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

MINIMUM OPERATIONAL PERFORMANCE SPECIFICATION FOR SURFACE MOVEMENT RADAR SENSOR SYSTEMS FOR USE IN ADVANCED SURFACE MOVEMENT GUIDANCE AND CONTROL SYSTEMS (A-SMGCS)

ED-116

January 2004

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FOREWORD

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CHAPTER 1

GENERAL

1.1 PURPOSE AND SCOPE

This EUROCAE Minimum Operational Performance Specification (MOPS) specifies the minimum performance requirements of Surface Movement Radar Sensor Systems for use in Advanced Surface Movement Guidance and Control Systems (A-SMGCS).

Throughout this document, the term “SMR” will be used to mean a Surface Movement Radar Sensor System, as described in paragraph 1.4.

Chapter 1 provides information required to understand the need for the SMR characteristics and tests defined in the remaining chapters. It describes typical SMR applications and operational objectives and, along with EUROCAE ED-87A, *Minimum Aviation System Performance Specifications for A-SMGCS*, forms the basis for the performance criteria stated in Chapters 2 and 3. Definitions and abbreviations essential to the proper understanding of this document are also provided in Chapter 1.

Chapter 2 contains general design requirements for an SMR for use during surface movement operations at an airport, including health and safety and environmental aspects.

Chapter 3 contains the Minimum Operational Performance Requirements for the SMR, defining performance under weather conditions likely to be encountered during surface movement operations.

Chapter 4 identifies laboratory means of testing performance characteristics of the SMR under environmental conditions representative of those that may be encountered in actual operations.

Chapter 5 describes recommended test procedures for demonstrating compliance with the requirements of Chapters 2 and 3 in the factory or laboratory.

Chapter 6 describes recommended test procedures for demonstrating compliance with the requirements of Chapters 2 and 3 for the installed SMR.

1.2 MOPS APPLICATIONS

The specifications contained in this document specify desired system characteristics that should prove useful to designers, manufacturers and users of SMR equipment.

It should be noted that this document provides *minimum* operational performance specifications for the SMR functions. These performance specifications are aimed toward the basic SMR application as a non-cooperative sensor in a multi-sensor A-SMGCS, as defined in EUROCAE ED-87A. Performance standards for functions or components that apply to capabilities that exceed the stated minimum requirements are identified as optional features.

Compliance with this MOPS ensures that the SMR will satisfactorily perform its intended functions, as given by section 1.3, during surface movement operations.

Compliance with the MOPS does not necessarily constitute compliance with regulatory requirements. Any regulatory application of this document wholly or in part is the sole responsibility of the appropriate air traffic control authority.

As the measured values of the equipment performance characteristics may be a function of the method of measurement, standard test conditions and methods of testing are recommended in this document.

The word “equipment” as used in this document includes all components and units necessary for the SMR to correctly perform its functions.

1.2.1 Mandating and Recommendation Phrases

1.2.1.1 "Shall"

The use of the word "Shall" indicates a mandated criterion; i.e. compliance with the particular procedure or specification is mandatory and no alternative may be applied.

1.2.1.2 "Should"

The use of the word "Should" (and phrases such as "It is recommended that...") indicates that although the procedure or criterion is regarded as the preferred option, alternative procedures, specifications or criteria may be applied, provided that the manufacturer, installer or tester can provide information or data to adequately support and justify the alternative.

1.3 SYSTEM DESCRIPTION

1.3.1 SMR Applications and Operational Objectives

SMRs in an A-SMGCS are intended for use during aerodrome ground operations to inform air traffic controllers about the presence and location of aircraft, vehicles and obstacles on those parts of the aerodrome surface where aircraft movements take place.

The SMR function is the non-cooperative detection of moving and stationary objects on the surface of an aerodrome. Non-cooperative detection is necessary in order to detect all objects of operational interest, including those that are not equipped with suitable transponders or other co-operative surveillance means.

As a sensor in an A-SMGCS, an SMR, combined with some cooperative surveillance means, can provide sufficient information to unambiguously identify aircraft and continuously track their positions. It is anticipated that, to gain full advantage of the improved surveillance capability offered by A-SMGCS, some changes to ATC procedures would be necessary.

The SMR application requires high resolution in order to discriminate between closely spaced targets, and provision of accurate and timely position information at an adequate update rate to determine target speed and direction. For a simple sensor system, the expected range for operational use under all specified weather conditions will not normally exceed 4 km.

Figure 1-1 below, reproduced from ED 87A, shows how the SMR fits in to the overall A-SMGCS.

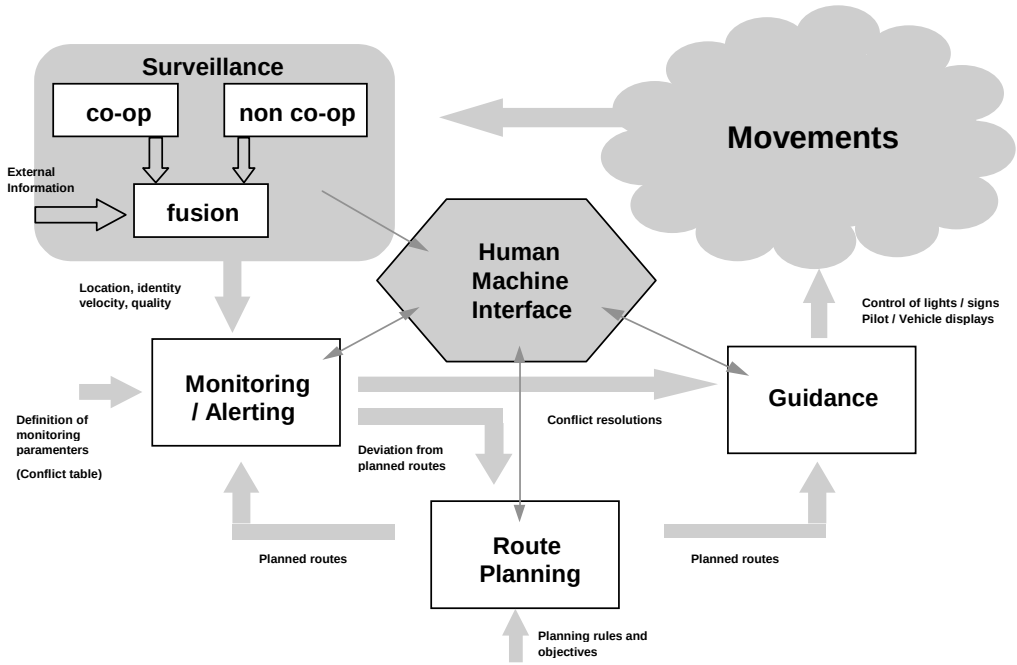

FIGURE 1-1 : CONCEPTUAL BLOCK DIAGRAM FOR A-SMGCS

1.3.2 SMR Types

SMR types fall into the following two main sub-categories:

1. **Conventional (rotating antenna) SMR** that scan mechanically in a continuous 360-degree arc, and
2. **Fixed Antenna SMR** that scan electronically in a sector.

Although the majority of the performance requirements specified in this MOPS will apply to both types, the document is primarily concerned with **conventional SMR**.

For the A-SMGCS application, an SMR will include some form of target extraction to enable it to output information about the location, size, and shape of detected objects.

In addition, SMRs should be capable of providing a “raw” primary radar image for presentation on a suitable display.

1.4 COMPOSITION OF AN SMR

The SMR should be modular in its construction and will normally include at least the following basic functional units:

- Antenna Unit
- Transmitter Unit
- Receiver Unit
- Local Control and Monitoring Unit
- Target Extractor Unit

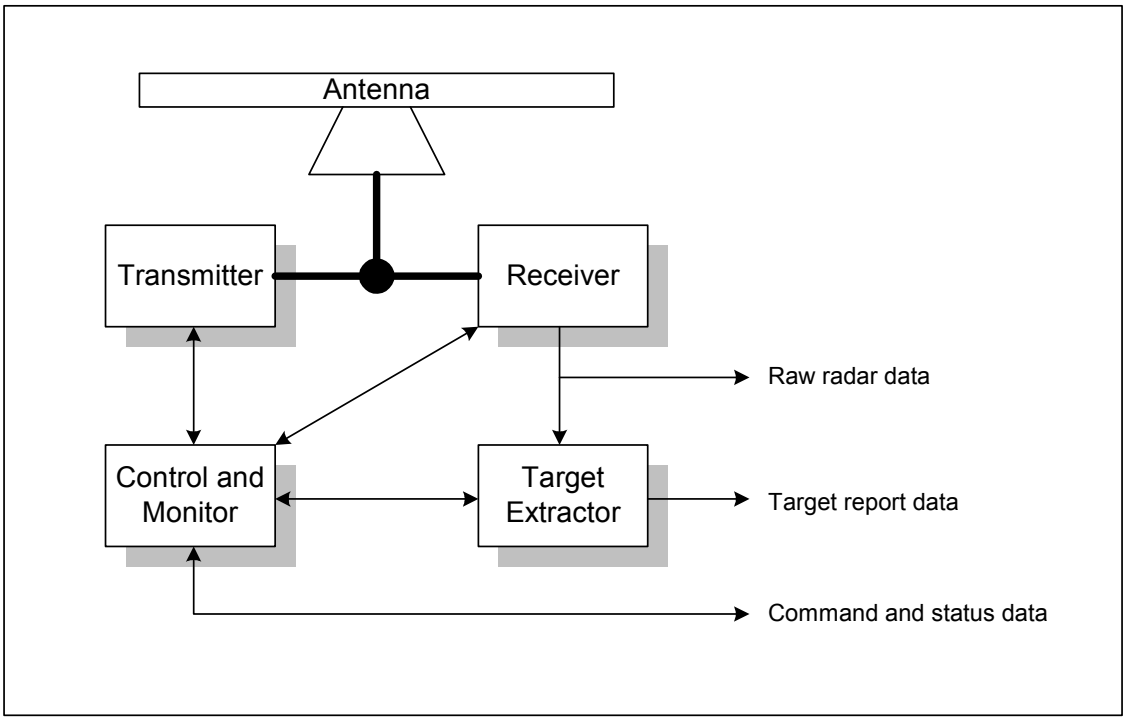

FIGURE 1-2 : COMPOSITION OF AN SMR

Other items, which may be considered in defining a complete SMR, are:

- Remote Control and Monitoring Unit
- Lightning Protection Devices
- Obstruction Lights
- Uninterruptible Power Supply (UPS)
- Radome
- Waveguide Dehydration Unit
- Air Conditioning Unit

1.4.1 Siting of SMR Equipment

The SMR antenna requires clear line of sight to the targets throughout the area to be covered. It can be mounted on a building or on a suitable mast or tower. In choosing a site for an SMR antenna, consideration must also be given to fixed reflecting surfaces and the resulting location of false returns.

Transmitter and receiver are often combined into one (transceiver) unit, and will normally be mounted close to the antenna unit in order to minimise signal attenuation caused by long waveguides.

A local control and monitoring unit co-located with the SMR transmitter/receiver will provide, as a minimum, a means to start and stop the SMR and a means to monitor its performance.

A remote control and monitoring unit (RCMU) provides a means for maintenance personnel to control and monitor the SMR from another location. For some applications, it may be desirable to control and monitor multiple SMRs from a single RCMU.

Target extractor units may be co-located with the SMR transmitter/receiver or installed at a different location connected to the receiver by a suitable analogue and/or digital communication link.

1.5 DEFINITIONS AND ABBREVIATIONS

1.5.1 Definitions

The following defined terms are used within the context of this document:

Advanced Surface Movement Guidance and Control System

Systems providing routing, guidance, surveillance and control to aircraft and affected vehicles in order to maintain movement rate under all local weather conditions within the aerodrome Visibility Operational Level (AVOL) whilst maintaining the required level of safety.

Aerodrome

A defined area (including any buildings, installations, and equipment) intended to be used either wholly or in part for arrival, departure and surface movement of aircraft.

Apron

A defined area on an aerodrome, intended to accommodate aircraft for purposes of loading or unloading passengers, mail or cargo, fuelling, parking or maintenance.

Availability

The probability that a system or an item is in a functioning state at a given point in time.

Classification

A function which groups targets into various types (e.g. large, medium, small).

Continuity of Service

The ability of a system or an item to perform its required function without unscheduled interruption throughout the duration of the intended operation.

Data Fusion

A generic term used to describe the process of combining surveillance information from two or more sensor systems or sources.

Integrity

An attribute of a system or an item indicating that it can be relied upon to perform correctly on demand. (It includes the ability of the system to inform the user in a timely manner of any performance degradation.)

Manoeuvring Area

That part of an aerodrome to be used for take-off, landing and taxiing of aircraft, excluding aprons.

Movement Area

That part of an aerodrome to be used for take-off, landing and taxiing of aircraft, consisting of the manoeuvring area and aprons.

Obstacle

All fixed (whether temporary or permanent) and mobile objects, or parts thereof, that are located on an area intended for the surface movement of aircraft or that extend above a defined surface intended to protect aircraft in flight.

Raw Video

A signal at the output of an SMR receiver that can be processed to present the primary radar image on a screen.

Reliability

The ability of a system or an item to perform a required function under specified conditions, without failure, for a specified period of time.

Reported Position Accuracy (RPA)

The difference, at a specified confidence level, between the reported position of the target and the actual position of the target at the time of the report.

Requirement

An identifiable element of a function specification that can be validated and against which an implementation can be verified.

Target

Any aircraft, vehicle or obstacle, whether stationary or moving, which is located within the coverage area of the SMR and which is of sufficient size to be operationally significant.

Target Report

A data record containing all relevant information pertaining to a target detected by the SMR.

Track

A progressive series of estimates of a target position.

Update

A renewal of target reports relating to all targets under surveillance

1.5.2 Abbreviations

A-SMGCS	Advanced Surface Movement Guidance and Control System
ASTERIX	All Purpose Structured Eurocontrol Radar Information Exchange
ATC	Air Traffic Control
BITE	Built-in Test Equipment
EUROCAE	European Organisation for Civil Aviation Equipment
HMI	Human Machine Interface
ICAO	International Civil Aviation Organisation
MASPS	Minimum Aviation System Performance Specification
MOPS	Minimum Operational Performance Specification
RCS	Radar Cross Section
RCMU	Remote Control and Monitoring Unit
RF	Radio Frequency
RPA	Reported Position Accuracy
SNMP	Simple Network Management Protocol
SMR	Surface Movement Radar (Sensor System)
UPS	Uninterruptible Power Supply
WGS-84	World Geodetic Survey (1984)

1.6 REFERENCES

The following documents are incorporated by reference. The latest issue in effect shall be the one that will apply.

1) EUROCAE ED-87A: Minimum Aviation System Performance Specification for Advanced Surface Movement Guidance and Control Systems (January 2001)

2) EUROCAE ED-79/SAE ARP 4754: Certification Considerations for Highly-integrated or Complex Aircraft Systems (April 1997)

3) ICAO AOPG: Manual of Advanced Surface Movement Guidance and Control Systems (A-SMGCS)

4) ICAO: SARPS Annex 14 Aerodromes

5) ICAO: Aerodrome Design Manual (Doc. 9157, 1993)

6) ICAO: Annex 10 Volume IV (Radar of surveillance systems and anti-collision systems)

7) Eurocontrol Standard Document for Surveillance Data Exchange - Part 7 Transmission of Monosensor Surface Movement Data, SUR.ET1.ST05.2000-STD-07-01

8) The Internet Engineering Task Force, RFC 1155 Structure of Management Information

CHAPTER 2

GENERAL DESIGN REQUIREMENTS

2.1 INTRODUCTION

This chapter establishes the design criteria and general operational requirements for SMR equipment.

Other aspects of the SMR design are purely dependent on the manufacturer's philosophy as long as the minimum operational performance requirements specified in Chapter 3 are met.

2.2 AIRWORTHINESS AND CERTIFICATION

SMR is a ground based equipment and as such has no airworthiness requirements. The equipment will be required to meet European EMC standards as well as maintaining emissions within ITU regulations.

SMR equipment shall in no way, under normal or fault conditions, impair the airworthiness of aircraft in the vicinity.

2.3 OPERATION OF CONTROLS

The SMR equipment shall be designed so that controls intended for use during normal operations cannot be operated in any position, combination or sequence that would result in a condition detrimental to the reliability of the SMR equipment.

Controls, or access to parameters which affect the performance of the SMR, shall be protected in some way and shall not be readily accessible to maintenance personnel.

2.4 INSTALLATION

The SMR shall be compatible with the physical and environmental conditions expected to be present in installed locations. Installation of the equipment should permit ease of access for maintenance and testing. It should be physically impossible to install replaceable modules of the SMR improperly.

2.5 TEST METHODOLOGY

Tests should be performed using a combination of modelling and simulation, direct performance measurement on site, and analysis and extrapolation of results. Normally, testing of individual items of equipment would be performed both at the factory, or laboratory, and on site, whereas complete SMR testing can only reasonably be conducted on site, using a combination of targets of opportunity, controlled airport vehicles, and calibrated test targets.

2.6 EFFECTS OF TESTS

Unless otherwise stated, the design of the SMR shall be such that, during and after the application of the specified tests, no condition exists which would be detrimental to the subsequent performance of the system.

2.7 SOFTWARE MANAGEMENT DESIGN

Software design shall follow the guidelines specified in EUROCAE document ED-109 "Guidelines for Communication, Navigation, Surveillance and Air Traffic Management (CNS/ATM) System Software Integrity Assurance". The software criticality level will depend on the particular equipment function, however a minimum assurance of level 4 is required.

2.8 SMR COVERAGE

The SMR will normally be expected to provide continuous coverage of all aircraft and vehicles and obstacles on those areas of the aerodrome where aircraft movements take place.

Typically, for a single SMR, coverage may be specified for objects on the ground from 150m to 2500 m in range with up to 360-degree azimuth coverage from the antenna position, and in the air to at least the height of the antenna throughout the coverage area.

Where adequate coverage, consistent with the required performance, cannot be obtained with a single SMR, a network of two or more SMRs should be employed.

2.9 ANTENNA UNIT CHARACTERISTICS

2.9.1 Construction

The SMR antenna unit should be of lightweight construction suitable for installation on the roof of a building or on a separate mast or tower. The design of the antenna shall be such that it maintains its intended performance characteristics in all expected environmental loading conditions, such as wind load and ice accretion.

2.9.2 Materials and Finish

The SMR antenna assembly, including any enclosure and all external waveguide sections and accessories, should utilise materials, coatings and finishes which are resistant to weathering and to industrial pollutants such as sulphur dioxides and/or nitric oxides.

2.9.3 Antenna Radiation Patterns

The antenna vertical polar diagram shall be shaped consistent with providing minimum returns from precipitation and multipath reflections.

The antenna horizontal beamwidth shall be consistent with the requirement for target discrimination. Typically, this would mean a horizontal beamwidth in the order of 0.4°.

2.9.4 Side Lobes and Back Radiation

The azimuth and elevation radiation side lobes and back radiation levels shall be such as to meet the overall SMR performance requirements.

2.9.5 Polarisation

The SMR antenna should utilise circular polarisation in order to minimise returns from precipitation.

2.9.6 Antenna Drive

The SMR antenna drive unit should be so designed to minimise excessive torque during start up and should rotate at a minimum of 60 RPM.

2.9.7 Antenna Support Structure

The antenna support structure shall be sufficiently strong to support the complete antenna system, including turning gear and radome (if required), under all specified operating and non-operating weather conditions.

The stability of the antenna support structure shall be sufficient to ensure system performance requirements are met under all specified operating weather conditions, in particular the specified operating wind speed and ice loading. In particular, the torsional stiffness of the platform should be better than 0.05^0.

2.9.8 Radome

Where a radome is used to protect the antenna, consideration shall be given to the effects on the performance of the antenna. The radome should be weatherproof and resist icing, corrosion and growth of fungi.

Depending on climatic conditions at the airport, the radome may need to be fitted with heaters and a dehumidifier to ensure that the SMR meets its overall performance requirements under all environmental conditions.

2.9.9 Obstruction Lamps

Consideration shall be given to the mounting of obstruction lights as required under ICAO Annex 14.

2.10 TRANSMITTER/RECEIVER CHARACTERISTICS

2.10.1 Operating Frequency

Operating frequency allocation shall be made in accordance with ITU regulations with regard to allowable spectrum, frequency stability and spurious transmissions.

Typically, SMRs operate either in the X-band (9.0 - 9.5 GHz) or in the Ku-band (15.4 - 16.9 GHz).

2.10.2 Transmitter Output Power

The output power of the SMR transmitter shall be sufficient to achieve the specified coverage.

2.10.3 Transmitter Pulse Width

For a SMR using a pulsed radar transmitter, the width of the output pulse of the SMR transmitter shall be sufficiently small to achieve the specified target discrimination requirement. Typically, this would mean a pulse width in the order of 40 nanoseconds.

2.10.4 Sector Blanking

The SMR transmitter should have a facility to inhibit transmission of RF radiation in configurable sectors. Multiple sectors should be definable to a resolution of 1^0 or better.

2.10.5 Receiver Protection

The receiver shall be isolated from the transmitter during transmission by appropriate devices to the extent required to prevent the receiver from damage or overload due to leakage, both under normal operation and in the event of a defective RF component.

The receiver shall be protected from damage caused by other high power transmitters in the vicinity.

Receiver protection shall remain effective even when the SMR is switched off.

2.10.6 Elapsed Time Indicators

Elapsed time indicators should be provided to record the radiating and stand-by time of each transmitter/receiver channel.

2.11 EQUIPMENT INTERFACES

The SMR should provide an output suitable for the presentation of a raw primary radar image.

The output of the Target Extractor unit shall be a digital data output utilising standard communication protocols. The ASTERIX Category 10 data format shall be used for target reports.

Slant range correction commensurate with antenna height shall be applied to maintain the target report position accuracy.

In addition, the SMR shall provide a control and monitoring interface based on standard communication protocols. The Simple Network Management Protocol (SNMP) is preferred. This protocol is described in the referenced RFC 1155 standard document.

2.12 EXTERNAL TIME REFERENCE

The SMR target extractor shall be capable of deriving A-SMGCS system time to an accuracy of at least $1/64^{th}$ second from an external source. (The Data Fusion system of A-SMGCS will be the master source of A-SMGCS system time).

2.13 HEALTH AND SAFETY

The SMR shall comply with all relevant health and safety legislation; European Standard; or Code of Practice, including but not limited to the following:

- Inflammable atmospheres
- Human Exposure (International Commission on Non-Ionising Radiation Protection (ICNIRP) guidelines)
- Electro-mechanical detonators
- Hazardous substances

2.14 SAFETY INTERLOCKS

A safety interlock shall be provided to disable the antenna drive, and turn off the transmitter power, when maintenance is required on the SMR antenna.

Turning gear shall be fitted with a suitable locking mechanism to prevent the antenna from moving during maintenance.

Furthermore, safety circuits shall be incorporated to shut down automatically the SMR antenna unit under abnormal operating conditions such as may cause serious damage, e.g. bearing failure, low oil level, and overloading of the drive motor.

2.15 GROUNDING

SMR equipment grounding and power distribution shall be appropriate to ensure system performance and safety of personnel.

2.16 LIGHTNING PROTECTION

The SMR equipment and associated data links shall include appropriate lightning conductors and transient protection to ensure continued operation during lightning storms without equipment failure.

2.17 ELECTROMAGNETIC INTERFERENCE AND SUSCEPTIBILITY

The SMR equipment shall have appropriate EMI/EMC characteristics for operation in an airport environment. The EU directive 98/336/EEC is applicable.

The SMR shall not interfere with other airport electrical, electronic, or communications equipment, nor shall the performance of the SMR equipment be in any way affected by other equipment on or near the airport.

2.18 NOISE AND VIBRATION

The installation of the SMR shall ensure that audible noise and vibration are confined to within acceptable levels commensurate with the environment. This is particularly important where SMR antennas are to be installed above Visual Control Rooms.

2.19 POWER SUPPLIES

All SMR electrical equipment should operate from standard mains voltage and frequency at the airport.

2.19.1 Uninterruptible Power Supply

Consideration should be given to the need for an uninterruptible power supply both for power conditioning and to support the SMR in the event of a mains power failure for an appropriate time, consistent with the availability and continuity of service requirements.

2.20 RELIABILITY, AVAILABILITY AND INTEGRITY

2.20.1 Reliability

For A-SMGCS applications, the SMR shall be designed, as a minimum, to meet a probability of failure requirement of 10^{-4} per operational hour. Depending on operational requirements for system availability, the SMR may be designed for a dual redundant configuration, in order to minimise single points of failure. In most cases, redundancy in the transmitter, receiver, target extractor units and power supplies will be necessary.

2.20.2 Availability

The SMR shall be capable of sustained operation 24 hours a day throughout the year.

The availability of the system, allowing for necessary maintenance, shall be 99.9%.

SMR equipment should be installed and configured in such a way that all possible essential maintenance can be carried out without interrupting operation.

NOTE: *Maintenance of the SMR antenna drive unit is likely to require some interruption of service.*

2.20.3 Integrity

The SMR design should preclude failures that result in erroneous data for operationally significant time periods. The SMR should have the ability to provide continuous validation of performance and timely alerts to the user when it must not be used for the intended operation.

2.21 MAINTAINABILITY

2.21.1 Service Life

The SMR should be designed for a service life of at least 15 years.

2.21.2 System Access

System access for maintenance shall be possible.

A means of easy and safe access to the antenna, and to the outside of the radome, if fitted, shall be provided for ease of maintenance.

A means should be provided to hoist the equipment into place for installation or replacement.

2.21.3 Technical Control and Monitoring

Built-in test equipment (BITE) shall be incorporated as appropriate throughout the entire SMR.

All essential and critical system operation parameters shall be monitored and suitably displayed for easy interpretation.

It should be possible to monitor the status of at least the following:

- Antenna turning
- Turning gear (oil level, pressure, temperature, etc.), where relevant
- Transmitter power
- Receiver noise figure
- Transmitter/receiver failure
- Equipment overheating
- Obstruction lamps
- UPS (if fitted)

There shall be a means to monitor and adjust the correct alignment of the SMR.

In case of critical system failure or degradation, alarms shall be given to expedite system diagnostics and troubleshooting.

Fault isolation shall be provided to individual module level.

It should be possible for the SMR to be monitored and controlled both locally and from a remote location. Consideration should be given to the possibility of establishing connection to a manufacturer's facility for off-line maintenance or diagnostics.

It should be possible for the essential SMR monitoring parameters to be output to the A-SMGCS monitoring system. The SNMP protocol is recommended.

CHAPTER 3

MINIMUM PERFORMANCE SPECIFICATION

3.1 INTRODUCTION

Performance requirements, against which the SMR will need to be verified, will depend on the intended use of the system at a particular site, as defined by the operational requirements for that site.

The operational performance specifications contained in this chapter are considered to be the minimum requirements for SMR performance under weather conditions likely to be encountered during surface movement operations.

Each requirement in this chapter must be verifiable by a suitable test procedure described in Chapters 4, 5 and 6.

3.2 ENVIRONMENTAL CONDITIONS

Unless otherwise stated, the operational performance requirements in this chapter shall be met under all specified weather conditions including fog, hail, snow, icing, wind and rainfall, and all modes of operation.

3.2.1 Temperature and Humidity

SMR equipment that is to be installed exterior to buildings shall be designed to operate from -25°C to +55°C, and relative humidity up to 100% non-condensing. In certain parts of Europe, where extremes of temperature are experienced, this should be specifically addressed.

All equipment installed in equipment rooms, suitably protected from the outside environment, shall be designed to operate from +10°C to +30°C, and a relative humidity from 10% to 80%.

3.2.2 Precipitation

Typical requirements:

Rainfall: up to 16mm/hr

Hail: up to a diameter of 12mm at 17m/s

3.2.3 Icing

Typical requirements:

Icing: up to 10mm thick

3.2.4 Wind Speed

The maximum wind speed (3-second gust) for operation of the outdoor equipment shall be not less than 80 knots (41m/s).

The maximum wind speed (3-second gust) for survival of the outdoor equipment shall be not less than 120 knots (62m/s).

3.3 GENERAL REQUIREMENTS

3.3.1 Start-up and Restart Procedures

The start-up and restart procedures of the SMR shall be simple; the start-up and restart times shall be less than 3 minutes from cold start to stable operation.

NOTE: *After long periods of non-operation in temperatures below -20^{o}C, the restart time will necessarily be extended to allow oil in mechanical systems to be brought to operating temperature.*

The SMR shall restart automatically following a disruption of service due to power transients or outages.

The SMR shall recover automatically after data link interruptions.

3.3.2 Redundancy

Where dual redundant systems are used to meet availability requirements, a means shall be provided to allow automatic and manual changeover within three seconds (including detection time) in the event of a channel failure or temporary removal of one channel for maintenance, without interruption to the SMR operation.

3.4 OPERATIONAL REQUIREMENTS

3.4.1 Coverage

Unless otherwise stated, the SMR shall meet the operational performance requirements in this section continuously, throughout the specified coverage area.

3.4.2 Detection Sensitivity

The SMR shall be capable of detecting with a probability of 90%, and a false alarm rate of 10^{-4} per scan, all types of vehicle, aircraft and obstacle, whether moving or stationary, having an equivalent radar cross-section (RCS) of at least one square metre, everywhere within the specified coverage area.

For testing purposes, a reflector of one square metre equivalent radar cross-section at the operating frequency and polarisation, at a height of one metre, shall be used. The probability of detecting this target shall be better than 99% in clear weather conditions.

3.4.3 Data Renewal Rate

The SMR shall perform a complete scan of the entire specified coverage area and provide a new set of data at least once per second.

3.4.4 Target Dynamics

The SMR shall detect targets with speed in the range of zero to at least 250 knots in any direction anywhere within the specified coverage area.

3.4.5 Displacement Detection

The SMR shall be able to detect a minimum target displacement of 7.5 metres in any direction anywhere within the specified coverage area.

3.4.6 Target Classification

The Target Extractor unit shall output information relating to target size in order to assist the A-SMGCS in discerning the various types of target, i.e. aircraft, vehicles or other objects, within the specified coverage area.

3.4.7 Target Discrimination

The SMR shall discriminate and resolve two point source targets separated by 30m in any direction within the intended coverage area.

3.4.8 Area Blanking

The Target Extractor unit shall provide an area blanking capability to inhibit the generation of both raw video and target reports from areas where detection is not required. It is desirable that separate blanking masks operate on raw video and target reports.

The resolution of blanking areas and any other processing-related maps shall be equal to or better than 3 metres.

Processing maps should be configurable off-line and capable of being displayed on the control and monitoring unit.

3.4.9 Target Extraction Capacity

The Target Extractor unit shall provide automatic extraction for a minimum of 250 targets per 360 degrees of SMR antenna scan.

3.4.10 Target Reports

The Target Extractor unit shall output target reports in ASTERIX Category 10 data format. As a minimum, the following data fields shall be populated.

- Message Type
- Data Source Identifier
- Target Report Descriptor
- Time of Day
- Position Report
- Target Size and Orientation
- System Status

3.4.11 False Target Reports

There shall be no false target reports due to antenna side lobes and back lobes, second-time-around returns, transients in the receiver and/or signal processor chain, or interference from other radars in the vicinity.

False targets due to indirect or multipath reflections from stationary or moving targets via fixed structures shall be reduced to an acceptable level. (This is likely to be a function of SMR location.)

Areas where false returns arise through multipath reflections shall be identified during site acceptance testing and the information formally recorded and made available to operators using the SMR.

3.4.12 Position Accuracy

The SMR should provide a raw video output, the accuracy of which for a point source shall be better than 7.5m (at 95 % confidence level).

The SMR shall provide a target-extracted output, the Reported Position Accuracy of which for a point source shall be better than 7.5m (at 95 % confidence level).

3.4.13 Processing Delays

The processing delay of the raw video within the SMR shall not exceed 250 milliseconds from the radar beam illuminating the target until the output of the associated video.

The processing delay for target reports shall not exceed 500 milliseconds from the radar beam illuminating the target until the output of the associated report.

CHAPTER 4

MINIMUM PERFORMANCE SPECIFICATION UNDER ENVIRONMENTAL TEST CONDITIONS

4.1 INTRODUCTION

Some parameters, which cannot be adequately verified once the SMR is installed, will need to be verified through laboratory and environmental chamber tests.

a. The environmental test conditions and performance criteria described in this section provide a laboratory means of determining the overall performance characteristics of the SMR under conditions representative of those that may be encountered in actual operation.

b. Unless otherwise specified, the test procedures applicable to the determination of SMR performance under environmental test conditions are contained in European standard documents and apply for non-airborne equipment.

c. Some of the environmental tests contained in this section do not have to be performed unless the manufacturer wishes to qualify the SMR for that particular environmental condition; these tests are identified by the phrase “If Required”. If the manufacturer wishes to qualify the SMR to these additional environmental conditions, then the “If Required” tests shall be performed.

4.2 ENVIRONMENTAL TESTING

The following tests determine whether the SMR can comply with the listed environmental test conditions and applicable test procedures described in the corresponding standard.

The SMR manufacturer shall provide sufficient functional test data to show compliance of the equipment before, during and after the various tests detailed in the following tables.

In most cases, it is acceptable to demonstrate that a particular model and modification state of SMR meets these requirements, together with evidence that the equipment being provided exactly conforms to that model and modification state

4.2.1 Test Plan and Procedures

A test plan and test procedures shall be prepared, and may be submitted to the appropriate authorities for review.

Except where tests are obviously GO/NO GO in character (e.g. the determination of whether or not mechanical devices function correctly), the actual numerical values obtained for each of the parameters tested shall be recorded.

4.2.2 Test Article

The tests shall be conducted on a production SMR which should be in full conformity with production build.

If the tested item incorporates features that are still experimental or in the development stage, any tests involving the non-production features shall be repeated later on a production item, or evidence presented to substantiate that the test results are valid for the production equipment.

For EMC testing, the test regime should be validated with a “Notified Body” and subsequent units that are covered by the testing shall be “CE” marked. The aim of the EMC tests is to document compliance in accordance with the council directive 89/336/EEC, article 10 (5). The levels are indicative and should be verified by a Notified Body.

Test	Condition	Limit Indoor / Outdoor	Corresponding Standard
Low Temp	Storage: Operate:	-40° C / -65° C 10° C / -25° C	IEC 68-2-l, Test Ad IEC 945
High Temp	Storage: Operate:	+65° C / +65° C +30° C / +55° C	IEC 68-2-2 Bd. IEC 945
Env. Protection	Operate:	Not Applicable / IP 52	IEC Publication 529
Acoustic Noise	Operate	55dB (A) / 70dB (A) Reference level 1 pW	DS/ISO 3743 or 3746 IEC 945
Radiated and Conducted Emission	Operate	Class B	EN55022
Current Harmonics, Emission	Operate		EN61000-3-2
Voltage Fluctuations, Emission	Operate		EN61000-3-3
Electro Static Discharges Susceptibility	Operate	± 4 kV Contact discharge ±8 kV Air discharge	EN61000-4-2
Radiated Susceptibility	Operate	10 V/m, 80 % AM 27 - 1000 MHz and 1000 – 2000 MHz	EN61000-4-3
Bursts Susceptibility	Operate	AC power port: ± 2 kV Signal Ports: ±2 kV (Only wire > 3m)	EN61000-4-4
Surges Susceptibility	Operate	AC power-port: ± 4 kV CM, 12 Ω ± 2 kV DM, 2 Ω Shielded signal cables: ± 2 kV CM, 2 Ω	EN61000-4-5
Conducted Susceptibility	Operate	AC-power ports: 10VRMS, 80 % AM Separate earth: 10 VRMS, 80 % AM Signal & data lines: 10 VRMS, 80 % AM (Only cables > 3 m)	EN61000-4-6
Supply Voltage Interruptions / Dips, Susceptibility	Operate	AC-power input port: Reduction Time 3% 10 ms 60% 100 ms <95% 5 s	EN61000-4-11
Sand and Dust	Operate		If required
Fungus	Operate		If required
Salt Spray	Operate		If required
Icing	Operate		If required
Magnetic Effect	Operate		If required

TABLE 4.1 : ENVIRONMENTAL TEST REQUIREMENTS

CHAPTER 5

FACTORY TEST PROCEDURES

5.1 INTRODUCTION

This chapter specifies the conditions for testing and the test procedures for verifying the performance of the SMR in the factory or other premises prior to installation at site. The performance criteria are those contained in Chapters 2 and 3.

It should be noted that some performance parameters might be affected by processing load, dependent on the number of targets being handled. When undertaking the prescribed tests, consideration should be given to providing representative scenarios. Similar consideration should be given to weather conditions.

This chapter does not specify means to show compliance with regulatory requirements.

5.2 GENERAL CONDITIONS FOR TESTING

5.2.1 Test Plan and Procedures

A test plan and test procedures shall be prepared, and may be submitted to the appropriate authorities for review.

Except where tests are obviously GO/NO GO in character (e.g. the determination of whether or not mechanical devices function correctly), the actual numerical values obtained for each of the parameters tested shall be recorded.

5.2.2 Test Article

The tests shall be conducted with the SMR to be delivered, which should be in full conformity with production build.

If the tested item incorporates features that are still experimental or in the development stage, any tests involving the non-production features shall be repeated later on a production item, or evidence presented to substantiate that the test results are valid for the production equipment.

5.2.3 Testing of Spare Units

Where a system is to be supplied with spare units, representative system tests shall be repeated with the spare units installed.

5.2.4 Effects of Tests

The test articles shall complete all tests without maintenance and without necessity to re-calibrate the test articles.

5.2.5 Test Equipment

Any test equipment requirements shall be specified for each test procedure. Items of test equipment shall have been calibrated prior to the commencement of the test.

5.2.6 Test Report

The manufacturer shall prepare a summary report declaring the following:

1) The time and date of testing, and the participants and their roles in the testing.
2) The part numbers and serial numbers of all identified line replaceable units of the SMR as tested, with revision numbers and (software) configuration status if applicable.
3) The environmental conditions, where applicable.
4) The part number and serial numbers of each item of test equipment used and its calibration status.
5) A statement of all performance tests that have been successfully completed.
6) A specific statement for each performance test that was not performed or successfully completed.
7) A specific statement for each declared or identified operational limitation.

5.2.7 Safety Precautions

Any unusual characteristics or hazards to personal or property (e.g. RF radiation, etc.) resulting from operation of the SMR shall be analysed and documented before the test.

While the materials, methods, applications, and processes described or referenced in this procedure may involve the use of hazardous materials, this procedure does not address the hazards that may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and processes, and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

5.2.8 Power Input

The test(s) shall be conducted with the SMR powered by a source representative of the installed equipment electrical power system.

5.2.9 Environment

During the tests, the environmental conditions shall not exceed those specified.

5.2.10 Warm-Up Period

All tests shall be conducted after a warm-up period as specified.

5.3 BASIC CONFORMITY TESTS

Degradation is not allowed as a result of exposure to the conditions listed.

5.3.1 Conformity Inspection

The SMR shall be inspected to determine conformity with acceptable workmanship and engineering practices, that proper mechanical and electrical connections have been made, and that the equipment is complete in accordance with the specifications.

5.3.2 System Operations

The SMR shall be operated according to the documented system operating procedures. Proper function shall be verified.

5.3.3 Power Supply

Under test conditions, verify the proper operation of the equipment throughout the specified range of supply voltage.

5.3.4 Displays and Controls Accessibility

Demonstrate that all equipment controls and displayed data are readily accessible, intuitive and easily interpreted.

5.3.5 Start-up and Restart

Demonstrate that the SMR start-up and restart times are less than 3 minutes from cold start to stable operation, and that the system restarts automatically following a disruption of service due to power transients or outages.

Demonstrate that the SMR recovers automatically after a data link interruption.

5.3.6 Redundancy

Where dual redundant systems are used to meet availability requirements, demonstrate that a means is provided to allow automatic and manual changeover within three seconds (including detection time) in the event of a channel failure or temporary removal of one channel for maintenance, without interruption to the SMR operation.

5.3.7 Materials and Finish

Demonstrate that outdoor equipment, including the SMR antenna assembly, any enclosure, and all external waveguide sections and accessories, utilise materials, coatings and finishes which are resistant to weathering and to industrial pollutants such as sulphur dioxides and/or nitric oxides.

5.3.8 Antenna Radiation Patterns

Demonstrate that the antenna vertical polar diagram is in accordance with the manufacturer's specifications and shaped consistent with providing minimum returns from precipitation and multipath reflections.

Demonstrate that the antenna horizontal beamwidth is in accordance with the manufacturer's specifications and consistent with the requirement for target discrimination.

5.3.9 Side Lobes and Back Radiation

Demonstrate that the azimuth and elevation radiation side lobes and back radiation levels are in accordance with the manufacturer's specifications such as to meet the overall SMR performance requirements.

5.3.10 Polarisation

If the SMR antenna is circularly polarized in order to minimise returns from precipitation, demonstrate that it performs in accordance with the manufacturer's specifications.

5.3.11 Antenna Drive

For a rotating SMR antenna, demonstrate that the antenna unit starts smoothly in order to minimise excessive torque when being switched on and rotates at the desired speed.

5.3.12 Operating Frequency

Demonstrate that the operating frequency is in accordance with the specification and with ITU regulations with regard to allowable spectrum, frequency stability and spurious transmissions.

5.3.13 Transmitter Output Power

Demonstrate that the output power of the SMR transmitter is in accordance with the manufacturer's specification and sufficient to achieve the specified coverage.

5.3.14 Transmitter Pulse Width

For an SMR using a pulsed radar transmitter, demonstrate that the width of the output pulse of the SMR transmitter is in accordance with the manufacturer's specification and sufficiently small to achieve the specified target discrimination requirement.

5.3.15 Receiver Noise Figure

Demonstrate that the noise figure of the SMR receiver is in accordance with the manufacturer's specification.

5.3.16 Sector Blanking

Where a sector blanking facility is provided, demonstrate that the RF transmission is inhibited in configurable sectors is in accordance with the specification.

5.3.17 Receiver Protection

Demonstrate that the SMR receiver is isolated from the transmitter during transmission by appropriate devices to the extent required to prevent the receiver from damage or overload due to leakage, either under normal operation or in the event of a defective RF component.

5.3.18 Elapsed Time Indicators

Where the equipment is fitted with elapsed time indicators, demonstrate that the radiating and stand-by time of each transmitter/receiver channel is correctly indicated.

5.3.19 Equipment Interfaces

Demonstrate that the SMR provides an output suitable for the presentation of a raw primary radar image.

Demonstrate that the output of the Target Extractor unit utilises the ASTERIX Category 10 data format for target reports.

Demonstrate that slant range correction commensurate with antenna height can be applied to maintain the target report position accuracy.

Demonstrate that the SMR provides a control and monitoring interface based on standard communication protocols, and that the interface functions as specified.

5.4 PERFORMANCE TESTS

In the following test descriptions each performance test is presented under a separate heading in the following format:

- Requirement (ref. Chapter 3) - definition of parameter to be tested
- Test Equipment – description of any test equipment needed to perform the test
- Test Procedure - description of test method, including analysis of test data

5.4.1 Target Dynamics Test

Requirement (3.4.4):

The SMR shall detect targets with speed in the range of zero to at least 250 knots in any direction anywhere within the specified coverage area.

Test Equipment:

The following test equipment will be required:

- A means of generating targets at various velocities suitable for input to the Target Extractor unit of the SMR
- A means of recording, decoding and viewing the data output of the Target Extractor unit, i.e. a Data Logger

Test Procedure:

The test procedure is as follows:

- Generate a scenario with the specified maximum number of targets (250), including targets travelling at speeds of 250 kt and at zero velocity.
- Record the output of the Target Extractor unit
- Use the results to confirm that all targets are present throughout the scenario and that their velocities match the input scenario.

5.4.2 Target Classification Test

Requirement (3.4.6):

The Target Extractor unit shall output information relating to target size in order to assist the A-SMGCS in discerning the various types of targets, i.e. aircraft, vehicles or other objects within the specified coverage area.

Test Equipment:

The following test equipment will be required:

- A means of generating targets of various dimensions suitable for input to the Target Extractor unit of the SMR
- A means of recording, decoding and viewing the data output of the Target Extractor unit, i.e. a Data Logger

Test Procedure:

The test procedure is as follows:

- Arrange a scenario with a number of simulated targets of various dimensions.
- Analyse the target report data to ensure that the data in the related ASTERIX Category 10 data fields are consistent with the target dimensions of the input scenario.

5.4.3 Area Blanking Test

Requirement (3.4.8):

The Target Extractor unit shall provide an area blanking capability to inhibit the generation of both raw video and target reports from areas where detection is not required. It is desirable that separate maps operate on raw video and target reports.

The resolution of blanking areas and any other processing related maps shall be equal to or better than 3 metres.

Test Equipment:

The following test equipment will be required:

- A means of generating targets at various locations suitable for input to the radar processing element of the SMR
- A means of displaying the output data in a graphical format, e.g. a radar maintenance display facility.

Test Procedure:

There are two parts to this test procedure. The first is to test the raw video output, the second to test the target report output of the Target Extractor unit.

1) Raw Video Test:

- Set up a scenario with small raw video targets in known positions. Arrange for a raw video blanking area to be drawn approximately through the middle of each of the targets.
- Confirm (with a suitably zoomed display) that the area blanking facility removes approximately half of each target. Then arrange for the blanking area to be moved a distance equivalent to the specified resolution of the area blanking facility.
- Confirm (with a suitably zoomed display) that the raw video image of each target is blanked by the corresponding amount.

2) Target Report Test:

- Set up a scenario with a simulated target in some randomly chosen position. Arrange for a raw video blanking area to be drawn close to the target without blanking it.
- Move the blanking area towards the target in increments equivalent to the specified resolution of the area blanking facility until the target is removed.
- Confirm that the target reappears when it is moved the same distance back from the blanking area.
- Repeat several times with the target in different positions.

5.4.4 Target Extraction Capacity Test

Requirement (3.4.9):

The Target Extractor unit shall provide automatic extraction for a minimum of 250 targets per 360 degrees of SMR antenna scan.

Test Equipment:

The following test equipment will be required:

- A means of generating 250 targets at various locations suitable for input to the radar processing element of the SMR
- A means of displaying the output data in a graphical format, e.g. a radar maintenance display facility

Test Procedure:

To save time, this test should be combined with the target dynamics test. The test procedure is as follows:

- Set up a test scenario with 250 targets of various velocities
- Confirm that the SMR outputs all target reports on all scans

5.4.5 Target Report Test

Requirement (3.4.10):

The Target Extractor unit shall output target reports in ASTERIX Category 10 data format.

Test Equipment:

The following test equipment will be required:

- A means of generating targets of various dimensions suitable for input to the Target Extractor unit of the SMR
- A means of recording, decoding and viewing the data output of the Target Extractor unit, i.e. a Data Logger

Test Procedure:

To save time, this test should be combined with the target classification test. The test procedure is as follows:

- Set up a suitable test scenario to exercise all mandatory fields of the ASTERIX Category 10 format.
- Record the Target Extractor output data.
- Analyse the output data to establish that the format is being correctly utilised.

CHAPTER 6

SITE TEST PROCEDURES

6.1 INTRODUCTION

This chapter specifies the conditions for testing and the test procedures for verifying the performance of the SMR when installed at site. The performance criteria are those contained in Chapters 2 and 3.

It should be noted that some performance parameters might be affected by processing load, dependent on the number of targets being handled. When undertaking the prescribed tests, consideration should be given to providing representative scenarios. Similar consideration should be given to weather conditions.

Some parameters, particularly those concerning system reliability, availability, and continuity of service, will need to be tested over an extended period of time. This may impose constraints on the initial operational use of the SMR until adequate statistical evidence has been obtained to provide the necessary degree of confidence. The length of time required to gather sufficient evidence may be reduced where the equipment is simultaneously in use, operationally or in pre-operational mode, at a number of sites.

This chapter does not specify means to show compliance with regulatory requirements.

6.2 GENERAL CONDITIONS FOR TESTING

6.2.1 Test Plan and Procedures

A test plan and test procedures shall be prepared, and may be submitted to the appropriate authorities for review.

Except where tests are obviously GO/NO GO in character (e.g. the determination of whether or not mechanical devices function correctly), the actual numerical values obtained for each of the parameters tested shall be recorded.

6.2.2 Effects of Tests

The test articles shall complete all tests without maintenance and without necessity to re-calibrate the test articles.

6.2.3 Test Equipment

Any test equipment requirements shall be specified for each test procedure. Items of test equipment shall have been calibrated prior to the commencement of the test.

6.2.4 Test Report

The manufacturer shall prepare a summary report declaring the following:

1) The time and date of testing, and the participants and their roles in the testing.
2) The part numbers and serial numbers of all identified line replaceable units of the SMR as tested, with revision numbers and (software) configuration status, if applicable.
3) The environmental conditions, where applicable.
4) The part number and serial numbers of each item of test equipment used and its calibration status.
5) A statement of all performance tests that have been successfully completed.
6) A specific statement for each performance test that was not performed or successfully completed.

7) A specific statement for each declared or identified operational limitation.

6.2.5 Safety Precautions

Any unusual characteristics or hazards to personal or property (e.g. RF radiation, etc.) resulting from operation of the SMR shall be analysed and documented before the test.

While the materials, methods, applications, and processes described or referenced in this procedure may involve the use of hazardous materials, this procedure does not address the hazards that may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and processes, and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

6.2.6 Power Input

The test(s) shall be conducted with the SMR powered by the installed equipment electrical power system.

6.2.7 Associated Equipment and Systems

All other electrical or mechanical equipment likely to be operated simultaneously on ground shall be activated for the test(s).

6.2.8 Environment

During the test, the environmental conditions shall not exceed those specified.

6.2.9 Warm-Up Period

All tests shall be conducted after a warm-up period as specified.

6.3 BASIC CONFORMITY TESTS

Degradation is not allowed as a result of exposure to the conditions listed.

6.3.1 Conformity Inspection

The installed SMR shall be inspected to determine conformity with acceptable workmanship and engineering practices, that the equipment is complete in accordance with the specifications, that proper mechanical and electrical connections have been made, and that the equipment is installed in accordance with the manufacturer's recommendations.

6.3.2 Maintainability

Verify access and removal of the equipment in accordance with the prescribed maintenance practices.

Verify that it is not possible to incorrectly install or connect any Line Replaceable Unit (LRU).

6.3.3 System Operations

The installed SMR shall be operated according to the documented system operating procedures. Proper function shall be verified.

6.3.4 Displays and Controls Accessibility

Demonstrate that all equipment controls and displayed data are readily accessible, intuitive and easily interpreted.

6.4 PERFORMANCE TESTS

In the following test descriptions each performance test is presented under a separate heading in the following format:

- Requirement (ref. Chapter 3) - definition of parameter to be tested
- Test Equipment – description of any test equipment needed to perform the test
- Test Procedure - description of test method, including analysis of test data

The parameters to be tested are those defined in Chapter 3.

6.4.1 Detection Sensitivity Test

Requirement (3.4.2):

The probability of detecting any target having an equivalent RCS of at least one square metre, shall be better than:

- 90% under all weather conditions
- 99% in clear weather conditions

everywhere within the specified coverage area.

Test Equipment:

The following test equipment will be required:

- A reflector of one square metre RCS at the operating frequency and polarisation, mounted on a pole at a height of one metre above the ground.
- A means of displaying the raw video output, e.g. a radar maintenance display facility
- A means of recording, decoding and viewing the data output of the Target Extractor unit, i.e. a Data Logger

Test Procedure:

The generic test procedure for detection sensitivity will be as follows:

- Place the reflector at a suitable location at least 30 m from any other object on the airport surface.
- Align the reflector for optimum detection, as required.
- Monitor the SMR output over a period of time (at least 1000 updates will be required to give a reasonable sample for testing).
- Record the number of raw video paints and data reports from the test reflector.
- Use the results to calculate the probability of detecting a target according to the following formula:

$$\frac{\text{Total no. of correct paints/reports} * 100\%}{\text{Expected no. of paints/reports}}$$

The test should be undertaken in several locations, throughout the required coverage area, to ensure that the results include the worst-case locations.

NOTE: *For an SMR using circular polarisation, triple-bounce reflectors (corner reflectors) will not be calibrated.*

The height of one metre is chosen to provide a standard test scenario. The pole on which the reflector is mounted shall be of low-reflective material so as not to influence the calibration of the reflector.

6.4.2 Data Renewal Rate Test

Requirement (3.4.3):

The Data Renewal Rate shall be at least once per second.

Test Equipment:

The following test equipment will be required:

- A means of displaying the raw video output, e.g. a radar maintenance display facility
- A means of recording, decoding and viewing the data output of the Target Extractor unit, i.e. a Data Logger

Test Procedure:

The test should be performed in clear weather conditions. A number of known targets will be monitored over a period of time.

- Select a single target to be followed and record the number of target reports for that target over a period of time (60 seconds should be adequate).
- Repeat the test several times for a number of different targets (say 5).
- Use the results to calculate the mean update rate according to the following formula:

$$\text{Data Renewal Rate} = \frac{\text{No. of target reports}}{\text{No. of seconds}}$$

6.4.3 Target Dynamics Test

Requirement (3.4.4):

The SMR shall detect targets with speed in the range of zero to at least 250 knots in any direction anywhere within the specified coverage area.

Test Equipment:

The following test equipment will be required:

- A means of displaying the output data in a graphical format, e.g. a radar maintenance display facility

Test Procedure:

This test should be performed using targets of opportunity and test vehicles. It is unlikely that any target will attain the upper speed limit while within the aerodrome movement area; however, for the purposes of the test, it is sufficient to ensure that all traffic using the aerodrome is adequately detected, regardless of speed or direction of movement. In particular, landing aircraft and aircraft accelerating from zero speed to take-off speed on a runway should be observed.

- Select a single target to be followed and record the target reports over a period of time (several minutes).
- Estimate the target speed by measuring the distance between consecutive updates.
- Confirm that the target is correctly detected, independent of its speed and direction of motion.
- Repeat for a number of different targets moving at varying speeds and in different directions throughout the coverage area.

6.4.4 Displacement Detection Test

Requirement (3.4.5):

The SMR shall be able to detect a minimum displacement of a point source target of 7.5 metres in any direction anywhere within the specified coverage area.

Test Equipment:

The following test equipment will be required:

- A means of displaying the output video in a graphical format, e.g. a radar maintenance display facility
- A means of recording, decoding and viewing the data output of the Target Extractor unit, i.e. a Data Logger
- Three portable radar reflectors (typically, ten square metre RCS at the operating frequency) suitably mounted to be at one metre above the surface
- Measuring Tape

Test Procedure:

There are two parts to this test procedure. The first is to test the raw video output, the second to test the target report output of the Target Extractor unit.

1) Raw Video Test:

- Place three radar reflectors in a line, perpendicular to the direction of the radar beam and with a spacing of 30 m between the reflectors as shown in Figure 6.1 (azimuth test). These should be visible to an operator viewing the raw video display.
- Verify that the three returns are visible on the display (the display should be zoomed to clearly see the area where the reflectors are located).
- Move the centre reflector by 5.5 m towards one of the other reflectors. The operator (with a suitably zoomed display) should be able to see the displacement and confirm in which direction the reflector has been moved.
- Repeat the test with the reflectors placed directly in line with the radar beam as shown in Figure 6.2 (range test).
- The test should be undertaken in several locations, throughout the required coverage area, to ensure that the results include the worst-case locations.

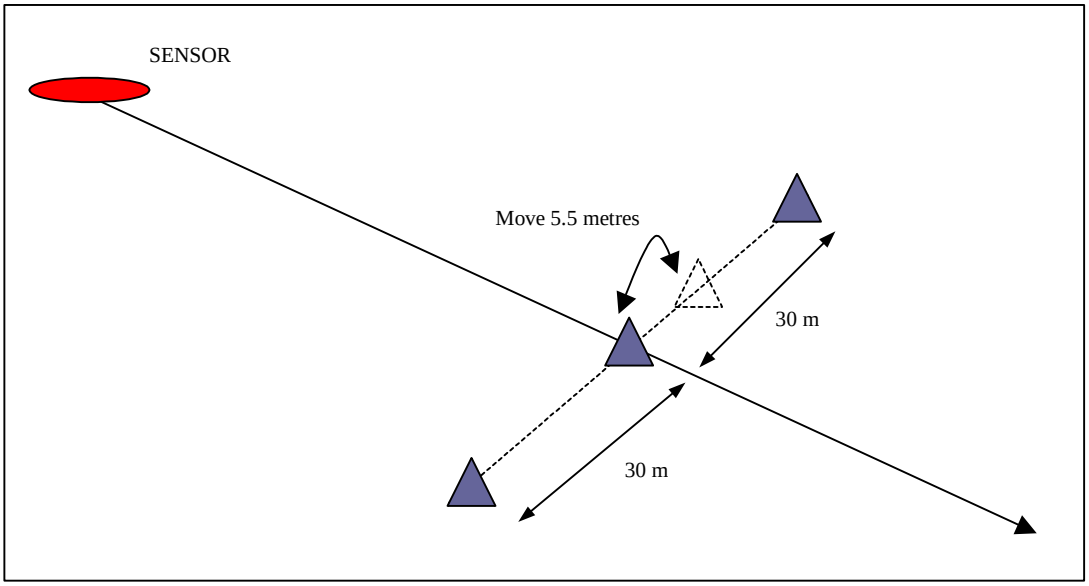

FIGURE 6-1 : DETECTION DISPLACEMENT TEST – AZIMUTH

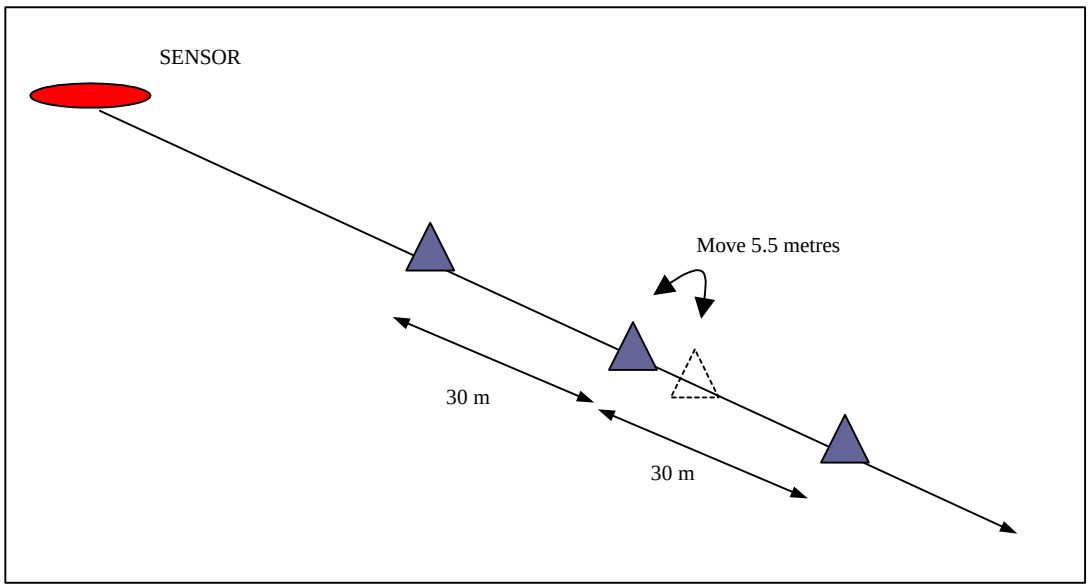

FIGURE 6-2 : DETECTION DISPLACEMENT TEST - RANGE

NOTE: *The movement of 5.5 m along and perpendicular to the radar axis allows for a 7.5 m movement in any direction to be achieved.*

2) Target Extractor Test:

The same test scenarios as above should be used for verifying the Target Extractor unit output. However, in this case, the reported positions of the three reflectors should be noted and this should reflect the appropriate change when the centre reflector is relocated.

6.4.5 Target Classification Test

Requirement (3.4.6):

The Target Extractor unit shall output information relating to target size in order to assist the A-SMGCS in discerning the various types of targets, i.e. aircraft, vehicles or other objects within the specified coverage area.

Test Equipment:

- A means of recording, decoding and viewing the data output of the Target Extractor unit, i.e. a Data Logger

Test Procedure:

This test should be performed using targets of opportunity and test vehicles. To save time, it should be conducted simultaneously with another test, for example the Target Dynamics test. The test procedure is as follows:

- Select a single target to be followed and record the target reports over a period of time (several minutes).
- Confirm that the SMR reports a target size that is consistent with the raw video image of the target being illuminated.
- Repeat for a number of different sized targets moving in different directions throughout the coverage area.

***NOTE**: The SMR should never report a target size less than the theoretical minimum radar cell size, which is predominantly determined by the transmitter pulse width and the antenna horizontal beamwidth.*

6.4.6 Target Discrimination Test

Requirement (3.4.7):

Discriminate and resolve two point source targets separated by 30m in any direction within the intended coverage area.

Test Equipment:

The following test equipment will be required:

- A means of displaying the output video in a graphical format, e.g. a radar maintenance display facility
- A means of recording, decoding and viewing the data output of the Target Extractor unit, i.e. a Data Logger
- Three portable radar reflectors (each of ten square metres equivalent RCS at the operating frequency) suitably mounted to be at 1 metre above the aerodrome surface
- Measuring Tape

Test Procedure:

The test procedure is as follows:

- Place three radar reflectors at the points of a triangle, along and perpendicular to the direction of the radar beam, as shown in Figure 6.3. The reflectors should be visible to an operator viewing the raw video display.

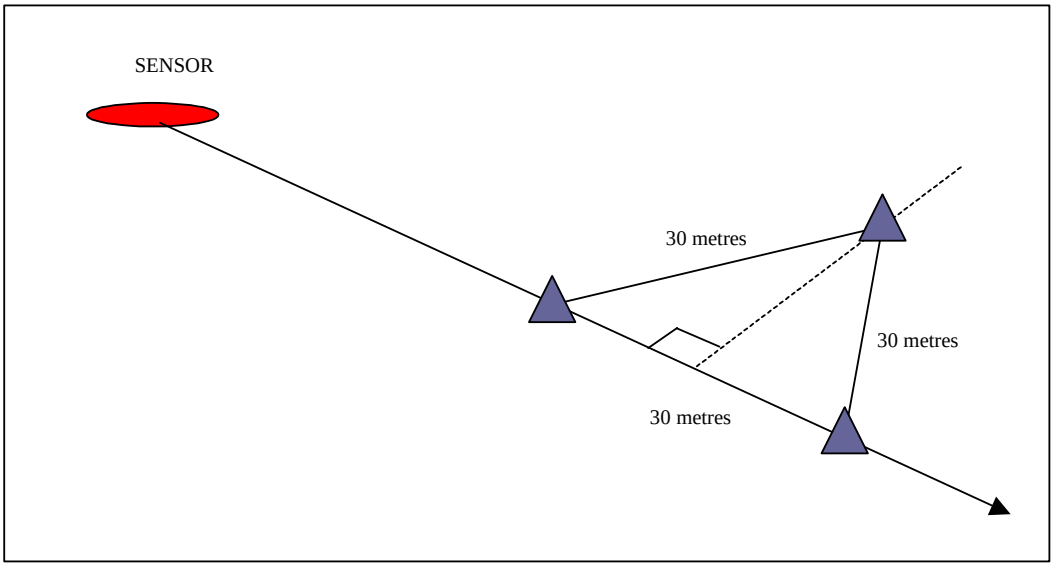

FIGURE 6-3 : TARGET DISCRIMINATION TEST

There are two sets of observations to be made and recorded. The first is to test the raw video output, the second to test the target report output of the Target Extractor unit.

The test should be undertaken in several locations, throughout the required coverage area, to ensure that the results include the worst-case locations.

1) Raw Video Test:

- Confirm (with a suitably zoomed display) that the reflectors are visible as three distinct returns on the reference display.

2) Target Extractor Test

- Confirm that the output of the Target Extractor unit includes three distinct target reports, one for each reflector.

NOTE: *The pattern of the reflectors is chosen to ensure that the result is not influenced by differences in the SMR's range resolution and azimuth resolution.*

The test should be carried out with the reflectors located at or near the maximum specified range of the SMR.

6.4.7 False Target Report Test

Requirement (3.4.11):

False target reports shall be reduced to an acceptable level.

Test Equipment:

The following test equipment will be required:

- A means of recording, decoding and viewing the data output of the Target Extractor unit, i.e. a Data Logger

Test Procedure:

The test procedure is as follows:

- Choose an area in which there is a known and consistent number of fixed known targets and a known or contrived target activity.
- Monitor the area over a period of time (at least 1000 updates) and count all target reports received.
- Repeat the test in as many areas as is practical to adequately represent the operational requirement and to avoid the data being distorted by any anomalies specific to one area.
- Use the results to calculate the number of false target reports per scan according to the following formula:

$$\frac{\text{No. of target reports} - (\text{No. of known targets} * \text{No. of updates})}{\text{No. of updates}}$$

6.4.8 Identification of Reflection Areas

Requirement:

Areas where false returns arise through multipath reflections shall be identified during site acceptance testing and the information formally recorded and made available to operators using the SMR.

Test Equipment:

The following test equipment will be required:

- A means of displaying the raw video output and target report data in a graphical format, e.g. a radar maintenance display facility
- Traffic of opportunity

Test Procedure:

The test procedure is as follows:

- Perform a traffic study, using targets of opportunity during normal airport operations
- Formally record all incidents or multipath reflections affecting manoeuvring areas and provide formal documentation to make the operator aware of constraints of the SMR.

NOTE: *Where serious reflection problems are found, consideration should be given to identifying the reflecting surface and taking measures to counter the problem.*

6.4.9 Position Accuracy Test

Requirement (3.4.12):

The SMR should provide a raw video output, the accuracy of which for a point source shall be better than 7.5m (95 % level of confidence).

The SMR shall provide a target-extracted output, the Reported Position Accuracy of which for a point source shall be better than 7.5m (95% level of confidence).

Test Equipment:

The following test equipment will be required:

- A means of displaying the output data in a graphical format, e.g. a radar maintenance display facility
- A means of recording, decoding and viewing the data output of the Target Extractor unit, i.e. a Data Logger

Test Procedure:

This test will be performed on the extracted video output only. Since the extracted video is derived from the raw video, it is reasonable to infer that the raw video output would be at least as accurate as the extracted output.

The test procedure is as follows:

- Locate a static target, for example a calibrated reflector or a small vehicle, at a known and accurately surveyed position.
- Record the position reported at the output of the Target Extractor unit at each update over a statistically significant number of measurements (in this case around 100 will be adequate).
- For each data point calculate the error in the X position, Δx, and in the Y position, Δy, where:

Δx = (Known X position - Reported X position) in metres

Δy = (Known Y position - Reported Y position) in metres

- Use the results to calculate the position error for each target report according to the following formula:

Position error = $\sqrt{(\Delta x^2 + \Delta y^2)}$

- Repeat the test in as many areas as is practical to adequately represent the operational requirement and to avoid the data being distorted by any anomalies specific to one area.
- Confirm that for at least 95% of the target reports the error is less than 7.5 m.

6.4.10 Processing Delay Test

Requirement (3.4.13):

The processing delay of the raw video within the SMR shall not exceed 250 milliseconds from the radar beam illuminating the target until the output of the associated video.

The processing delay for target reports by the SMR shall not exceed 500 milliseconds from the radar beam illuminating the target until the output of the associated report.

Test Equipment:

The following test equipment will be required:

- A means of displaying the raw video output and target report data in a graphical format, e.g. a radar maintenance display facility
- A radar reflector (ten square metres equivalent radar cross-section at the operating frequency), suitably mounted to be 1 metre above the ground (a simple corner reflector, which needs to be accurately aligned will suffice)
- A means of quickly suppressing the return from the radar reflector (e.g. a length of cord to pull the reflector over)
- An electronic counter
- Access to radar digital turning data (azimuth count pulses and azimuth reset pulse.)

Test Procedure:

To carry out a scientific test to establish this requirement may be expensive to arrange and unnecessarily complex for most situations. The following simple two-part test will ensure that the target is being presented on the scan that it is detected (and not on a subsequent scan), and that the delays are consistent with the requirements.

1) Part 1:

- Set up and align a reflector at a known and clear location. One of the test team remains close to the reflector and in contact with an observer who will monitor the return on a display under test, but far enough distant such that the return from the reflector can be separately identified.
- As the reflector paints on the display, the observer indicates this so that the reflector can be rapidly removed (re-directed) by the other test team member
- The observer should confirm that the reflector does not paint and is not reported on the next scan.

NOTE: *If a paint or target report is detected on the next scan, but not on subsequent scans it is an indication that the delay in presenting a target is in excess of one scan.*

2) Part 2

Once it has been determined that there is not a delay in excess of one scan, a more accurate estimation of the delay can be obtained. This part of the test relies on the SMR having a digital turning information output that can be accessed and linked to a digital counter. The counter is arranged to be started / reset by the Azimuth Reset Pulse (ARP) and to count the Azimuth Count Pulses (ACP). An operator presses a button to stop the count. The set-up is shown in Figure 6.4.

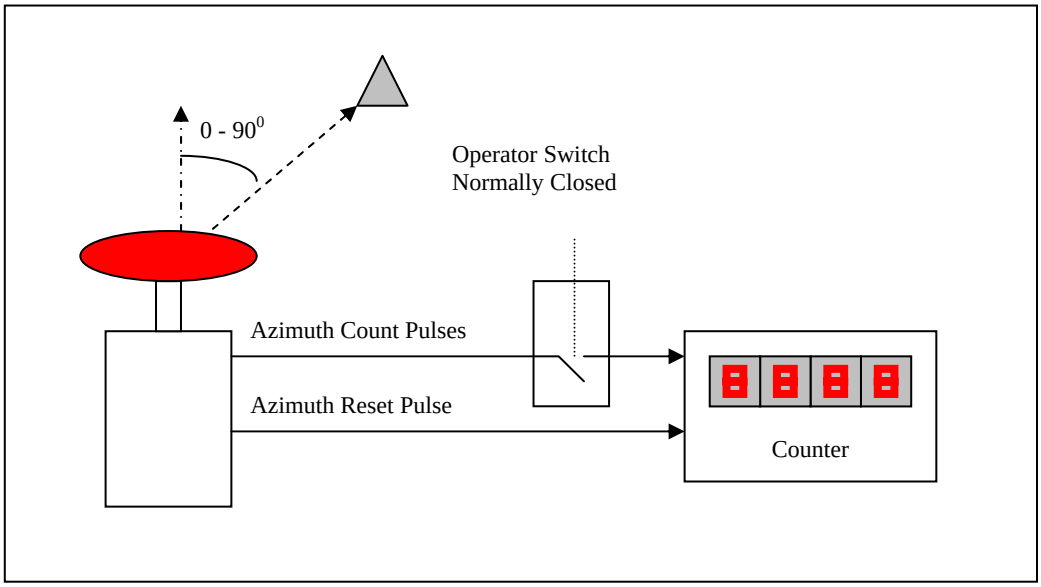

FIGURE 6-4 : PROCESSING DELAY TEST - PART 2 SET-UP

- Place a known target at a bearing of between North and 45 degrees with respect to the antenna position (assuming the digital turning system resets at North).
- The operator should press the button as soon as the selected return paints on the display.
- Record the azimuth count (C1) on the counter and calculate the processing delay using the following formula:

$$\text{Processing delay} = \frac{(C1 - C2) * T}{C3}$$

Where:

C1 is the recorded azimuth count

C2 is the calculated true azimuth count for the bearing at which the target is placed

C3 is the total count for one complete rotation of the antenna

T is the time for one complete rotation of the antenna (nominally one second)

NOTE: *Obviously, the reaction time of the operator will be included in the test result. However, this can be estimated and subtracted to give a more accurate final result. The test will give a result adequate to determine if there is excessive delay.*

6.4.11 Continuity of Coverage Test

Requirement: (3.4.1)

The SMR shall provide continuous cover throughout the agreed coverage area.

Test Equipment:

The following test equipment will be required:

- A means of displaying the raw video output and target report data in a graphical format, e.g. a radar maintenance display facility
- A small vehicle
- Traffic of opportunity

Test Procedure:

The test procedure is as follows:

- The vehicle should be driven along both the centrelines and edges of all paved areas intended to be covered by the SMR.
- Formally record any areas where there is a break in coverage and use in formal documentation to make the operator aware of constraints of the system.

A traffic study, using targets of opportunity during normal airport operations should complement the vehicle testing.

NOTE: *Where the operational requirement extends to coverage of unpaved areas, these should also be tested. In particular, the limits of coverage in enclosed areas such as cul-de-sacs should be documented.*

When using a small vehicle, the worst-case scenario is being tested and, in many cases, the tail plane of an aircraft will continue to give a return in areas where a small vehicle is invisible to the SMR.

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