

**Considerations for
Low Power SSR Mode-S Transponder
(LPST)
Operations**

Edition Number	:	1.0
Edition Date	:	24 October 2007
Status	:	Released Version
Intended for	:	General Public

DOCUMENT CHARACTERISTICS

TITLE		
Considerations for Low Power SSR Mode-S Transponder (LPST) Operations		
EATM Infocentre Reference:		
Document Identifier	Edition Number:	1.0
	Edition Date:	24 October 2007
Abstract		
To support a future Concept of Operation, this document provides Considerations for the operation of a Low Power SSR Mode-S Transponder (LPST)		
Keywords		
SSR Transponder	Mode-S Transponder	ADS-B
Low power transponder	LPST	LAST
Transponder	TCAS	ACAS
		Light Aviation
		Safety
Contact Person(s)	Tel	Unit
J. Berends	9 3411	DAP/SUR
E. Potier	9 3504	DAP/SUR

STATUS, AUDIENCE AND ACCESSIBILITY		
Status	Intended for	Accessible via
Working Draft <input type="checkbox"/>	General Public <input checked="" type="checkbox"/>	Intranet <input type="checkbox"/>
Draft <input type="checkbox"/>	EATMP Stakeholders <input type="checkbox"/>	Extranet <input type="checkbox"/>
Proposed Issue <input type="checkbox"/>	Restricted Audience <input type="checkbox"/>	Internet (www.eurocontrol.int) <input type="checkbox"/>
Released Issue <input checked="" type="checkbox"/>	<i>Printed & electronic copies of the document can be obtained from the EATMP Infocentre (see page iii)</i>	

ELECTRONIC SOURCE		
Path:		
Host System	Software	Size
Windows 2000	Microsoft Word 2000	319 Kb



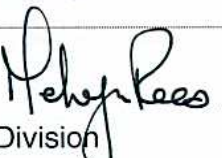
EATMP Infocentre
 EUROCONTROL Headquarters
 96 Rue de la Fusée
 B-1130 BRUSSELS

Tel: +32 (0)2 729 51 51
 Fax: +32 (0)2 729 99 84
 E-mail: eatmp.infocentre@eurocontrol.int

Open on 08:00 - 15:00 UTC from Monday to Thursday, incl.

DOCUMENT APPROVAL

The following table identifies all management authorities who have successively approved the present issue of this document.

AUTHORITY	NAME AND SIGNATURE	DATE
<i>Please make sure that the EATMP Infocentre Reference is present on page ii.</i>		
DAP/SUR	Eric Potier 	14/11/2007
DAP/SUR	J. Berends Surveillance Domain Manager 	14/11/2007
DAP/SUR	M. Rees Head of Surveillance Division 	14/11/07.

DOCUMENT CHANGE RECORD

The following table records the complete history of the successive editions of the present document.

EDITION NUMBER	EDITION DATE	INFOCENTRE REFERENCE	REASON FOR CHANGE	PAGES AFFECTED
1.0	24 Oct 07		Released Version	All

CONTENT

EXECUTIVE SUMMARY	1
REFERENCES	3
LIST OF ABBREVIATIONS	4
1. INTRODUCTION	6
2. PURPOSE	8
3. BACKGROUND	9
3.1 Current SSR Transponder Carriage Regulations	9
3.1.1 ICAO	9
3.1.2 EUROCAE MOPS	10
3.1.3 State Authorities	11
3.2 Current Operational Use of SSR/SSR Mode-S Transponders	11
3.2.1 Current Technology	11
3.2.2 Current Users and Stakeholders	13
3.2.3 Uses and Interfaces	14
3.3 Current Issues and Risks	14
3.3.1 Traffic Growth and the Environment	14
3.3.2 The Role of SSR/SSR Mode-S	15
3.3.3 Airspace Design and Segregation.....	16
3.3.4 Use of Class G Airspace by Commercial Air Traffic.....	17
3.3.5 Airspace Infringements.....	17

3.3.6	Separation of Aircraft Outside Controlled Airspace.....	17
3.3.7	Interference Levels on the SSR 'Reply' Frequency	18
3.3.8	The role of Primary Surveillance Radar	19
3.3.9	A Need for Greater Technical Interoperability Between Aircraft	19
4.	RATIONALE FOR AN LPST	20
5.	OPERATIONAL REQUIREMENTS	21
5.1	General Requirements	21
5.2	Operational Needs of the General Aviation Community	22
5.3	Required Attributes of an LPST for Light Aircraft.....	22
5.4	Interoperability Requirements for an LPST	24
5.5	Future Developments in Surveillance	25
6.	OPERATIONAL APPLICATION.....	26
6.1	Operational Objectives.....	26
6.2	Operational Benefits.....	26
6.2.1	Improved Interoperability with Airborne Collision Avoidance Systems	27
6.2.2	Improved Interoperability with Ground-Based Safety Nets	27
6.2.3	Access to Airspace and Freedom of Movement for Light Aircraft.....	28
6.2.4	Increased Use of Mandatory Transponder Carriage Airspace.....	28
6.2.5	Improved Detection and Management of Airspace Infringements	28
6.2.6	Improved Potential to Create 'Known' Traffic Environments.....	28
6.2.7	Improved Detection of Aircraft with Low Visibility to Primary Radar	29
6.2.8	Increased Potential to Employ Flexible Use of Airspace	29
6.2.9	Means of Compliance to Implement ICAO Annex 6 Requirements	30

6.3	Applicability Criteria.....	30
7.	OPERATIONAL POLICY AND PROCEDURES.....	33
7.1	Operational Capability and Employment.....	33
7.1.1	Existing Mandatory Transponder Carriage Scenarios	33
7.1.2	Establishment of New Mandatory Transponder Carriage Scenarios	34
7.1.3	Impact on ATC System Capacity	34
7.1.4	Interaction of LPST Units with Safety Nets	35
7.1.5	ICAO 24-bit Aircraft Address Assignment and Encoding.....	35
7.2	Implementation Conditions	37
7.2.1	Transition Periods	37
7.2.2	Exemption Principles.....	38
7.2.3	Minimum Equipment List Issues.....	39
7.3	Regulatory Issues	40
7.3.1	International Standards	40
7.3.2	Single European Sky Legislation.....	41
7.3.3	EUROCAE Means of Compliance.....	42
7.3.4	EUROCONTROL Strategy	42
7.3.5	National Regulatory Requirements	43
7.4	Links to Other Programmes	43
7.4.1	Implementation of SSR Mode S in Europe	43
7.4.2	CASCADE/ADS-B	44
7.4.3	Wide Area Multilateration	44
7.5	Civil/Military Interoperability	45

7.6	Issues Requiring Further Progression	45
7.6.1	International Standards	45
7.6.2	Trials and Testing	46
7.6.3	Certification.....	46
8.	RECOMMENDATIONS.....	47

EXECUTIVE SUMMARY

Secondary Surveillance Radar (SSR) and SSR Mode-S (Mode Select) are now an intrinsic element of the European Air Traffic Management Network (EATMN) and it is in widespread employment to help maximise aviation safety levels and enable Air Traffic Control (ATC) efficiency. In particular, the associated pressure-altitude reporting transponders that are fitted to aircraft are essential to the operation of SSR/SSR Mode-S interrogators, airborne collision avoidance systems, such as TCAS, and ground-based safety nets, such as Short-Term Conflict Alert (STCA).

The predicted doubling of commercial air transport movements in European airspace over the next 20 years presents a significant challenge in terms of maintaining existing levels of aviation safety and successfully accommodating the foreseen traffic within the overall Air Traffic Management (ATM) system. In addition, emerging environmental considerations need to be taken into account to reduce the perceived adverse impact of traffic growth on global warming. Traditionally, protection of public transport flights has been achieved by establishing volumes of controlled airspace and by segregating the flights from other aircraft and activities that are not interoperable with safety nets or ATC procedures. However, this system does not necessarily make optimum use of the limited airspace resource, and does not address the problem of managing infringements of controlled airspace. Consequently, improved technical interoperability between all aircraft and ATM systems will be essential for providing access to airspace for all classes of aircraft in the future.

Currently, many smaller aircraft are not technically or operationally capable of fitting and using a standard SSR transponder that is compliant with ICAO Annex 10 minimum peak power output standards. This is mainly due to issues of space, weight, power supply, antenna siting, proportionality of cost, and radiological risks.

Therefore, it is not possible for States to achieve full technical interoperability of all aircraft with SSR-based safety nets and ATC surveillance systems. Moreover, for many operators of light aircraft there is no suitable means of compliance with which to voluntarily equip their aircraft to access mandatory SSR or SSR Mode-S transponder carriage airspace. However, it is considered that in many cases, the existing limitations could be overcome by the availability of a small, pressure-altitude reporting **Low-Power SSR Mode-S Transponder**

(LPST). Such an LPST would have to provide a defined set of SSR Mode-S Level 2es¹ transponder functionalities in order to provide optimum inter-system interoperability whilst having the minimum effect on radio spectrum usage and mutual interference.

The purpose of these Considerations for Low Power SSR Mode-S Transponder Operations (further referred in this document as “LPST Considerations Material”) is to provide a link between the potential operational requirements and the foreseen technical specification for an LPST. In particular, it sets out the operational policies and procedures for the use of LPST units in European airspace. Amongst these, it discusses applicability criteria, necessary operational capability and interoperability with SSR/SSR Mode-S facilities within existing airspace structures, provision of mandatory transponder carriage areas, the impact on existing ATM system capacity, and interaction with SSR/SSR Mode-S based safety nets. The LPST Considerations Material also identifies the issues and risks associated with the introduction of an LPST that will need to be addressed.

The LPST Considerations Material proposes that the availability of an LPST must maximise opportunities for all aircraft to access all classes of airspace. Additionally, an LPST will need to support the expansion of SSR Mode-S in European airspace as a replacement for classical SSR. To achieve these objectives, the LPST must be suitable for both motorised and non-motorised aircraft and be suitable for use in all classes of European airspace below 15,000 feet. The LPST should be acceptable for use in all European States and documentation will need to be developed to enable it to be certified against a recognised standard. In this regard, the LPST Considerations Material will be an essential element for supporting the development of a standard.

The LPST Considerations Material provides guidance and information on exemption principles and proposes that States consider coordinated applicability and exemption arrangements. It also includes information and consideration of regulatory issues surrounding ICAO Standards and Recommended Practices (SARPs), Single European Sky (SES) legislation, EUROCAE Minimum Operational Performance Specifications (MOPS) and the EUROCONTROL ATM2000+ strategy.

The LPST Considerations Material concludes by setting out a number of areas requiring further work. These include trials and testing to validate detection range, interoperability issues, radiological hazards, antenna siting and power source performance.

Overall, the LPST Considerations Material recommends that, subject to successful technical

¹ es = Extended Squitter (ADS-B) capable and Surveillance Identifier (SI) compatible

feasibility assessment, processes be initiated to adopt an LPST into ICAO SARPs and EUROCAE MOPS. It further recommends that States should approve the use of LPST on aircraft within European airspace.

REFERENCES

- [1] Study to Address the Detection and Recognition of Light Aircraft in the Current and Future ATM Environment, Issue 1.0, dated 31 March 2005.
- [2] ICAO Annex 6 to the Convention on International Civil Aviation (Operation of Aircraft), Parts I to III.
- [3] ICAO Annex 10 to the Convention on International Civil Aviation (Aeronautical Telecommunications), Volume IV, Surveillance Radar and Collision Avoidance Systems.
- [4] EUROCAE Minimum Operational Performance Specification for Light Aviation Secondary Surveillance Radar Transponders, ED-115, dated August 2002.
- [5] The Surveillance Strategy for the ECAC, Edition 2.0, dated 18 November 2005.
- [6] EUROCONTROL Standard Document for Radar Surveillance in En-Route Airspace and Major Terminal Areas, Edition 1.0, dated March 1997.
- [7] Regulation (EC) No 551/2004 of The European Parliament and of The Council of 10 March 2004 on the organisation and use of the airspace in the single European sky (the airspace Regulation).
- [8] Regulation (EC) No 552/2004 of The European Parliament and of The Council of 10 March 2004 on the interoperability of the European Air Traffic Management network (the interoperability Regulation).
- [9] EUROCONTROL Air Traffic Management Strategy for the Years 2000+, 2003 Edition, Volumes 1 and 2.

LIST OF ABBREVIATIONS

ACAS	Airborne Collision Avoidance System
AD	Air Defence
ADD	Aircraft Derived Data
AIC	Aeronautical Information Circulars
AIP	Aeronautical Information Publication
AMC	Acceptable Means of Compliance
ANSP	Air Navigation service Provider
ASAS	Airborne Separation Assistance System
A-SMGCS	Advanced Surface Movement Guidance and Control System
ATC	Air Traffic Control
BITE	Built In Test Equipment
CAA	Civil Aviation Authority
CAS	Controlled Airspace
CAT	Commercial Air Transport
CIMSEL	Civil/Military SSR Environment Liaison
CWS	Collision Warning Systems
DAP	Downlinked Aircraft Parameters
EASA	European Aviation Safety Agency
EATMN	European Air Traffic Management Network
ECAC	European Civil Aviation Conference
EHS	Enhanced Surveillance
ELS	Elementary Surveillance
FDPS	Flight Data Processing System
FIR	Flight Information Region
GA	General Aviation
HMI	Human Machine Interface
ICAO	International Civil Aviation Organisation
IFF	Identification Friend or Foe
IFR	Instrument Flight Rules
LAST	Light Aviation SSR (Mode-S) Transponder
LPST	Low Power SSR Mode-S Transponder
MEL	Minimum Equipment List
MOPS	Minimum Operational Performance Specifications

MSR-FG	Mode S Regulators Focus Group
MTOM	Maximum Take-Off Mass
MTOW	Maximum Take-Off Weight
SARPs	Standards and Recommended Practices (ICAO)
SARPs	Standards And Recommended Practices
SES	Single European Sky
SMGCS	Surface Movement Guidance and Control System
SSR	Secondary Surveillance Radar
SSR Mode-S	Secondary Surveillance Radar Mode Select
STCA	Short Term Conflict Alert
TAS	True Air Speed
TCAS	Traffic Alert and Collision Avoidance System (ICAO SARPS)
TDOA	Time Difference of Arrival
TMA	Terminal Manoeuvring Area
TMZ	Transponder Mandatory Zones
VFR	Visual Flight Rules

1. INTRODUCTION

Secondary Surveillance Radar (SSR) and SSR Mode-S (Mode Select) are now an intrinsic and essential element of Air Traffic Management (ATM) in Europe and it is vital for aviation safety nets, such as Traffic Alert and Collision Avoidance Systems (TCAS²) and Short Term Conflict Alert (STCA). SSR/SSR Mode-S and Automatic Dependent Surveillance-Broadcast (ADS-B) sensors, TCAS and Safety Nets like STCA all depend on the carriage and operation of co-operative transponders on aircraft³ to facilitate detection. Under current international standards, non-motorised aircraft and many light aeroplanes⁴ and helicopters are not technically or operationally able to carry and operate SSR/SSR Mode-S transponders, and/or their equipage is not mandated by State authorities in Europe. Therefore, in certain scenarios the safety and efficiency benefits of SSR/SSR Mode-S are not being maximised in European airspace, and access to certain types of airspace is not feasible for many types of aircraft in the General Aviation⁵ (GA) community.

Over recent years, there has been considerable debate in Europe, primarily through EUROCONTROL fora such as the Mode S Regulators Focus Group (MSR-FG) and the Civil/Military SSR Environment Liaison (CIMSEL) Focus Group, about the utility of developing a Low Power SSR Mode-S Transponder (LPST) with which to facilitate an increase in the number of light and very light aircraft that could feasibly equip with an SSR/SSR Mode-S transponder.

In 2004, EUROCONTROL published the results of an in-depth study [1] to

² TCAS is based on ICAO Airborne Collision Avoidance System (ACAS) SARPS

³ ICAO Annex 6 defines an aircraft as: 'any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface.'

⁴ ICAO Annex 6 defines an aeroplane as: 'A power-driven heavier-than-air aircraft, deriving its lift in flight chiefly from aerodynamic reactions on surfaces which remain fixed under given conditions of flight.'

⁵ For the purposes of this LPST Considerations Material, General Aviation activity is defined as that activity that does not involve Commercial Air Transport or State aircraft operations.

determine the current and future operational requirements for the recognition and detection of individual light aviation aircraft by ATM systems and TCAS, and to assess the feasibility of equipping airframes to meet such requirements⁶.

The UK CAA has also taken a major lead in LPST research, including the sponsoring of flight trials of an SSR Mode A/C LPST technology demonstrator in order to assess the feasibility of the concept.

In order to further inform and foster the debate and to provide a link between the operational and technical requirements, this LPST Considerations Material has been drafted.

⁶ “Light Aviation SSR Transponders” MOPS are available (EUROCAE ED-115 [4]) and compliant with ICAO requirements. Consequently these “LAST MOPS” do not define “Low Power SSR Mode-S Transponders”. The published document [1] is known as the “LAST Report” but also addresses Low Power SSR Mode-S Transponder issues.

2. PURPOSE

This LPST Considerations Material specifies how the operational concept for the use of LPST units on light and very light aircraft could be applied. It is designed to take the concept and capability under consideration for an LPST and it is also designed to provide details and information concerning operational elements, operational employment, user requirements, airborne equipment functionality and measures necessary to ensure continued safe and efficient flight. The LPST Considerations Material also serves as a link between user requirements and likely technical specifications for LPST products.

The LPST Considerations Material firstly describes the current position regarding transponder carriage in Europe and then explains the rationale behind the need for an LPST, including background issues and the risks that need to be overcome. It considers operational requirements, particularly from the user perspective, and sets out how a concept of operation is to be applied. Operational policies and procedures are then discussed, and the impacts of introducing LPST carriage and operation are analysed. The LPST Considerations Material concludes by making appropriate recommendations.

The LPST Considerations Material has been produced for the benefit of all Stakeholders within the European aviation community and has been drafted on the assumption that Stakeholders have a working knowledge of SSR/SSR Mode-S, ADS-B and TCAS and its employment.

The LPST Considerations Material should be reviewed and updated throughout any subsequent development and evolution of LPST products and their associated employment.

3. BACKGROUND

3.1 Current SSR Transponder Carriage Regulations

3.1.1 ICAO

International standards and recommended practices (SARPs) concerning the carriage and operation of pressure-altitude reporting SSR transponders on aircraft are set out in Annex 6 to the Chicago Convention on International Civil Aviation [2], published by the International Civil Aviation Organisation (ICAO). In particular, Part II sets out specific SARPs for GA aircraft. ICAO Annex 10 [3] sets out SARPs for the technical requirements of SSR transponders. Contracting States must enshrine these SARPs and, therefore, transponder carriage requirements into national legislation, or they must notify a 'difference'.

Currently, ICAO Annex 6 SARPs specify that all aeroplanes and helicopters must carry and operate a pressure-altitude reporting transponder, irrespective of airspace classification or flight rules. In principle, this is required if conducting international flights. By default, the minimum standard is for motorised aircraft to carry an SSR transponder capable of reporting Mode C altitude data. Many States also normally seek to conform with ICAO SARPs for domestic flights as well.

ICAO Annex 10 SARPs for the minimum power requirements of SSR transponders then impact on what types of motorised aircraft can feasibly operate a transponder. Specifically, the peak pulse power available at the transponder antenna must be between 21 dBW and 27 dBW, except where transponders are used solely below 15,000 ft where a lower power output level of 18.5 dBW is permitted. However, meeting these power requirements presents a significant challenge in many light and very light aeroplanes and rotorcraft.

Notwithstanding the aforementioned lower power output alleviation, where a transponder is an SSR Mode-S variant, SARPs further restrict carriage of this lower power type of transponder to only those aircraft "*not capable*" of

operating at altitudes exceeding 15,000 ft. Moreover, 21 dBW is the minimum power output permitted for Mode S transponders operated by aircraft with a maximum cruising true airspeed (TAS) exceeding 175 kt. This is designed to ensure efficient interoperability with Traffic Alert and Collision Avoidance System II (TCAS II) equipped aircraft.

Furthermore, whatever the capability of the Mode-S transponder that is installed in an aircraft, Annex 10 SARPs require the use of antenna diversity on aircraft with a maximum take-off mass (MTOM) in excess of 5,700 kg or a maximum cruising TAS in excess of 250 kt.

3.1.2 EUROCAE MOPS

EUROCAE Minimum Operational Performance Specifications (MOPS) are recommendations and are valid as statements of official policy only when adopted by a particular Government. Nevertheless, MOPS are used as important reference material to support airworthiness processes and certification, such as European Aviation Safety Agency (EASA) Acceptable Means of Compliance (AMC). Moreover, EUROCAE documents are also increasingly being used to support technical specifications setting out acceptable means of compliance for the Single European Sky (SES) implementing rules.

EUROCAE Document ED-115 [4] provides the MOPS for a specific Light Aviation SSR Transponder (LAST). This document has been designed to ensure that LAST units in compliance with the MOPS will be compatible with ICAO Annex 10, Volume IV, Amendment 77.

The minimum power output requirement for an ED-115 MOPS-compliant LAST is 18.5 dBW, and LAST units are only intended for aircraft with a maximum take-off weight (MTOW) of less than 1,200 kg and a maximum cruising TAS of 175 kt conducting flights under Visual Flight Rules (VFR) below 15,000 ft. Suitable retail products are now available in Europe.

EUROCAE ED-115 MOPS also note that national authorities may approve the use of LAST units with a lower power output than the ICAO minimum that would be required for a Low Power SSR Mode-S Transponder. However, these units would not currently be ICAO compliant and may not be acceptable

in the airspace of other States as a means of compliance with national transponder carriage requirements.

3.1.3 State Authorities

Variations in transponder carriage applicability currently exist in Europe and these are likely to remain for the foreseeable future. Most State authorities in Europe apply SSR/SSR Mode-S transponder carriage rules by relating the requirements to designated types and/or volumes of airspace, rather than aircraft types. Typically, this can apply to specific airspace classifications or to so-called 'Transponder Mandatory Zones' (TMZ) within or around airspace classifications and structures. Some States do, however, mandate requirements based on flight rules or particular activity, such as public transport operations or Instrument Flight Rules (IFR) flights. European States have not yet fully enshrined the ICAO Annex 6 SARPs for the operation of SSR transponders on GA aeroplanes and helicopters into national legislation.

The recent introduction of SSR Mode S for IFR flights and the forthcoming introduction of Mode-S transponder requirements for VFR flights in some European States should improve harmonisation of carriage requirements between certain States. However, recent Aeronautical Information Circulars (AIC) issued by those States implementing SSR Mode S confirm that existing national transponder carriage rules will actually remain broadly the same in terms of airspace and types of aircraft that are required to equip with and operate transponders; existing Mode A/C capable transponders will just have to be replaced to provide Mode S functionality as the means of compliance. Moreover, exemptions from transponder carriage within designated mandatory carriage airspace would continue to be granted where it is considered impractical to equip specific aircraft.

3.2 Current Operational Use of SSR/SSR Mode-S Transponders

3.2.1 Current Technology

Transponders are the co-operative link on board aircraft for communication with SSR/SSR Mode-S interrogators, ADS-B, based on 1090 MHz Extended Squitter (1090 ES) and TCAS. SSR/SSR Mode-S facilitates an independent

mechanism for detecting aircraft by these ground and airborne systems but it is wholly reliant on the carriage and operation of suitable equipment on aircraft. ICAO Annex 10 SARPs define how transponders must 'reply' on 1090 MHz to the 'challenges' made by interrogators on 1030 MHz.

SSR/SSR Mode-S transponders and currently available LAST units typically comprise a main unit with display and input facilities, which is usually installed next to other avionics in a cockpit panel and then connected to a single or dual external antenna system. A suitable external power source is normally required, either from a separate battery supply or from the on-board electrical generation system of the host platform.

SSR transponders operate in civil Mode A/C, providing a 4-digit octal number identity facility, and Mode C, providing pressure-altitude reporting based on the standard altimeter setting of 1013.2 millibars. This 'classical' SSR technology is being phased out in some European States by the introduction of SSR Mode-S, which uses the 1090 MHz reply frequency much more efficiently and facilitates the extraction of additional parameters from aircraft, known as Downlinked Aircraft Parameters (DAPs, in ADS-B referred as ADD, Aircraft Derived Data).

The minimum requirement for SSR Mode-S, commonly known as Elementary Surveillance (ELS), provides the following:

- A unique ICAO 24-bit Aircraft Address, of which there are nearly 17 million addresses available worldwide;
- SSR Mode A identity code;
- Pressure-altitude reporting (Mode C) at intervals down to 25 ft where supported by the aircraft avionic;
- Flight status, whether airborne or on the ground;
- Aircraft identification, based on the callsign used in flight or the aircraft registration marking;
- Transponder capability reports, to indicate whether or not the transponder is capable of supporting more advanced communication protocols;
- TCAS active resolution advisory when TCAS II is also installed on the aircraft.

A more advanced version of Mode S, commonly known as Enhanced Surveillance (EHS), is being implemented in several States in Europe for operations in major terminal and en-route airspace structures.

Mode S EHS is used to extract additional data from aircraft avionics such as heading, speed, track, turn and selected vertical intention reports; these are known as Downlinked Aircraft Parameters (DAPs). Mode S EHS will only be required for aircraft with a MTOM in excess of 5,700 kg or a maximum cruising TAS in excess of 250 kt, and it is aimed primarily at Commercial Air Transport (CAT) aircraft.

3.2.2 Current Users and Stakeholders

The following users currently carry and operate aircraft transponders either voluntarily or to meet regulatory requirements:

- Commercial Air Traffic operators;
- State Aircraft operators;
- Private and business operators of some aeroplanes and helicopters in the GA community;
- Private and business operators of some non-motorised aircraft in the GA community, such as gliders and balloons, when required for access to certain types of airspace.

The following stakeholders rely on the interaction of aircraft transponders with interrogators and safety net systems:

- Civil Air Navigation Service Providers (ANSPs) in both the en-route and terminal airspace environments;
- Military Air Traffic Control units;
- Military Air Defence (AD) units;
- Civil and military operators of aircraft equipped with Traffic Alert and Collision Avoidance System (TCAS) or other Collision Warning Systems (CWS).

3.2.3 Uses and Interfaces

SSR/SSR Mode-S transponders are required to facilitate the following uses and interfaces:

- Interaction with SSR-based surveillance systems, such as interrogators and wide area multilateration systems, to provide an air situation picture for civil and military ATM and ATC purposes;
- Interaction with military Identification Friend or Foe (IFF) and SSR/SSR Mode-S interrogators to provide a radar picture for Air Defence and airspace policing purposes;
- In conjunction with Flight Data Processing Systems (FDPS) that correlate SSR radar track data with flight plans;
- Interaction with ATC safety nets, such as STCA, for collision warning;
- Interaction with Advanced-Surface Movement Guidance and Control System (A-SMGCS), and SSR-based multilateration systems to safely and efficiently manage surface movements at aerodromes;
- Interaction with civil and State aircraft equipped with TCAS I, TCAS II or CWS for collision warning and avoidance purposes.

3.3 Current Issues and Risks

The EUROCONTROL study into the detection and recognition of light aviation aircraft [1] examines, in detail, the interoperability, separation assurance and ATM synchronisation issues associated with the operation of light and very light aircraft. This LPST Considerations Material takes into account the scenarios and issues covered by the study.

3.3.1 Traffic Growth and the Environment

Airspace use in Europe has become increasingly complex over the last few decades, with growing pressure on authorities to accommodate rapidly growing levels of public transport flights more efficiently and safely, while balancing the requirements of military and General Aviation, including sporting and recreational aviation activities. Overall levels of air traffic in Europe are expected to double by 2022 compared to 2002 to accommodate the expected

continuing rise in public demand for air travel.

However, there is an associated environmental penalty from the increased overall contribution that aviation will make to carbon emissions, which is expected to rise from the current 5-6% contribution to around 25% by 2030 if measures to reduce pollution are not taken by the industry as a whole. Moreover, the public and their politicians are increasingly expecting authorities to ensure that these measures are taken.

Therefore, the European ATM system will have to increase capacity in an environmentally beneficial manner; and this can only be achieved through increased efficiencies in the management and flow of aircraft. In particular, greater use of optimum climb-out profiles, continuous descent profiles, direct routes and minimal holding of aircraft in terminal airspace, will need to be implemented. This, together with developments in aircraft navigation techniques, will result in changes to the design of airspace and the procedures flown by commercial aircraft. This could have a potential adverse impact on the continued availability of suitable contiguous airspace for sporting, recreational and military activity; particularly, if total segregation of these aircraft is required because of a lack of technical interoperability with the ATM surveillance systems and anti-collision safety nets that are supporting commercial flights.

3.3.2 The Role of SSR/SSR Mode-S

SSR/SSR Mode-S has a key role to play in managing air traffic and facilitating collision avoidance and warning systems. Where SSR Mode-S is deemed essential for ATM and safety reasons, such as in high density controlled airspace (CAS), aircraft not equipped with co-operative SSR/SSR Mode-S transponder technology are routinely segregated and denied access to the airspace. In airspace where SSR/SSR Mode-S is not deemed essential, the lack of equipage of transponders on some aircraft means that the potential safety and efficiency benefits of SSR Mode-S use are not being maximised. In particular, collision avoidance and warning systems used in the airspace are effectively 'blind' to these aircraft.

Even in airspace where SSR/SSR Mode-S transponder carriage and operation

is effectively mandatory, State authorities and/or ATC units sometimes permit limited exemptions from the requirements. This is usually to take account of the operational or technical impracticality of fitting current ICAO compliant transponder products to some aircraft, particularly sailplanes. Where this alleviation occurs, the benefits of SSR Mode-S are not maximised and risks arise.

3.3.3 **Airspace Design and Segregation**

The establishment of Controlled Airspace is generally the most expedient course to take in order to manage Commercial Air Traffic flights and protect them from other non-interoperable aviation activity. Unsurprisingly, therefore, as Commercial Air Traffic levels have increased in recent years, so has the amount of Controlled Airspace. To date, however, the proportional growth of Controlled Airspace compared with traffic growth has been much less, indicating that efficiency in use of existing Controlled Airspace structures has also been improved. Nevertheless, future airspace redesign must now also allow for more efficient routing, optimum flight profiles and less holding of aircraft in order to manage traffic growth in an environmentally sound way.

In some States, the net effect of increased levels of Controlled Airspace and airspace redesign is that available airspace for non-transponder equipped aircraft is reducing, either through new Controlled Airspace requirements or through the establishment of mandatory transponder carriage areas in airspace surrounding Controlled Airspace.

This, in itself, presents safety risks to non-transponder equipped aircraft, as they are being forced to operate closer together in ever decreasing volumes of available airspace. The operational requirements of pilots flying non-transponder equipped aircraft are also becoming increasingly difficult to meet because of the lack of available airspace or access to airspace; in particular, insufficient contiguous Class G airspace within which to conduct cross-country flights.

3.3.4 Use of Class G Airspace by Commercial Air Traffic

Rigid and permanent airspace segregation does not necessarily optimise the use of the limited airspace resource, and it cannot always meet user requirements for optimum routing. Also, some regional airports used by Commercial Air Traffic operators may not always meet the criteria for the establishment of protective Controlled Airspace conjoined to the major en-route structure. Therefore, Commercial Air Traffic flights, either voluntarily or unavoidably, sometimes have to be conducted outside of Controlled Airspace; usually during the critical stages of departure, final approach and landing.

In these situations, the benefits of the TCAS safety net is not being assured if transponder carriage is not mandatory in the airspace and the situational awareness of ATC providers on conflicting traffic is less than in Controlled Airspace due to the lack of SSR/SSR Mode-S data from all aircraft operating within the shared airspace.

3.3.5 Airspace Infringements

The presence of more Controlled Airspace also increases the chances of infringements of that airspace occurring, with the resultant serious safety and flow capacity implications that ensue from these events. SSR/SSR Mode-S is a very useful tool in helping to firstly detect airspace infringements and then manage the impact of them. However, where airspace is infringed by non-transponder equipped aircraft, these benefits cannot be realised; controllers may not appreciate that a 'non-squawking' aircraft has actually infringed the airspace and the absence of altitude data from infringing aircraft means that participating aircraft in the airspace cannot be separated from them efficiently. Safety nets are also not activated if the infringing aircraft is not equipped with SSR/SSR Mode-S.

3.3.6 Separation of Aircraft Outside Controlled Airspace

In most States, airspace outside of the major terminal and en-route Controlled Airspace structures is shared by a wide variety of aviation activity. This can bring together IFR and VFR flights, conducted by both high performance and

low performance civil and military aircraft. Some of these aircraft will be equipped with collision avoidance and warning systems and some may also be receiving an ATIS that is being based on 3-dimensional positional references derived from an SSR-based surveillance picture.

Many light aircraft operating outside of Controlled Airspace in Europe will not currently be transponder equipped and the primary method of separation from other aircraft in this airspace is known as 'See and Avoid'. However, there are continuing doubts about the effectiveness of 'See and Avoid' as a suitable method of separating aircraft, particularly in a mixed IFR and VFR environment and in situations where high performance aircraft are involved.

In some classes of airspace, the efficiency and safety benefits of SSR/SSR Mode-S in Europe are not currently being maximised because of the lack of harmonised transponder carriage requirements and the impracticality and economic viability of equipping many light aircraft with currently available SSR Mode-S transponder products.

3.3.7 Interference Levels on the SSR 'Reply' Frequency

The growth of air traffic and, particularly, growth in the level of aircraft using systems that operate on the SSR 'reply' frequency of 1090 MHz, has increased the incidence of interference on that frequency and increased the amount of 'garbling' of legitimate replies received from SSR transponders. Consequently, 'classical' SSR is now being replaced by the more spectrally efficient SSR Mode-S technology in several 'core' European States. For many operators, particularly from non-commercial and military sectors, SSR Mode S is seen as an expensive and complex system, and its adoption even in commercial aircraft and ground systems has been and in some cases still is problematic.

Military organisations operate a very high number of aircraft and ground stations which need to be adapted to these needs as well. Budget restrictions and in some cases the lack of technical solutions do not allow a complete adaptation in the near future by military organisations.

Nevertheless, it is essential that 'classical' SSR is phased out soon in order to improve the efficiency and safety benefits of the use of SSR Mode-S in the

modern higher capacity ATM environment.

3.3.8 The role of Primary Surveillance Radar

The Surveillance Strategy for ECAC [5] requires Primary Surveillance Radar (PSR) “as required”. This requirement is a safety argument based on the mitigation of transponder failures and possible infringements of non transponder equipped aircraft, in particular in Major TMA’s. In the future, also security arguments for PSR are expected.

However, due to frequency issue, environmental issue and cost, full PSR coverage will be difficult to achieve. In addition, the detection by PSR becomes increasingly difficult in clutter area (including wind turbines parks) and with new types of aircraft which have smaller equivalent surface (smaller aircraft, composite aircraft) and consequently are less detectable by PSR.

3.3.9 A Need for Greater Technical Interoperability Between Aircraft

Some States and stakeholders now believe that a greater degree of technical interoperability needs to be achieved between all aircraft and aviation activity in Europe. As the impact of efficient airspace design takes hold, improved access for all users to different categories of airspace must occur through improved technical interoperability. Collision risks must be reduced in all areas, but especially where flights unavoidably take place in a mixed environment of commercial, private and military users.

This interoperability is needed for operations wholly contained inside and outside of Controlled Airspace, and for the transit of aircraft between the two.

The only realistically achievable method of accomplishing this in the short to medium term in Europe is through the interaction of SSR/SSR Mode-S transponders on all aircraft with the current SSR-based safety nets and ATM surveillance infrastructure.

4. RATIONALE FOR AN LPST

As described at Paragraph 3.1.1 above, the lowest power output requirement for an ICAO-compliant SSR transponder is 18.5 dBW and, only then, when operated below 15,000 ft. Most non-motorised aircraft and some light and very light aeroplanes and helicopters lack suitable power supplies or installation space to support units that meet this standard. Operating restrictions, radiological concerns arising from the ICAO minimum power output requirements, and installation issues for transponder units and antennae in small aircraft also currently present equipage obstacles for many types of light aircraft.

Therefore, in general, most non-motorised aircraft and many light and very light aeroplanes and helicopters cannot meet the legislation to be equipped with SSR/SSR Mode-S transponders, even to meet the literal adoption of ICAO Annex 6 SARPs.

In order to try and overcome some of the installation difficulties presented by ICAO SARPs, the EUROCAE MOPS described at Paragraph 3.1.2 above have been provided to support the development of LAST equipment. However, as conformance with the ICAO minimum power output is still required, MOPS-compliant LAST units are still not suitable for many types of light aircraft, particularly non-motorised variants.

Therefore, suitable lower power units should be made available so that all types of light aircraft can be equipped with an SSR/SSR Mode-S transponder, either to support a regulatory requirement or to give operators the voluntary option of equipping in order to meet an operational requirement or to afford them some electronic collision avoidance protection against TCAS equipped aircraft.

Consequently, until an LPST is available, the benefits of SSR/SSR Mode-S cannot be maximised in European airspace and the desired technical interoperability of all aircraft, as opposed to increased airspace segregation, cannot be achieved.

5. OPERATIONAL REQUIREMENTS

5.1 General Requirements

The overall operational requirement would be to maximise the opportunities for safety nets, such as TCAS and STCA, and SSR-based ATM surveillance systems to detect aircraft in all airspace. Within this, the general requirements for an LPST are as follows:

- To provide opportunities for all aircraft to be able to equip with SSR Mode-S transponders to meet regulatory requirement or on a voluntary basis;
- To provide one surveillance source, irrespective of ground based surveillance system being SSR Mode A/C/S, ADS-B or Multilateration;
- To maximise opportunities for all users to access airspace;
- To facilitate the efficient use of all classifications of airspace;
- To facilitate the accommodation of traffic growth within the ATM system in a safe, efficient and environmentally sound manner;
- To maximise freedom of movement for all aircraft operating in airspace within States and between States;
- To facilitate detection of airspace infringements;
- To facilitate safe and efficient management of airspace infringements;
- To ensure that interference in the SSR spectrum is managed to tolerable levels;
- To support the introduction of SSR Mode S in European States as a replacement for 'classical' SSR;
- To guarantee high levels of reliability of transponder performance, especially for transponders that are not regularly verified by ATC procedures;
- To minimise the need for SSR Mode-S transponder carriage exemptions and alleviations;
- To facilitate continued civil/military IFF/SSR interoperability;

- To facilitate civil/military airspace sharing.

5.2 Operational Needs of the General Aviation Community

In general terms, the EUROCONTROL study into the recognition and detection of light aviation aircraft [1] sets out the operational requirements for activity in the GA sector as follows:

- Maximum freedom of movement within all airspace regimes and environments;
- Operations under VFR using the 'See and Avoid' rule;
- The right to change flight rules from IFR to VFR, and vice versa, in the air or at least to receive special handling;
- Sufficient Class G airspace and VFR access to Controlled Airspace, free flight and dynamic routing;
- Sufficient contiguous airspace to permit unrestricted cross-country flying;
- The ability to reserve airspace for particular activities.

5.3 Required Attributes of an LPST for Light Aircraft

An LPST suitable for light and very light aircraft might need the following general attributes in order to satisfy GA user requirements:

- Suitability to be used in those aircraft that cannot practicably carry and operate an transponder with a peak pulse power available at the transponder antenna of 18.5 dBW or more;
- Suitability for use on both motorised and non-motorised aircraft;
- Suitability to be used for flights that do not meet the VFR criteria;
- Suitability to be used in all classes of airspace;
- Acceptability for use in the airspace of all European States;
- Operates with a peak and mean pulse power available at the transponder antenna that causes no harmful radiological effects to the occupants of aircraft when the antenna is situated very close to the human body;
- SSR Mode S capability and 'backwards compatibility' with SSR Mode A/C;

- Mode-S Short Squitter (TCAS) capability;
- Mode-S Extended Squitter (ADS-B) capability
- Ability to operate with interchangeable hard-coded 'personality' modules containing ICAO 24-bit aircraft addresses, which must not permit the manual reprogramming of these addresses using the operational HMI interface of the transponder;
- Designed to ensure that the contents of registers 08₁₆, 20₁₆, 21₁₆, 22₁₆ and 25₁₆ of the LPST are cleared on each occasion that the unit is moved between aircraft;
- Capability to perform at typical temperatures encountered between the surface and FL 150 in European airspace;
- Capability to be operated for a minimum duration of 10 hours, from either the power supply of the host aircraft or integral internal batteries, in a mixed Mode A/C/S environment and providing TCAS and ADS-B squitters as required;
- Low battery warning function;
- Capability to be recharged from external power sources;
- Small, transportable and easily transferable between aircraft;
- Maximum weight of 1 – 1.5 kg, including integral batteries;
- Capability to be operated with an integral antenna or with an external antenna mounted on the host-aircraft;
- Capability to be easily and quickly installed and removed from aircraft without suitable avionics panel space;
- Robust and rugged design;
- Easily operated with gloved fingers;
- Visible display in all light conditions.
- Capability to perform in non-enclosed cockpit environments;
- Proportionate capital cost;
- Proportionate installation and certification costs;
- Proportionate annual operating costs;

- Proportionate ongoing annual maintenance requirements;
- Built-in test facility;
- Electromagnetic compatibility with existing avionics and electrical equipment installed in light aircraft.

5.4 Interoperability Requirements for an LPST

An LPST would have to meet the following interoperability requirements:

- Minimum of Level 2es compliance with ICAO Annex 10 Vol IV AL77 [3] with the exception of the peak pulse power available at the transponder antenna and receiver sensitivity;
- Compliance with current EUROCAE ED-115 MOPS [4] for LAST units, with the exception that, subject to testing, the maximum peak pulse power requirement available at the transponder antenna for an LPST should be 14.7 dBW, and the LPST should be suitable for use on flights that do not meet the VFR criteria;
- Minimum of SSR Mode S ELS functionality, as described in Paragraph 3.2.1 above;
- ADS-B 1090 Extended Squitter compliant;
- Receiver sensitivity should be balanced against transmitter peak pulse power such that interrogations received from sources within the transponder transmit range will be detected on a high number of occasions;
- Receiver sensitivity should be sufficient to ensure that required interoperability and performance characteristics for interaction with TCAS units are fully met;
- Minimum detection range by ground-based interrogators, operating in either Mode A/C or Mode S, of 40 nm within radar line-of-sight;
- Minimum detection range of 40 nm within line-of-sight of a passive receiver used as part of a Wide Area Multilateration system or ADS-B;
- Operated at an altitude of less than 15,000 feet altitude and a cruising true airspeed of less than 175 kt to ensure appropriate interaction with airborne collision avoidance system algorithms.

5.5 Future Developments in Surveillance

The EUROCONTROL Surveillance Strategy for ECAC [5] presents a set of evolutionary recommendations for a transition from the current surveillance systems to future systems, operating side-by-side during the transition phase. It provides a path from the current SSR-based infrastructure, to one using Automatic Dependent Surveillance-Broadcast (ADS-B). This is a dependent cooperative surveillance technique, which will be combined with SSR Mode S and Wide Area Multilateration (WAM), where and when required.

A number of technologies are available for transmitting ADS-B data from aircraft. The main one is the Mode S 1090 MHz Extended Squitter (1090ES) data link, which has been agreed for initial delivery of ADS-B based services by the ICAO 11th Air Navigation Conference.

ICAO compliant Mode S transponders potentially can provide 1090ES and, therefore, deliver ADS-B. Consequently, the LPST should be designed to be capable of providing 1090ES functionality.

Additional advantages of transmitting ADS-B are:

- Low surveillance coverage can be easily and inexpensively achieved using ADS-B 1090ES;
- ADS-B 1090ES will be used by new HYBRID Surveillance TCAS in order to use more efficiently the 1030/0190 link;
- ADS-B 1090ES will also be used by Wide Area Multilateration (WAM) system in order not systematically interrogate the transponder to get additional airborne information (altitude, Aircraft Identification);
- ADS-B ES will allow future Airborne Separation Assistance System (ASAS) applications like Airborne Situational Awareness;

6. OPERATIONAL APPLICATION

6.1 Operational Objectives

The objectives for the operation of LPST units within designated volumes of airspace could be as follows:

- To solve increasing safety risk due to increasing close proximity cohabitation between VFR traffic and IFR traffic:
 - by providing interoperability with ground based ATC system safety nets (improved detection, knowledge of altitude;
 - by providing an airborne safety net between VFR and IFR based on interoperability of all types of light and very light aircraft with TCAS systems and other airborne collision warning systems;
- To keep an acceptable level of freedom for VFR while increasing controlled airspace capacity:
 - by providing a means of compliance for operators to be able to equip all types of light and very light aircraft for access to mandatory SSR/SSR Mode-S transponder carriage airspace and to ease their transit from one G class area to another one;
- To facilitate interoperability of all types of light and very light aircraft with ground-based SSR-dependent safety nets;
- To facilitate interoperability of all types of light and very light aircraft with current and emerging SSR-based ATM surveillance systems;
- To provide a means of compliance for operators to be able to equip all types of light and very light aircraft for access to mandatory SSR Mode-S transponder carriage airspace;
- To facilitate the provision of aircraft identification and pressure-altitude reporting information by all types of light and very light aircraft.

6.2 Operational Benefits

LPST units will provide a means of compliance with which to facilitate the

availability of SSR/SSR Mode-S and ADS-B data on all light and very light aircraft operating below FL 150. Consequently, the provision of aircraft identification and pressure-altitude reporting information from all aircraft could then be made mandatory within volumes of airspace without having to segregate many light and very light aircraft. Moreover, voluntary equipage of light and very light aircraft would be technically and operationally feasible, and so operators could choose to voluntarily equip aircraft in order to gain access to airspace, maximise freedom of movement and reduce collision risks in all airspace.

6.2.1 Improved Interoperability with Airborne Collision Avoidance Systems

The current requirements for equipage of aircraft with TCAS II are not airspace specific but are based on aircraft weight and passenger seating configuration. Consequently, TCAS II equipped aircraft, although primarily found in greater numbers within Controlled Airspace, will operate in all classes of airspace. TCAS I systems are also now in widespread use and there is the future potential for military platforms to be equipped with bespoke SSR-based collision warning systems.

An LPST provides a means of compliance with which States can maximise opportunities for detection of all aircraft by airborne collision avoidance equipment installed on aircraft operating in all classes of airspace below FL 150. Consequently, collision risks can be reduced by TCAS equipped aircraft based on TCAS warning and Resolution Advisory.

6.2.2 Improved Interoperability with Ground-Based Safety Nets

Ground-based safety nets, such as STCA, utilise SSR/SSR Mode-S data to provide alerts of collision risks in specific volumes of airspace, usually Controlled Airspace. An LPST provides the potential for States to maximise opportunities for detection of all light and very light aircraft below FL 150 by SSR-reliant ground-based safety nets. Consequently, collision risks can be reduced.

6.2.3 Access to Airspace and Freedom of Movement for Light Aircraft

The ability to carry and operate an SSR Mode-S transponder in the form of an LPST increases the potential for all light and very light aircraft operators to gain clearances to access Controlled Airspace or to obtain a Controlled Airspace crossing below FL 150. This could be particularly beneficial for protecting freedom of movement in the face of any future redesign of Controlled Airspace that provides more direct routings for Commercial Air Traffic operating between regional airports.

6.2.4 Increased Use of Mandatory Transponder Carriage Airspace

An LPST provides a means of compliance for all States to be able to establish Mandatory Transponder carriage Zones within or around high risk airspace to reduce collision risks without reducing the amount of accessible airspace available for light and very light aircraft. In particular, such zones could be created within Class G airspace as 'buffers' to Controlled Airspace or as mitigation for the effects of wind farms on primary radars without restricting the freedom of movement of sporting and recreational activity below FL 150.

6.2.5 Improved Detection and Management of Airspace Infringements

For some ANSPs, the need to provide mitigation for the impact of airspace infringements is a significant issue. The provision of SSR/SSR Mode-S data by all aircraft would help to improve the detection of infringements, and provide for safer and more efficient management of the incidents once they have occurred.

An LPST provides the means of compliance for States to ensure that all aircraft can provide the necessary data below FL 150.

6.2.6 Improved Potential to Create 'Known' Traffic Environments

A 'Known' traffic environment is one within which all traffic is known to ATS, either with position only or with flight intentions as well. Within this environment, continuous two-way communication may be required, an SSR/SSR Mode-S transponder will always be required but not all traffic will be

subject to ATC clearance.

An LPST provides the means of compliance for States to set up these 'Known' traffic environments in all classes of airspace in order to improve ATM productivity by reducing controller workload and enabling more efficient use of airspace. With an LPST, this could be achieved without having to segregate light and very light aircraft below FL 150.

6.2.7 Improved Detection of Aircraft with Low Visibility to Primary Radar

Detecting light and very light aircraft with low primary radar cross-sections or when they are operating in areas with high levels of primary radar 'clutter' can be problematic for ANSPs unless the aircraft are also equipped with SSR/SSR Mode-S transponders.

Consequently, an LPST could provide mitigation to increase detection of light and very light aircraft in these circumstances. Generally, this would be associated with the establishment of mandatory transponder carriage airspace but it could also be employed as possible mitigation for the impact of issues such as wind farm developments in the vicinity of aerodromes.

6.2.8 Increased Potential to Employ Flexible Use of Airspace

In some circumstances, levels of Commercial Air Traffic movements from aerodromes do not justify the establishment of permanent protective Controlled Airspace to support the terminal or en-route phases of flight of these aircraft. In many cases, there will be short 'peak' periods during some or all days where Controlled Airspace would be beneficial.

An efficient use of airspace in these cases would be to have the facility to turn protective airspace on and off to meet the demand, while not unduly restricting the freedom of movement of sporting and recreational airspace users through the establishment of more permanent structures. However, flexible airspace use of this nature carries with it safety risks from an increased likelihood of airspace infringements occurring. As explained in Paragraph 6.2.5 above, an LPST could provide suitable mitigation for reducing airspace infringement risks and, thereby, present States with the potential to implement more flexible and efficient use of airspace.

6.2.9 Means of Compliance to Implement ICAO Annex 6 Requirements

An LPST would provide the necessary means of compliance for all States to implement the ICAO Annex 6 SSR transponder carriage SARPs fully for General Aviation, by ensuring that all light and very light aeroplanes and helicopters (conducting international flights) could be suitably equipped with pressure-altitude reporting transponders.

6.3 Applicability Criteria

An LPST should be suitable for operation in all classes and types of European airspace.

However, where technically and operationally feasible, an ICAO compliant transponder with a peak power output of at least 18.5 dBW shall be fitted to light and very light aircraft requiring equipage with an SSR/SSR Mode-S transponder. Where this is not deemed practical, an LPST can be used on aircraft meeting the following applicability criteria:

- The aircraft should have a MTOM of less than 1,200 kg and a maximum cruising TAS of less than 175 kt;
- The aircraft should be operated IFR or VFR below FL 150.

The criteria for determining whether or not it is practical to fit an ICAO compliant transponder with a peak power output of at least 18.5 dBW should be based on the following:

- An LPST can be used if the installation and/or operation of an ICAO Annex 10, Vol IV, AL 77 compatible 18.5 dBW transponder and associated antenna is not technically feasible;
- An LPST can be used if the installation and/or operation of an ICAO Annex 10, Vol IV, AL 77 compatible 18.5 dBW transponder, including an ED-115 MOPS-complaint LAST unit, is not feasible for reasons of size, weight or available space;
- An LPST can be used if there is no suitable power source on the aircraft to support a transponder with a peak power output of at least 18.5 dBW for the expected flight duration plus one hour;

- An LPST can be used where it is not feasible to operate a transponder with a peak power output of at least 18.5 dBW due to the risk of intolerable radiological hazards being caused to the occupants of the aircraft.

State authorities could also, in exceptional circumstances, specifically approve the use of an LPST on aircraft to which the aforementioned applicability criteria do not apply.

The aforementioned criteria should apply to voluntary and mandatory equipage circumstances.

Some or all aircraft in following categories and groups are potential candidates to which the applicability criteria for equipage with LPST units may apply:

- **Light Aeroplanes.** Aeroplanes with a MTOM in excess of 750 kg and less than 1,200 kg defined by EASA CS-23 and listed in ICAO Doc 8643 as L, A, S and T;
- **Very Light Aeroplanes.** Aeroplanes with a MTOM not exceeding 750 kg defined by EASA CS-VLA and listed in ICAO Doc 8643 as L, A, S and T;
- **Sailplanes.** Sailplanes (including Gliders) and powered sailplanes defined by EASA CS-22 and listed in ICAO Doc 8643 as GLID.
- **Small Rotorcraft.** Rotorcraft with a MTOM in excess of 600 kg and less than 1,200 kg defined by EASA CS-27 and listed in ICAO Doc 8643 as H and G;
- **Very Small Rotorcraft.** Rotorcraft with a MTOM not exceeding 600 kg defined by EASA CS-VLR and listed in ICAO Doc 8643 as H and G;
- **Amateur Aircraft.** Aircraft of less than 1,200 kg defined by EASA as aircraft of which at least 51% is built by an amateur, or a non-profit making association of amateurs, for their own purposes and without any commercial objective;
- **Microlight and Ultra-light Aircraft.** Aircraft listed in ICAO Doc 8643 as ULAC, GYRO and UHEL;
- **Hang Gliders and Para Gliders;**
- **Historic and Vintage Aircraft;**
- **Gas and Hot-Air Balloons.** Aircraft listed in ICAO Doc 8643 as BALL;

- **Free Balloons.** Aircraft listed in ICAO Doc 8643 as BALL;
- **Airship or Dirigible.** Aircraft listed in ICAO Doc 8643 as SHIP;
- **Motorised and Non-Motorised Parachutes.**

7. OPERATIONAL POLICY AND PROCEDURES

States should determine a need for the deployment of LPST units in their airspace and publish policies and procedures covering their use. These policies should be co-ordinated on a regional basis in Europe, if required facilitated by EUROCONTROL. It is recognised that the extent of the need for deployment of LPST units will vary between States, from a level of mandatory carriage requirements at one extreme through to just creating an appropriate regulatory framework to support a voluntary use of the equipment at the other.

7.1 Operational Capability and Employment

In all LPST equipage circumstances, whether voluntary or mandatory, States will need to take into account the operational capabilities of LPST units carefully, in terms of the range at which they can be detected by SSR/SSR Mode-S, Wide Area Multilateration or ADS-B. LPST capabilities will need to be balanced against the overall need for SSR/SSR Mode-S carriage and the ability to achieve the operational objectives set out in this LPST Considerations Material. In some circumstances, States may have to consider the need to place restrictions and limitations on how LPST units are deployed and operated within specific volumes of airspace.

7.1.1 Existing Mandatory Transponder Carriage Scenarios

Existing transponder carriage requirements, and any current safety cases associated with reliance on SSR/SSR Mode-S data, will be based on the employment of ICAO compliant equipment with a peak pulse power output at the antenna end of the transmission line of the transponder of at least 18.5 dBW. The criteria for the probability of detection of transponder equipped aircraft should, as a minimum, be based on the requirements of EUROCONTROL Surveillance Standard [6]. Some ANSPs may even set more stringent criteria.

Therefore, where States permit the use of LPST units within existing mandatory transponder carriage scenarios, safety cases may have to be re-opened by ANSPs to test the continued validity of the safety arguments. It

may be that, on examination, the operation of LPST units in some airspace may not be acceptable due to the lack of appropriate performance with the existing surveillance infrastructure; for example, within Controlled Airspace around an aerodrome for which the SSR/SSR Mode-S radar cover is provided by a 'feed' from an en-route sensor source that may be located away from the aerodrome vicinity.

Where it is deemed unacceptable to permit the use of LPST units within an existing volume of airspace that requires transponder carriage, States should promulgate this accordingly within the Integrated Aeronautical Information Package for that State.

7.1.2 Establishment of New Mandatory Transponder Carriage Scenarios

Following the introduction of LPST units, any new mandatory transponder carriage requirements established by States should take into account the operational capability of the LPST to ensure that aircraft equipped with these units can be accommodated safely within the specific airspace volume.

7.1.3 Impact on ATC System Capacity

In addition to the aforementioned issues concerning the range of detection of LPST units on SSR/SSR Mode-S interrogators, the deployment of LPST units in States could significantly increase the overall number of aircraft carrying and operating SSR transponders. Depending on how States implement the carriage requirements for LPST units, this may be a general increase across an FIR or may be specific to particular locations and areas within an FIR. In particular, 'clustering' effects could occur through large gatherings of light and very light aircraft for particular events or to take advantage of meteorological conditions.

Therefore, ANSPs will need to assess whether or not individual constituents or overall systems used to support ATS can safely manage any resultant increase in SSR data resulting from LPST carriage and operation. Technical mitigation, such as ATC filtering on displays using SSR codes, Mode-S address or height, may have to be employed or systems may also have to be upgraded to increase track and processing capacity. Moreover, States may

have to implement temporary alternative airspace arrangements for pre-planned events involving very large numbers of aircraft.

7.1.4 Interaction of LPST Units with Safety Nets

Systems such as TCAS and STCA provide safety nets to help prevent collisions; and they are implemented to improve safety over and above the minimum tolerable levels achieved through other systems and procedures. Therefore, any interaction of these safety net systems with LPST equipped aircraft will provide additional benefits over and above the current situation.

Consequently, there should be no limiting factors in how LPST units are used in airspace where TCAS and/or STCA systems are present.

Notwithstanding, in circumstances or areas where it is known that large 'clusters' of LPST equipped aircraft could operate within small volumes of airspace, States should consider whether or not special arrangements for this activity need to be put into place to ensure that the safety nets can continue to work efficiently.

7.1.5 ICAO 24-bit Aircraft Address Assignment and Encoding

It is envisaged that some variants of LPST units will be transportable between aircraft, and different configurations of aircraft structures, to meet user requirements. For example, balloons, hang gliders and paragliders may have different combinations of equipment for different circumstances but only need a single LPST at any time. An owner of several light or very light aircraft may also only require one LPST if they only operate one aircraft at a time. Other LPST variants may be fixed installations within a cockpit avionics panel or ones that are easily removed for recharging purposes.

Current assignment methodology for 24-bit aircraft addresses in ICAO Annex 10 SARPs [3] primarily requires addresses to be assigned to individual aircraft and not particular owners or transponders. However, to cater for removable transponders, such as LPST units, that are intended for use in several different aircraft, a forthcoming amendment to Annex 10 will make provision for the assignment of unique addresses to the removable transponder itself.

The Appendix to chapter 9:

A World-wide scheme for the allocation, assignment and application of aircraft addresses (applicable November 2007)

Section 5.2. reads:

Aircraft addresses shall be assigned in accordance with the following principles:

- a) *at any one time, no address shall be assigned to more than one aircraft with the exception of aerodrome surface vehicles on surface movement areas. If such exceptions are applied by the State of Registry, the vehicles which have been allocated the same address shall not operate on aerodromes separated by less than 1 000 km;*

- b) *only one address shall be assigned to an aircraft, irrespective of the composition of equipment on board. In the case when a removable transponder is shared by several light aviation aircraft such as balloons or gliders, it shall be possible to assign a unique address to the removable transponder. The registers 08_{16} , 20_{16} , 21_{16} , 22_{16} and 25_{16} of the removable transponder shall be correctly updated each time the removable transponder is installed in any aircraft;*

Where an LPST is used with a 24-bit aircraft address that is assigned to the host aircraft, procedures for safely and accurately changing the 24-bit aircraft address used by the transponder will need to be put in place. The design of the LPST will need to make this as simple as possible to ensure that errors or corruption in the 24-bit aircraft address are not introduced.

States should also ensure the 24-bit aircraft address assignment system takes account of the forthcoming requirement to assign addresses to transponders as well as aircraft. In particular, the assignment process will need to ensure that operators of LPST units can be easily and quickly contacted in order to facilitate expeditious reporting and rectification of any observed anomalies with the 24-bit aircraft address.

The methods of employing 24-bit aircraft addresses with LPST units could be

as follows:

- The 24-bit aircraft address encoded into an interchangeable 'personality module' device that is attached to the LPST, or;
- The 24-bit aircraft address encoded into an installation cradle or slot on the airframe into which the LPST has to be inserted prior to each flight, or;
- The 24-bit aircraft address encoded within the LPST unit itself.

Whatever method is adopted, manual programming of the 24-bit aircraft address using the operational input interfaces of the LPST should not be permitted. The 24-bit aircraft address should only be encoded by a competent authority as an engineering function.

In the case where an LPST unit is shared between different aircraft or different configurations of an aircraft, the registers 08₁₆, 20₁₆, 21₁₆, 22₁₆ and 25₁₆ of the transponder shall be correctly updated each time it is installed. It is envisaged that the registers could be preloaded within an appropriate storage module and activated with a switch setting to match the required aircraft registration or configuration.

7.2 Implementation Conditions

7.2.1 Transition Periods

States may need to phase in the implementation of LPST carriage and develop comprehensive transition plans. Light and very light aircraft make up the largest proportion of the aviation fleet in States. Moreover, only a small proportion of the fleets below 1,200 kg MTOM within States are currently equipped with SSR transponders. Therefore, any future mandatory requirements in States to deploy LPST units in light and very light aircraft must take account of the potential significance of any associated equipage programme. Even non-regulatory approaches, such as establishing more mandatory transponder carriage areas and encouraging equipage with LPSTs, will also need to be mindful of the likely supply and demand issues for equipment.

Currently, LPST units still need to be developed, tested and brought to market.

Change proposals to international standards also need to be processed. A suitable market will need to be encouraged to ensure that potential manufacturers will be willing to develop and build the systems. Moreover, the supply chain will need to be able meet demand and the price of the equipment will need to be proportionate to the benefits and the other costs of operating the applicable aircraft.

Consequently, States will need to consider applying suitable transition periods to any implementation of scenarios involving the mandatory or likely voluntary equipage of light and very light aircraft. These transition arrangements will need to allow stakeholders sufficient time to purchase and install suitable LPST units in their aircraft. During the transition periods, exemptions should need to be granted and mitigation for these exemptions put in place. At the end of a transition period, the level of service to those exempted aircraft may then need to differ from that provided to aircraft which comply fully with the airborne equipment carriage requirements.

Implementation dates will also have to balance the need to realise the benefits of the carriage of LPST units with the adverse impact that any exemptions may cause. Implementation dates may also have to be aligned with, or take into account, other related programmes, such as SSR Mode S requirements for VFR flights in some States or any deployments of ADS-B and WAM.

7.2.2 Exemption Principles

ICAO Doc 7030 calls for the application and extent of exemptions, in the interests of harmonisation, to be co-ordinated on a regional basis. The granting of dispensations and exemptions from SSR Mode-S transponder carriage and operation is a sovereign State responsibility. However, in order to satisfy the Doc 7030 co-ordination requirements, states should endeavour to comply with the exemption application principles set out below, subject to specific flight safety considerations and any significant penalty which might otherwise be incurred. Additionally, State authorities should make every effort, within the airspace under their jurisdiction, to accommodate, in that airspace, aircraft which have been granted an exemption by another State. To this end, co-ordinated exemption arrangements should be considered.

The assessment of applications for exemptions for reasons of technical infeasibility should take into account the estimated annual flying hours of individual aircraft in the relevant airspace, together with the impact that non-compliance will have on the realisation of the benefits of the transponder carriage requirements.

The exemption principles that should be applied to the deployment of LPST units on light and very light aircraft could be as follows:

- Exemptions should be granted when the carriage of an LPST is impracticable;
- Exemptions should be granted when an exception to the requirement to carry and operate an LPST is authorised for a specific purpose;
- Exemptions should be granted where there are delays in equipage of aircraft because of factors that are beyond the control of the operator. In this case, operators will be expected to provide appropriate documentary evidence that equipment orders and fitment plans have been put in place;
- Exemptions should be granted to aircraft operators for flights conducted for the purpose of flight testing, delivery and for transit into and out of maintenance bases;
- Aircraft operators who are granted exemptions should be advised that the policy pertaining to exemptions will be subject to periodical review and, in the first instance, should be for a period not exceeding 3 years;
- Aircraft operators who are granted exemptions should be advised that it may not be possible to provide the same level of service as that applied to aircraft which comply with LPST carriage and operation requirements. In particular, it may not be possible to grant access to mandatory transponder carriage airspace, especially during peak flying periods.

7.2.3 Minimum Equipment List Issues

States will need to provide transponder failure guidance and Minimum Equipment List (MEL) policies for LPST units used in scenarios where the carriage and operation of transponders is mandatory. In deriving this policy, the following principles should be applied:

- Where the failure of an LPST unit becomes apparent when airborne, either through indications from BITE or from an ATIS unit, the pilot may elect to continue the flight but should attempt to exit any mandatory transponder carriage airspace as soon as possible unless otherwise authorised by ATC;
- Where a failure in an LPST unit cannot be rectified on landing, or is detected prior to take-off, a single flight may be undertaken through mandatory transponder carriage airspace to another airfield with rectification facilities. However, ATC clearance should be obtained prior to transit through mandatory transponder carriage airspace and routes should be planned to minimise the time spent within the airspace.

7.3 Regulatory Issues

7.3.1 International Standards

Policy precedent for the carriage and operation of SSR/SSR Mode-S transponders by light aviation aeroplanes is already provided in ICAO Annex 6; although, this applies only to motorised aircraft conducting international flights. Any national or European policy for the carriage of LPST units by light and very light aircraft would support and enhance these ICAO Annex 6 SARPs.

However, an LPST unit would not be compliant with current ICAO Annex 10 SARPs for peak pulse power output at the antenna. Therefore, within any harmonised European regulatory framework for the carriage and operation of LPST units, parallel change proposals to ICAO Annex 10 would need to be processed.

It is envisaged that these change proposals could include provision for the use of LPST units in line with the following principles:

- Where a national authority considers that a transponder with a minimum peak power output available at the antenna of 18.5 dBW cannot be installed in aircraft for technical or operational reasons;
- Where the use of LPST units is subject to regional air navigation agreement and included in the Air Navigation Plan;

- Applicable only for use in airspace where the required surveillance performance is commensurate with the LPST minimum capability for detection by SSR-based surveillance systems.

Where possible, implementation dates would need to take into account any likely changes to Annex 10 SARPs and States would need to notify ICAO of any differences if national implementations preceded these changes. Moreover, any differences would need to be published in Aeronautical Information Publications (AIP).

7.3.2 Single European Sky Legislation

There is currently no specific Single European Sky (SES) legislation on the general carriage of SSR/SSR Mode-S transponders by aircraft; although, there are ongoing proposals for the carriage of SSR Mode S level 2es transponders by General Air Traffic conducting IFR flights. Nevertheless, the policy objectives for the carriage and operation of LPST units support the following SES regulatory aims:

- **Airspace Regulation.** The airspace Regulation [7] states that: “Airspace is a common resource for all categories of users that needs to be used flexibly by all of them, ensuring fairness and transparency whilst taking into account security and defence needs of Member States and their commitments within international organisations.” Moreover: “Efficient airspace management is fundamental for increasing the capacity of the air traffic services system, to provide the optimum response to various user requirements and to achieve the most flexible use of airspace.” The use of LPST units on light and very light aircraft provides a supporting means of compliance in this regard to facilitate potential initiatives to implement flexible use of airspace below FL 150 and to provide access to airspace for light and very light aircraft.
- **Interoperability Regulation.** The Essential Requirements in the interoperability Regulation [8] state that: “The EATMN, its systems and their constituents shall support, on a coordinated basis, new agreed and validated concepts of operation that improve the quality and effectiveness of air navigation services, in particular in terms of safety and capacity.” In terms of surveillance systems, it goes on to state: “Surveillance data

processing systems shall accommodate the progressive availability of new sources of surveillance information in such a way as to improve the overall quality of service.” The introduction of LPST units on light and very light aircraft supports improved ATS awareness, ATM productivity and safety below FL 150. Moreover, surveillance systems deployed in Europe must now be made capable of accommodating additional information, such as that provided by increased carriage of SSR transponders on light aircraft.

7.3.3 EUROCAE Means of Compliance

EUROCAE MOPS, ED-115, for LAST units are valid as official statements of policy when adopted by States. Current MOPS note that national authorities may approve the use of LPST units within national airspace but these must be clearly labelled as nationally approved only. In addition, LAST and LPST units are currently only permitted by ED-115 for VFR operations. Therefore, within any harmonised European regulatory framework for the carriage and operation of LPST units, parallel change proposals to MOPS would need to be progressed to meet user and general interoperability requirements.

7.3.4 EUROCONTROL Strategy

One of the key objectives of the ATM 2000+ Strategy [9] is: “To provide sufficient capacity to accommodate the demand of all users in an effective and efficient manner at all times, and during typical busy hour periods without imposing significant operational, economic or environmental penalties under normal circumstances.”

The introduction of LPST units on light and very light aircraft within States would support this objective through greater possibilities for flexible use of airspace below FL 150 and through improved interoperability for these types of aircraft to be able to access airspace. However, EUROCONTROL could assist with the harmonisation of standards and approaches within Europe, particularly with regard to any technical regulations, means of compliance and implementation conditions.

7.3.5 National Regulatory Requirements

Within the bounds of international and European legislation, States will wish to individually decide how to apply SSR/SSR Mode-S transponder carriage rules within national airspace for light and very light aircraft operations below FL 150. Some are currently taking non-regulatory approaches, some are defining increasing amounts of mandatory transponder carriage airspace outside of Controlled Airspace, and some are considering extending mandatory transponder carriage requirements to all classes of airspace.

Due to differing operational requirements, national use of airspace below FL 150 and perceptions of risks, national transponder carriage regulations are likely to continue to vary in extent and degree for the foreseeable future; these will probably only start to converge when either the classifications of airspace in Europe are rationalised or through increased pressure from users.

However, in order to protect freedom of movement for light and very light aircraft between European States and to ensure that users in some States are not economically disadvantaged compared to others, States will need to employ co-ordinated and harmonised technical requirements for LPST units to ensure that they can be used throughout European airspace where the carriage and operation of SSR/SSR Mode-S (Level 2es) transponders is required. Moreover, those operators equipping with LPST units voluntarily in States should not be penalised from any lack of acceptance of their use in the airspace of other States. Therefore, in addition to harmonised technical standards, co-ordinated implementation conditions should also be adopted.

Those States that place restrictions on where aircraft equipped with LPST units can operate will need to notify any airspace within which the operation of LPST units is not permitted in the Integrated Aeronautical Information Package.

7.4 Links to Other Programmes

7.4.1 Implementation of SSR Mode S in Europe

The European SSR Mode S programme is an essential link to the deployment

of LPST units. Any LPST units used within the notified airspace of the Mode S implementing States to meet IFR or VFR carriage requirements will need to provide a minimum of Mode S ELS and support the use of Surveillance Identifier (SI) codes. Moreover, SSR Mode S technology will probably need to be the means of compliance required for LPST units in many States in order to manage the integrity of 1090 MHz in the face of increased transponder carriage.

7.4.2 CASCADE/ADS-B

The European CASCADE/ADS-B programme has been set up to plan and coordinate a first set of ADS-B applications, using the position broadcast by suitably equipped aircraft as a basis for ground based surveillance. The 11th ICAO Air Navigation Conference agreed that initial applications of ADS-B based services would be provided by the 1090ES data link. Therefore, LPST units will need to be compliant with ICAO Annex 10 Amendment 77 Level 2es.

7.4.3 Wide Area Multilateration

Multilateration is a form of Co-operative Independent Surveillance, which makes use of the 1090 MHz signals transmitted by an aircraft to calculate the position of that aircraft. A Multilateration system consists of a number of ground based antennas receiving a signal broadcast from an aircraft. A central processing unit then calculates the aircraft's position based upon the Time Difference of Arrival (TDOA) of the signal at the different antennas.

Multilateration systems can be passive or active. Active means that the system transmits SSR Mode A/C or SSR Mode S interrogations as required to either trigger a transponder reply or to request additional Mode-S data from the aircraft by a selective interrogation, using the aircraft ICAO 24-bit aircraft address.

The implementation of LPST units will support the deployment of Wide Area Multilateration (WAM) in approach or en-route areas and A-SMGCS on airports by facilitating detection of light and very light aircraft.

7.5 Civil/Military Interoperability

Military Air Defence and ATC authorities will face the same radar coverage and system issues (e.g. ATC system capacity) from the deployment of LPST units as civil ANSPs. Therefore, military authorities will need to take account of the presence of LPST equipped aircraft operating in airspace within which military units have an interest or are providing an ATS. States should ensure that military authorities make best endeavours to accommodate LPST equipped aircraft to achieve civil/military interoperability.

Moreover, those military authorities developing and deploying SSR-based collision warning systems on military aircraft will need to take account of the capabilities of LPST units.

7.6 Issues Requiring Further Progression

7.6.1 LPST Concept of Operation

A European wide concept of operation dealing with aircraft equipped with an LPST has to be agreed to support national regulations, to facilitate cross border flights and to enable the drafting of technical specifications.

7.6.2 International Standards

The use of LPST units will need to be presented to ICAO for acceptance and incorporation into ICAO SARPs. Supporting evidence from trials and testing will probably be required. Moreover, change proposals to ED-115 MOPS will need to be progressed to remove the VFR only caveat for LAST units and to ensure that LPST versions of LAST units are acceptable throughout the airspace of the European region.

Until the aforementioned is achieved, any deployment of LPST units may have to be undertaken with a notification of a difference to ICAO by States. Bilateral or multilateral agreement between States may also have to be set up to permit the use of LPST units in their airspace.

7.6.3 Trials and Testing

Trials will need to be conducted on the performance of LPST units, particularly against SSR interrogators and collision avoidance safety nets. Evidence from these will be needed to support any change proposals to current standards and to support certification requirements. Trials and testing will need to focus on assessment of the following issues:

- Detection of LPST units on current and emerging SSR-based ATM surveillance systems;
- Interoperability between safety nets, such as TCAS II and STCA, and LPST equipped aircraft;
- Potential radiological hazards from the proximity of LPST units to occupants of light and very light aircraft;
- Battery performance issues associated with the use of LPST units in a mixed Mode A/C and Mode S environment;
- Antenna siting for LPST units on light and very light aircraft.

7.6.4 Certification

Certification of LPST units will need to be carried out against applicable standards. An EASA AMC may be needed to support this process. This is expected to be based on EUROCAE ED-115 and ED-73, where applicable. Flight trials of LPST units will also be needed to support the certification process.

8. RECOMMENDATIONS

Subject to successful completion of feasibility assessment and testing of ATM surveillance system detection ranges, interoperability with SSR-based safety nets, antenna siting and radiological hazard issues, it is recommended that:

- Processes be initiated to progress the adoption of appropriate standards for LPST units in ICAO SARPs and EUROCAE MOPS;
- States should approve the use LPST units on aircraft within European airspace;
- Stakeholders are engaged to ensure that the potential use of LPST units is taken into account within surveillance strategies, through groups such as the MSR-FG, Mode S and ACAS Programme Steering Group (PSG), Mode S System Task Force (MS TF), Surveillance Team (SUR-T), Multilateration Task Force, CASCADE, Surveillance Standard Focus Group (SSFG) and the Surveillance Strategy Task Force (SSTF) and the Military Team CNS Focus Group (CNSFG).