Mode S system requires that each Mode S interrogator be allocated a specific Interrogator Code (IC) to provide discrimination between separate interrogators in areas of overlapping Mode S radar coverage. The original Mode S design provided for 16 Interrogator Identifier (II) codes (0-15) that allow multisite operation using all of the Mode S protocols for all-call lockout, simple data extraction from transponder registers and high-level data link communications. The II code value of 0 is reserved for a specific mode of operation. Multisite protocols require a non-zero code, and so only 15 II codes are generally available for allocation to Mode S ground stations.

2.2   This number is insufficient fully to satisfy civil ATC needs and the additional requirements of military ATC and Air Defence (AD). ICAO has therefore developed the capability for Mode S transponders to support an extension set of 63 Surveillance Identifier (SI) non-zero codes (1-63). Because there are only 15 II and 63 SI operationally usable codes, generically known as ICs, these codes must be carefully allocated and protected to avoid interference between adjacent interrogators.

2.3   II codes enable limited data link activity, including single segment Comm-A uplink and downlink broadcast protocols and Ground-initiated Comm-B (GICB) data extraction. However, since the great majority of Mode S ground stations will never use high-level data link communications, SI codes have been designed to enable only the message formats used for lockout and transponder register extraction purposes. SI codes provide complete multisite surveillance functionality but only provide support for communication protocols that do not require an II code.

2.4   In summary, SI codes allow all-call lockout and simple transponder register extraction but, contrary to II codes, cannot be used with high-level data link communication protocols.

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Annex E : Vertical View Display

In SSR Mode S selective interrogation using the unique ICAO 24-bit aircraft address overcomes miss-association problems relating to aircraft tracks that overlap in the horizontal (azimuth) plane, allowing them to be presented separately in terms of their height. Adaptation of HMIs to provide this additional vertical resolution and display enables the effective monitoring of aircraft vertical separation in situations where this cannot currently be performed in SSR Mode A/C using horizontal (azimuth only) presentations (e.g. with operation of stacks where aircraft tracks overlap horizontally).

A Mode S derived vertical view display is depicted in the illustration below.
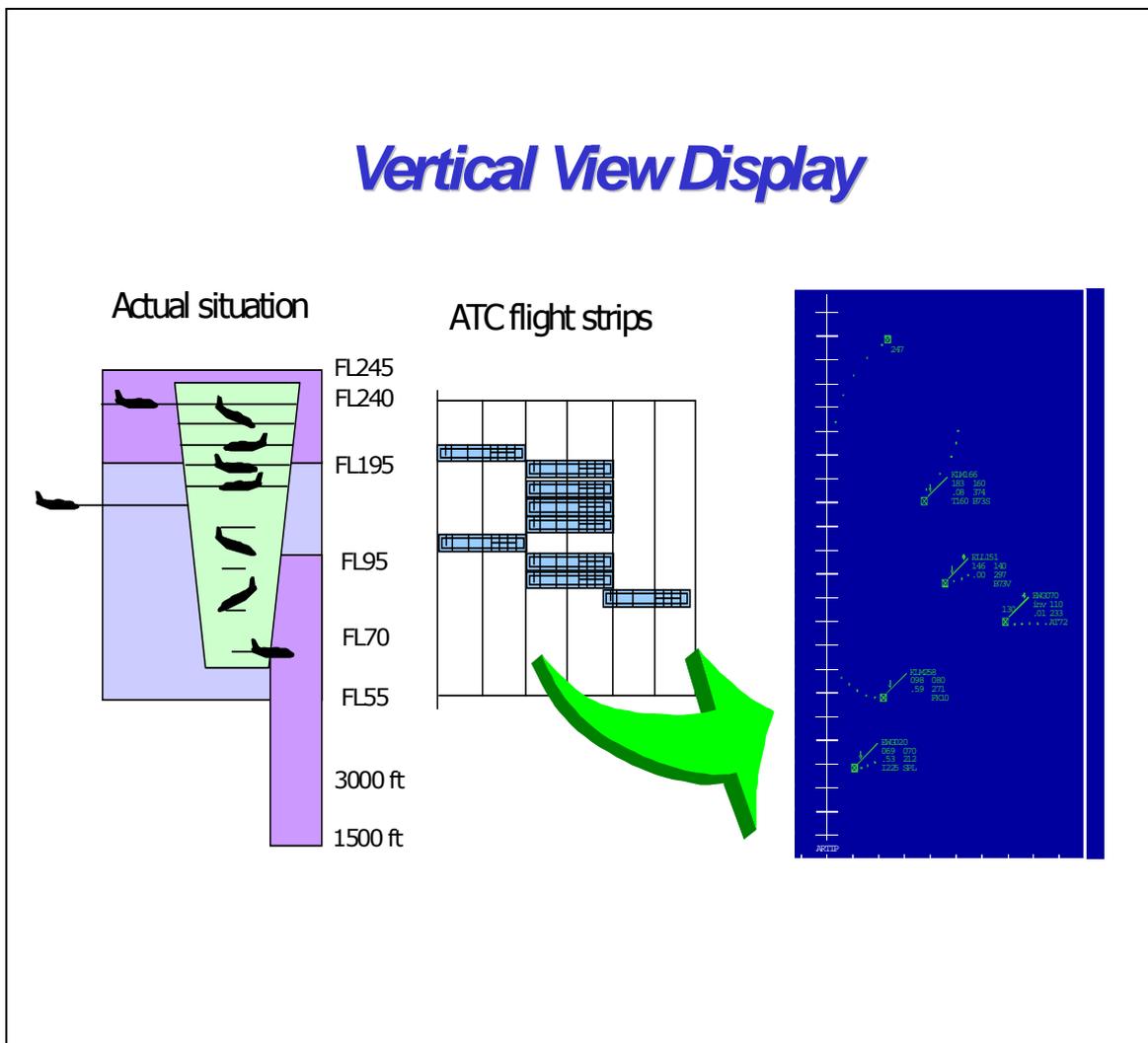
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Annex F : Specimen AIC on Mode S Multilateration

This Annex reproduces a draft text for a harmonised AIC to be issued by airports in support of their Mode S multilateration implementation or Advanced Surface Movement Guidance and Control System (A-SMGCS).

AIC
XX/2007

1.   Introduction

XXXX airport has installed an improved surface surveillance system, using Mode-S multilateration. Operational trials using this system will commence on dd/mm/yy.

2.   Operation of Mode S transponders when the aircraft is on the ground

Aircraft operators intending to use XXXX aerodrome shall ensure that the Mode S transponders are able to operate when the aircraft is on the ground.

Flight crew should:

Select AUTO mode and assigned Mode A code

If AUTO mode is not available Select ON (e.g. XPDR) and assigned Mode A code

- From the request for push back or taxi whichever is earlier;

- After landing, continuously until the aircraft is fully parked on stand;

- When fully parked on stand select STBY.

Whenever the aircraft is capable of reporting Aircraft Identification (i.e. callsign used in flight), the Aircraft's Identification should also be entered from the request for push back or taxi, whichever is earlier (through the FMS or the Transponder Control Panel). Air crew must use the ICAO defined format for entry of the Aircraft Identification (e.g. AFR6380, SAS589, BAW68PG)

To ensure that the performance of systems based on SSR frequencies (including

airborne TCAS units and SSR radars) is not compromised, TCAS should not be

selected before approaching the holding point. It should then be deselected after

vacating the runway.

For aircraft taxiing without flight plan, Mode A code 2000 should be selected.

3. Further Information

For additional information, please contact:

XXXXXXXXX Tel: xxxxxxxxxxxxxxxx

E-mail: xxxxx@xxxx

Enclosure 1: EUROCONTROL CFMU 'Flagging' Process

1. Introduction

To facilitate the automatic assignment of Mode S conspicuity codes to qualifying aircraft, the EUROCONTROL CFMU IFPS will 'flag' eligible flights by inserting the annotation "IFP/MODESASP" at Item 18 of the flight plan.

Flight plans are 'flagged' providing that the aircraft concerned is equipped with the appropriate level of Mode S transponder (and the flight plan annotated accordingly at Item 10 – Equipment) and the flight is planned to be conducted within Mode S Declared Airspace.

> *Note: During the initial phase of the introduction of Mode S ELS services, Mode S 'flagging' will only be applied to eligible flights that are planned to conduct the entire flight, from take-off until landing, within Mode S Declared Airspace. At a later stage, Mode S 'flagging' will also be applied to eligible flights that are planned to enter Mode S Declared Airspace at some stage during the flight, and remain within Mode S Declared Airspace continuously thereafter until the flight has landed.*

2. Process for Defining Mode S Declared Airspace

2.1 The following process, which supports the dynamic deactivation and reactivation of ELS participating aerodromes and, in turn, enables the immediate withdrawal (and subsequent reintroduction) of Mode S ELS services (as necessary) is currently followed by ANSPs and the CFMU when defining and establishing Mode S Declared Airspace within the CFMU environment database:

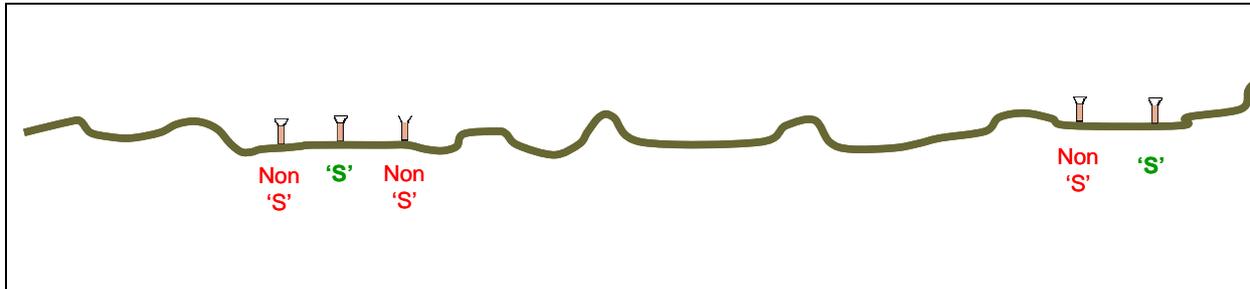2.1.1 ANSPs identify those aerodromes capable of operating Mode S ELS flights.

Figure 1

2.1.2 ANSPs identify existing, contiguous airspace sectors that link the ELS participating aerodromes (Terminal Control Areas (TMA), Control Areas (CTA), Control Zones (CTR) etc). Some of these airspace sectors will have base levels, whilst some will extend upwards from ground level.
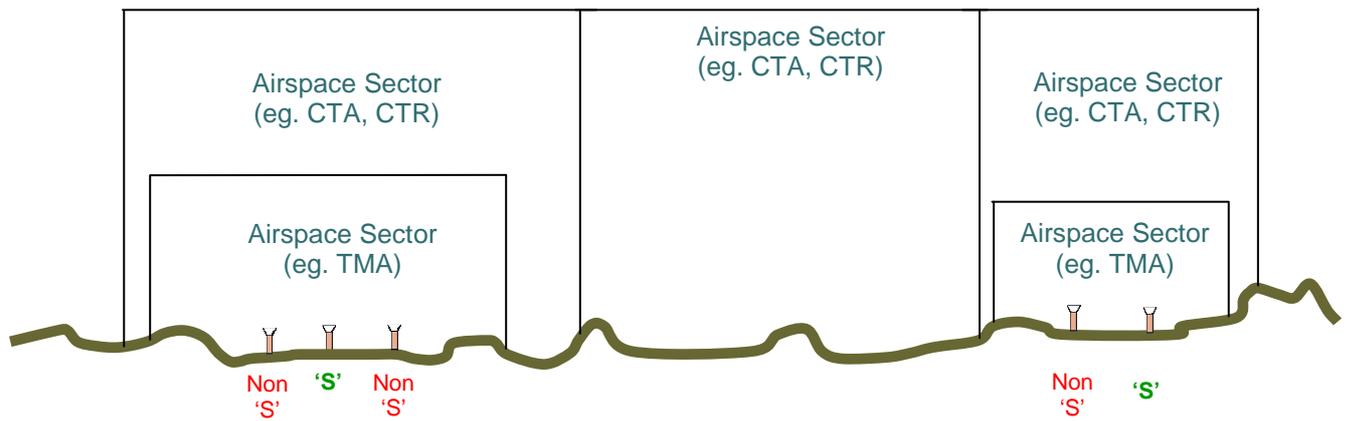
Figure 2

2.1.3 Those aerodromes where an SSR Mode S ELS service is operational within a TMA are specifically declared to the CFMU by the responsible ANSP for input into the Environment database, which will distinguish them from aerodromes not supporting Mode S ELS operations. These Mode S Declared Aerodromes can be independently deactivated and reactivated (i.e. outside of AIRAC constraints) and, since they form the 'beginning' and 'end' of a chain of contiguous Mode S ELS operations, this will assist ANSPs in any contingency arrangements that may have to be put in place following a degradation in Mode S radar cover. If a Mode S Declared Aerodrome is deactivated, then the automatic assignment of A1000 to participating inbound and outbound eligible flights will cease (however, flights may be flagged for up to 5 days before the actual date of participating flights – see 2.1.5 below). Likewise, should a Mode S Declared Aerodrome be reactivated, the assignment of A1000 will recommence.

In consultation with the CFMU, ANSPs identify the base levels of the airspace sectors so as to define the airspace to be 'declared' for the purposes of Mode S ELS. The CFMU then adds that portion of airspace within the airspace sectors, above the agreed base level, to the CFMU environment database as Mode S Declared Airspace. However, TMA airspace can extend from ground level upwards and will not require an 'agreed base level' to be established as only Mode S Declared Aerodromes will be recognised with respect to Mode S Declared Airspace.
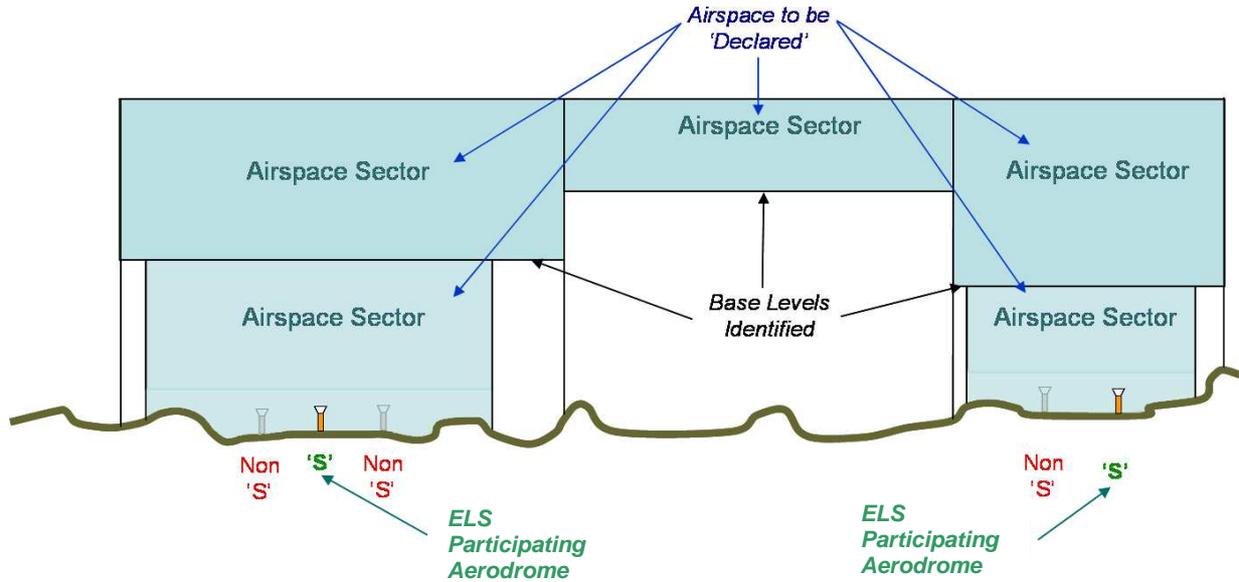
Figure 3

2.1.4 The entire airspace volume (TMAs, CTAs, CTRs etc), is defined in the CFMU environment database as one block of Mode S Declared Airspace, with independent Mode S Declared Aerodromes forming the 'beginning' and 'end' of the contiguous chain.
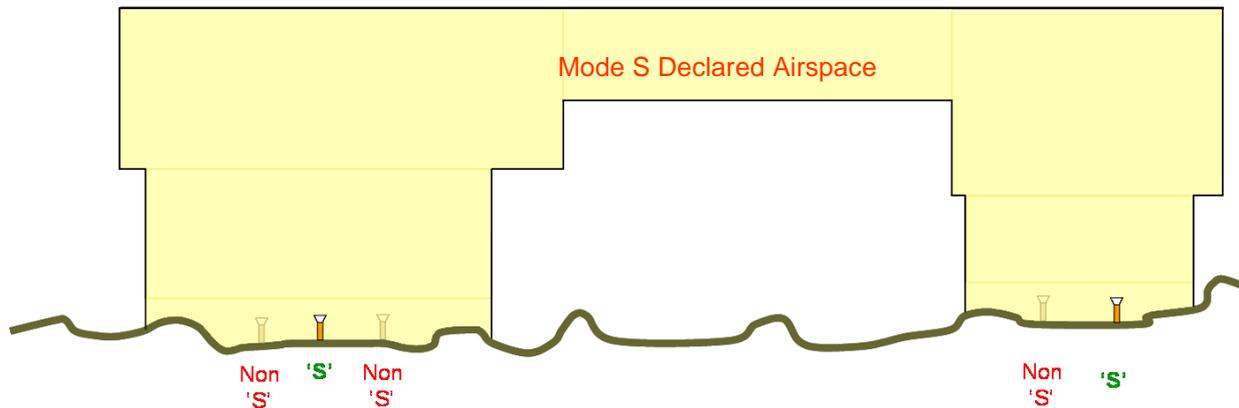

Figure 4

2.1.5 Mode S Declared Airspace is activated and deactivated on AIRAC dates. Consequently, should a situation arise such that Mode S ELS services have to be temporarily discontinued (e.g. a loss of Mode S Radar coverage) whilst the airspace is 'active', the ANSP concerned can request that the CFMU deactivate the Mode S Declared Aerodrome concerned, thereby suspending the automatic assignment of A 1000 for participating 'city-pair' flights to and from that aerodrome.

ANSPs must have in place contingency plans to manage the assignment of discrete Mode A codes to participating 'flagged' flights already in the system (for up to 5 days before the date of the flight). Aircraft that are airborne and have been assigned A1000 should be managed with respect to the prevailing operational environment.

3. Guidelines for the Declaration of Mode S Airspace/Aerodrome

The guidelines for the provision of ENV data are detailed in the document 'Provision of ENV Data' which is a Supplement of the CFMU Handbook and can be consulted on-line via the CFMU Library at the following address:

http://www.cfmu.eurocontrol.int/cfmu/public/site_preferences/display_library_list_public.html

The document includes a description of the roles and responsibilities, points of contact and communication procedures, a classification of the ENV data, forms that can be used to communicate different types of data and a description of the ENV data processes.

A National ENV Coordinator has been designated within each country in the CFMU area of responsibility.

The role of the designated National ENV Coordinator is to provide a single link between CFMU and the ANSPs to coordinate the data provision and data validation with the CFMU.

Mode S coordinators should declare Mode S airspaces/aerodromes via their National ENV Coordinator.

A dedicated form for the transmission of Mode S related ENV data is available to National ENV Coordinators via the OneSky on-line portal and be included in the 'Provision of ENV Data' document.

3.1 Mode S Related ENV Data

3.1.1 Airspaces

Mode S Declared Airspace is a volume of airspace in which an SSR Mode S Elementary Surveillance service is operational and that has been declared as such to the CFMU by the responsible ANSP.

Mode S Declared Airspace shall consist only of the following types of airspaces or a vertical portion thereof: Control Zone (CTR), Terminal Area (TMA), Control Area (CTA), sector, collapsed sector. A vertical portion of an airspace is the airspace that retains the original horizontal boundaries but is contained between a defined lower and upper flight level.

The original airspace, including its horizontal and vertical boundaries, may only be created or modified on an AIRAC date. Airspaces are static ENV data.

An airspace may only be deactivated or (re)activated as Mode S Declared Airspace on an AIRAC date.

3.1.2 Aerodromes

A Mode S Declared Aerodrome is an aerodrome where an SSR Mode S Elementary Surveillance service is operational and that has been declared as such to the CFMU by the responsible ANSP.

An aerodrome may only be created or modified in the CFMU ENV database on an AIRAC date. Aerodromes are static ENV data.

An aerodrome may be deactivated or (re)activated as a Mode S Declared Aerodrome on-line. The Mode S attribute of an aerodrome is dynamic ENV data.