Polish Air Navigation Services Agency

TECHNICAL INFRASTRUCTURE BUREAU - ATM/CNS SYSTEMS PROJECTS DEPARTMENT

Collocated surveillance radar system for Warszawa and Zabierzów sites

Functional and Technical Specification

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Abstract

The document contains functional and technical specification for collocated PSR/MSSR Mode-S radar sensor system. The specification is a description of the two (2) new radar systems for Kraków-Zabierzów and Warszawa sites. The specified systems will support en-route and approach air traffic control. For the support of air traffic control in local TMAs the document specifies the PSR radar with the 80 NM range.

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

EDITION	DATE	DOCUMENT STATUS	SECTIONS PAGES AFFECTED

TABLE OF CONTENTS

-page left blank-

1. INTRODUCTION

1.1 Purpose

This document describes the functional, performance and technical requirements for the collocated Primary Surveillance Radar with Monopulse Secondary Surveillance Radar Mode-S (based on EMS design) and the related equipment. The specification was created to define requirements for the two (2) radar system to be installed nerby International Airport Kraków-Balice (EPKK) in Zabierzów site and nearby Inetrnational Frideric Chopin Airport (EPWA) in Warszawa site.

Above mentioned Radar System will principally be used for air traffic control by Approach (APP) and En-Route (ACC) Air Traffic Control in Warsaw FIR.

The data generated by the specified Radar System will be used by RDP segments of PANSA ATM systems including new generation ATM System PEGASUS_21. The data from the Radar site will be sent to ATM System via PANSA Radar Network (PRANET) based on Eurocontrol's RMCDE nodes. This requires from the provided radar data outputs to be fully compatible with RMCDE inputs.

The Radars and related equipment offered by the Contractor shall satisfy the requirements described in this FTS.

1.2 Document Language

In this document the word **"shall"** denotes a requirement.

In order to clarify the status of the particular requirement the letter **[M]** or **[O]** has been assigned (on the right margin of the page). These letters have the following meaning:

[M]- means MANDATORY requirement where the compliancy is obligatory,

[O] - means OPTIONAL requirement where compliancy is optional.

The Contractor' means the body providing the radar system specified in this document.

At any stage of this document when there is reference to MSSR or secondary radar it shall be understood as MSSR Mode-S equipped.

1.3 Scope of Provision

1.3.1 General

The scope of work resulting from this specification shall generally consist of provision, installation and integration (including parameters' optimization) of complete collocated radar system with the test transponder and radome.

1.3.2 Radar System Equipment

Installation of the Radar Equipment shall generally consist of provision, installation and integration of the following:

1. PSR equipment;
2. MSSR Mode-S equipment (collocated with PSR);
3. Collocated antennas and pedestal;
4. All other necessary radars' related equipment:
    a. GPS receivers,
    b. Communication equipment,
    c. Power equipment,
    d. Monitoring and Control System (CAM)
    e. Local Display,
    f. Surveillance Data Filter and Combiner;
5. Set of spare parts for the radar system,
6. Technical Training,
7. Full Technical Documentation for the provided infrastructure and installed equipment.

The site survey is recommended in order to identify the sitting aspects and complete scope of the necessary equipment and installation.

2. GENERAL REQUIREMENTS

2.1 Radar System

GEN_2.1_1. The collocated radar system **shall** consist of: **[M]**

(a) PSR equipment,

(b) MSSR Mode S equipment,

(c) Collocated antennas with pedestal group,

(d) Control And Monitoring System (CAM) including PPI display,

(e) Surveillance Data Filter and Combiner (SDFC),

(f) Two GPS receivers,

(g) Local Display,

(h) Radome,

(i) Spare parts set.

GEN_2.1_2. The Contractor **shall** provide:

(a) Technical training for the technical staff,

(b) Full technical documentation for the provided infrastructure and installed site equipment.

GEN_2.1_3. All site equipment **shall** be provided and installed as an fully integrated collocated radar system. **[M]**

GEN_2.1_4. The Contractor **shall** assure full set of test and measurement tools (on his own cost) for radar requirements verification during the SAT, FAT acceptance. **[M]**

GEN_2.1_5. The PSR/MSSR Mode-S provided by Contractor for both hardware and software parts **shall** be made in accordance with the highest and modern technology standards. **[M]**

GEN_2.1_6. The provided Equipment **shall** be the brand-new, standard production equipment i.e. this equipment has passed through the design and test phases , has been produced and is already in operation in Air Traffic Control applications. The MSSR with Mode S **shall** be constructed and made in accordance with [Ref 21]. **[M]**

GEN_2.1_7. The following standards for collocated radar system and separately for MSSR and PSR **shall** apply: **[M]**

(a) [Ref.11]

(b) [Ref.20]

(c) [Ref.18]

(d) [Ref.12]

(e) [Ref.19]

GEN_2.1_8. In case when the requirements stated in this document are higher than requirements in external invoked documents the requirements herein specified **shall** apply. **[M]**

GEN_2.1_9. The offered system **shall** comply with appropriate valid Polish and EC (European Commision) regulations including valid implementing rules and community specifications. **[M]**

GEN_2.1_10. The Contractor **shall** define the scope of the offered equipment preparation for the known coming EC regulations. **[O]**

GEN_2.1_11. The Contractor **shall** provide for the offered radars CE Cerificates and separatelly the RTTE Declaration (when CE does not cover compliance with EC Directive no 1999/5/EC). **[M]**

GEN_2.1_12. The Contractor at the stage of installation **shall** provide for the delivered collocated radar system the Declaration of conformity and suitability for use according to EC Regulation no 552/2004. **[M]**

GEN_2.1_13. The software delivered with the radar system **shall** be developed and documented in the way to ensure the compliance with safety requirements of ESARR 6. **[M]**

GEN_2.1_14. The herein Specified Radar System **shall** send to ATCC detected but not smoothed aircraft positional data. **[M]**

GEN_2.1_15. The Contractor **shall** prepare (at the stage of the offer) appropriate radar coverage tables. It is suggested for the Contractor to familiarise with the radar site localization and its environs when preparing the tables. **[M]**

GEN_2.1_16. The proposed equipment **shall** provide maximum safety for the maintenance personnel. **[M]**

GEN_2.1_17. The equipment installation **shall** be such that access to any equipment cabinet, the removal of any sub-unit, PCB, and the use of extender cards where required, external test equipment etc. is not impeded by any adjacent cabinets, units etc. **[M]**

GEN_2.1_18. All the workstations of the radar system **shall** be provided with a multi function QWERTY keyboards, optical mousses and high resolution (min. 1280x1024 pixels) colour LCD monitors (19" or more). **[M]**

2.2 Availability, maintainability and integrity

GEN_2.2_1. The sensors **shall** be designed for unattended, remote controlled continuous operation twenty-four (24) hours a day, 365 days a year for at least 15 years. **[M]**

GEN_2.2_2. All radar equipment including communication infrastructure **shall** be physically and functionally redundant for maximum availability excluding elements which by its nature cannot be dual channel (e.g. antenna system, waveguides, RF channel switch) or when lack of redundancy of the unit is clearly accepted in this FTS. **[M]**

GEN_2.2_3. Design of the equipment **shall** be such that a failure of any unit shall not induce a failure of any other unit essential for radar continuous operation. **[M]**

GEN_2.2_4. The operational availability of full and coherent set of PSR data **shall** exceed 99.89 % a year. **[M]**

GEN_2.2_5. The operational availability of full and coherent set of MSSR data **shall** exceed 99.89 % a year. **[M]**

GEN_2.2_6. The data availability (and therefore system availability) and outage time availability **shall** be equal or better to those specified in the [Ref.11] Para 5.3.2, 5.3.3, 6.3.4 and 6.4.4. **[M]**

GEN_2.2_7. The availability shall be accompanied by MTTR (Mean Time To Repair) figures and an MTTR **shall** be at least: 30 min for electrical/electronic systems and max. 8 hours for antenna, rotary joint and APG (Azimuth Pulse Generator) units. **[M]**

GEN_2.2_8. The different system elements in cabinets **shall** be laid out in such a way that all units and sub-units are completely accessible. The maximum time needed to disassemble such unit or sub-unit shall not exceed 20 minutes. **[M]**

GEN_2.2_9. The radar equipment **shall** incorporate the necessary fault detection circuitry (BITE) and switching systems to ensure the continuous verification of the correct operation and changeover from the main (operational) equipment to the standby equipment in case of failure. **[M]**

GEN_2.2_10. The BITE output **shall** be integral to the CAM (Control And Monitoring System). **[M]**

GEN_2.2_11. The system **shall** be allowed to continue its operation when non-critical functions have been reallocated or even ceased to perform. **[M]**

GEN_2.2_12. When despite all relevant measures and precautions (use of UPS (Uninterruptable Power Supply) etc.) the system ceases to operate due to power failure, it **shall** be able to recover (upon power return) automatically within the operating conditions before the interruption. **[M]**

GEN_2.2_13. The external equipment provided in scope of radar delivery **shall** not degrade the overall radar system performance and availability below the values stated in this document. **[M]**

GEN_2.2_14. The singular outage time of the specified PSR or SSR due to failure **shall** not exceed 4 hours excluding failures of the antenna, driving motors and rotary joint. **[M]**

GEN_2.2_15. The cumulative outage time of the specified PSR or MSSR (excluding scheduled maintenance) **shall not** exceed 10 hours over a period of one year. **[M]**

GEN_2.2_16. MTBF for the specified radar system **shall** be better than 20000 hours and for the antenna system better than 40000 hours. **[M]**

GEN_2.2_17. The Contractor **shall** list in the technical documentation MTBF and MTTR values for radar system components. **[M]**

2.3 Peripheral Devices

GEN_2.3_1. The number of peripheral equipments required to support the radar system **shall** be minimal. **[M]**

GEN_2.3_2. All peripheral equipment required to support the operation of the system **shall** be included in the delivered equipment. **[M]**

GEN_2.3_3. Common and internationally recognised interface standards **shall** be employed for all peripheral devices. **[M]**

2.4 Environmental Conditions

2.4.1 External Conditions

GEN_2.4.1_1. Any radar system equipment or elements **shall** operate and maintain its full operational performance under the following external conditions: **[M]**

(a) Ambient Air Temperature: -40℃ to +50℃;

(b) Relative Humidity: Up to 100% (Lower than 90% at 40℃);

(c) Driving Rain: Up to 60 mm/h;

(d) Snow load: Up to 200 kg/m2 (in or out of operations);

(e) Hail: Up to 10 mm at 18 m/s;

(f) Wind resistance:

(i) In operation, bursts up to 160 km/h without frost or ice, up to 130 km/h with 12 mm frost or ice;

(ii) In survival, bursts up to 220km/h, without frost or ice, up to 180 km/h with 12 mm ice or frost.

GEN_2.4.1_2. The equipment dedicated for indoor operation (e.g. electronics, UPS) **shall** be adopted to external environment by appropriate technical means (e.g. shelter/room, air-condition). **[M]**

2.4.2 Storage Conditions

GEN_2.4.2_1. The equipment items **shall** be capable of undergoing, in their package, the constraints related to the transport by air, sea or land. **[M]**

GEN_2.4.2_2. All types of equipment, including spares, **shall** be constructed in the way to be capable of being stored at varying temperatures from -40℃ to +60℃ with an ambient relative humidity lower than 90% at 40℃. **[M]**

2.5 Technical Documentation

GEN_2.5_1. The Contractor **shall** provide complete and comprehensive detailed technical documentation for the radar system with its subunits. **[M]**

GEN_2.5_2. All deliverable documentation **shall** be written in English or Polish, using standardised presentation and notation. **[M]**

GEN_2.5_3. All deliverable documentation **shall** be provided in three (3) copies, each copy shall be in both paper and identical common computer readable format (e.g. pdf). **[M]**

GEN_2.5_4. In addition to the requirements above; flow charts, block diagrams and preventative/corrective procedures (including diagnostics) **shall** be delivered as a part of a system technical documentation. **[M]**

GEN_2.5_5. The System Cabling Schedule **shall** form part of the System Documentation. **[M]**

GEN_2.5_6. The COTS equipment's standard documentation (User Manual, Reference Manuals…) **shall** be provided, together with documents describing how they were customised to fit in the procured system. **[M]**

2.6 Training

GEN_2.6_1. The training for the delivered equipment **shall** be sufficient to enable Purchaser's technical staff to efficiently undertake the necessary trials to evaluate the site equipment, fault finding and correction down to LRU level, equipment parameterisation and preventive maintenance. **[M]**

GEN_2.6_2. The training program as a minimum **shall** cover: **[M]**

(a) Detailed system description, including data flows;

(b) Interpreting the system statuses;

(c) Initiating changes to the system configuration;

(d) Reinstating equipment after failure/maintenance;

(e) Routine maintenance;

(f) Fault isolation;

(g) Restoration of services by modules changing;

(h) Running and interpreting the diagnostic software;

(i) Installation, configuration and diagnostics of the delivered operating systems and applications software;

(j) PSR/MSSR tuning and optimization.

GEN_2.6_3. The Contractor before the training **shall** provide a detailed Training Plan for the radars (PSR/MSSR) and remaining equipment specified in this document. **[M]**

GEN_2.6_4. The Training Courses for radars **shall** be held at the radar manufacturer premises. For the factory testing personnel **shall** be conducted before FAT acceptance. **[M]**

GEN_2.6_5. The radar manufacturer's training personnel **shall** utilise a configured and fully functioning radar for all practical exercises during Training Courses. **[M]**

GEN_2.6_6. To ensure a sufficient level of the training, the Contractor **shall** provide Instructors who have appropriate high knowledge of English (equivalent to B2 or FCE). **[M]**

GEN_2.6_7. Time duration of the training **shall** be not shorter than: **[M]**

(a) 3 weeks (120 hours) for PSR,

(b) 2 weeks (80 hours) for MSSR and rest of the related equipment.

GEN_2.6_8. The Contractor **shall** provide 5-day (40 hours) post installation refreshment training on the installed collocated radar system. **[M]**

3. PRIMARY SURVEILANCE RADAR

3.1 Functional and Performance Requirements

3.1.1 Coverage Envelope

PSR_3.1.1_1. The system **shall** provide outputs enabling targets to be displayed within the following radar coverage envelope: **[M]**

(a) from a range of at the most 0.5 NM (Nautical Mile) (with respect to runway touch-down points),

(b) up to at least 80 NM with antenna rotation at least 12.3 ± 0.2 rpm, 1 m^2 target;

(c) from radar horizon up to at least 40° in elevation,

(d) bounded by a height of not less than 28,000 ft (FL 280),

(e) providing information for all targets throughout a complete antenna revolution of 360 ° in azimuth.

(f) Excluding shadings by artificial constructions and terrain obstacles.

PSR_3.1.1_2. Provision of low level cover **shall** be: **[M]**

(a) down to ground level, up to the RHD (Radar Horizon Distance) or to 15 NM,

(b) down to 2,000 ft up to 35 NM,

(c) down to 5,000 ft up to 50 NM,

(d) down to 6,000 ft up to 60 NM,

(e) down to 7,00 ft up to 70 NM,

(f) down to 10,000 ft up to 80 NM.

PSR_3.1.1_3. The fail-soft limit condition **shall** be that where the output power has been reduced to a level (to be specified in percentage by the Contractor), which is the safe limit of degraded operation of the Transmitter commensurate with the defined radar coverage envelope. The Contracotr **is free** to propose Transmitter duplication. **[M]**

3.1.2 Detection Performance

3.1.2.1 General Case

PSR_3.1.2.1_1. The system performance with a 1 m^2 target (standard target Swerling Case I) **shall** be such that a target **shall** be detected within the coverage volume defined in [Para 3.1.1], with a Pd (Probability of Detection) of at least 80%. **[M]**

PSR_3.1.2.1_2. The 1 m^2 target with radial velocity between 25 and 800 knots **shall** be detected with Pd of at least 80%. **[M]**

PSR_3.1.2.1_3. In the clear, the Pfa (Probability of False Alarm(s), False Alarm Probability) **shall** not exceed 10^{-6}. **[M]**

PSR_3.1.2.1_4. Targets with a larger RCS (Radar Cross Section) **shall** be detected with a higher probability. **[M]**

PSR_3.1.2.1_5. The above specified performances **shall** be maintained for pairs (or multiple instances) of targets if either their corresponding difference in slant range is >2 x nominal (compressed) pulse width or the difference in azimuth is > 3x nominal 3 dB beamwidth. **[M]**

3.1.2.2 Detection Performance

PSR_3.1.2.2_1. When the Doppler target speed is equal to the Doppler clutter speed, super-clutter visibility **shall** be provided at least for zero radial velocity. **[M]**

PSR_3.1.2.2_2. Super-clutter visibility **shall** be provided for other radial velocities. **[M]**

PSR_3.1.2.2_3. **Detection in Ground Clutter:** The ground clutter coverage envelope **shall** be that as defined in [Para 3.1.1], but with a Pd not less than 80% and a Pfa not exceeding 10^{-5}. **[M]**

PSR_3.1.2.2_4. **Detection in Rain Clutter:** The rain clutter coverage envelope **shall** be that as defined in [Para 3.1.1], but with a Pd not less than 80% and a Pfa not exceeding 10^{-5}. **[M]**

PSR_3.1.2.2_5. **Detection in Combined Clutter:** The combined clutter coverage envelope **shall** be that as defined in [Para 3.1.1], but with a Pd not less than 80% and a Pfa not exceeding 10^{-4} for ground clutter plus rain clutter case. **[M]**

3.1.3 Target Accuracy

The positional PSR accuracy due to random errors at the SDFC (Surveillance Data Filter & Combiner) input **shall** be:

PSR_3.1.3_1. The **slant range random error** standard deviation **shall** be equal or less than than 100 m (note: better than in [Ref.11] Para 6.4.3.1). **[M]**

PSR_3.1.3_2. The **azimuth random error** standard deviation **shall** be equal or less than value 0.15 ° (degrees). **[M]**

PSR_3.1.3_3. Systematic errors **shall** be minimised during system tuning and compensated in the radar system. **[M]**

PSR_3.1.3_4. Residual systematic errors **shall** be equal or better to those specified in the [Ref.11] Para 6.4.3.1. **[M]**

3.1.4 Target Resolution

PSR_3.1.4_1. The specified Pd and positional accuracy (see [Para 3.1.2] and [Para 3.1.3]) **shall** be maintained for pairs (or multiple instances) of targets under the conditions specified in the [Ref.11] Para 6.4.3.2.1. **[M]**

PSR_3.1.4_2. The above mentioned resolution **shall** be retained within the complete coverage volume as defined in [Para 3.1.1]. Particular attention should be given to the relation of the resolution performance in the upper/lower beam switching region. **[M]**

3.1.5 Velocity Response

PSR_3.1.5_1. The first blind speed **shall** under no circumstances occur at below 800 knots. **[M]**

PSR_3.1.5_2. Dim speeds (i.e. where the detection performance is reduced by 10 dB or more) **shall** be clearly identified in the technical documentation over the whole velocity range. **[M]**

PSR_3.1.5_3. Special techniques **shall** be applied to retain the required detection of targets having a low radial velocity (i.e. tangentially flying targets). **[M]**

PSR_3.1.5_4. The system **shall** be capable of detecting tangentially flying targets **[M]**

3.1.6 Interference

PSR_3.1.6_1. Equipment **shall** be resistant to extraneous RF interferences. **[M]**

PSR_3.1.6_2. Details **shall** be given in the technical documentation of the method(s) and technical means used by the equipment to be resistant to extraneous RF interferences. **[M]**

3.1.7 MTAT (Multiple Time Around Targets)

PSR_3.1.7_1. The proposed system **shall** be capable of rejecting MTAT under all operational conditions. **[M]**

PSR_3.1.7_2. The Contractor **shall** describe in the technical documentation the methods used for MTAT rejection. **[M]**

3.1.8 MTAC (Multiple Time Around Clutter)

PSR_3.1.8_1. The proposed system **shall** be capable of rejecting MTAC under all operational conditions. **[M]**

PSR_3.1.8_2. The Contractor shall describe in the technical documentation the methods used for MTAC rejection. **[M]**

3.1.9 Anomalous Propagation

PSR_3.1.9_1. The proposed system **shall** be capable of rejecting MTAT and MTAC resulting from anomalous propagation. **[M]**

PSR_3.1.9_2. Since anomalous propagation is generally seasonal in nature, the rejection mechanism **shall** be autoadaptive in order to obviate the requirement for regular intervention by maintenance personnel. “Seasonal” maps **may** be used. **[M]**

3.1.10 Filtering of Spurious PSR Plots

PSR_3.1.10_1. The maximum number of PSR false target reports/scan (clutter areas taken into account) **shall not** exceed 15 after tracking and/or filtering (NOTE: lower than in [Ref.11]). **[M]**

3.2 Technical Requirements

3.2.1 General

PSR_3.2.1_1. The PSR **shall** be a stable system using advanced transmission, reception and target extraction/ processing techniques, consisting of: **[M]**

(a) A Transmitter system providing a performance commensurate with the requirements of [Para 3.1]. It is to be noted that the Transmitter **shall** possess:

(i) Inherent frequency diversity, and a fail-soft capability (both at Transmitter output stage and at RF driver level).

(ii) Frequency synthesis at RF driver level providing a system stability commensurate with the desired system performance.

(iii) Solid-state Transmitter technology such that the equipment even at the limit of fail-soft mode (i.e. at a manufacturer defined percentage of the normal operating output power), still meets the operational requirements above, whilst also meeting the availability requirements given below.

(iv) "Graceful degradation" performance characteristics in the case of a failure of a Transmitter sub-system.

(b) Duplicated Receiving Channels including advanced processing providing a performance commensurate with the requirements of [Para 3.1],

(c) A duplicated Radar Data Processor for the output of PSR plots and/or tracks,

(d) A double-curvature Reflector Antenna Assembly, including the Radiating Units, Turning Gear, Pedestal and related units;

(e) A system for the extraction of Weather Data to NWS standards, having:

(i) Duplicated Weather Target Detection and Extraction processes;

(f) The necessary electrical and mechanical interfaces to an LVA (Large Vertical Aperture) MSSR Mode-S Antenna.

PSR_3.2.1_2. The Contractor **shall** state in the technical documentation: **[M]**

(a) the MTBCF (Mean Time Between Critical Failures) where the equipment no longer provides the 'essential data' specified in the [Ref.11] Para 5.3.1.2; and

(b) the MTBF (Mean Time Between Failures), i.e. where a failure does not affect the equipment operational performance, i.e. the 'full data' specified in the [Ref.11] Para 5.3.1.1.

3.2.2 PSR Operating Frequency

PSR_3.2.2_1. The PSR **shall** operate in the S Band. **[M]**

PSR_3.2.2_2. The operating frequency allocation **shall** be made according to ITU regulations. Special attention **shall** however be made to other radars within the coverage region specified which might produce interference (including neighbouring countries). **[M]**

3.2.3 System Configuration and Operation

PSR_3.2.3_1. The Contractor **shall** state in the technical documentation the I_T (Total System Improvement Factor) (Signal-To-Clutter Ratio at the output / Signal-To-Clutter Ratio at the input). **[M]**

PSR_3.2.3_2. The I_T figure "in the clear" **shall** be given and fully justified in the technical documentation. Therefore, all contributory elements to system instabilities shall be clearly stated and justified in the technical documentation. **[M]**

PSR_3.2.3_3. There **shall** be a continuous Radar Data exchange between the two Reception/Extraction Channels ("hot standby"), organised in such a way that useful Radar Data are available within one antenna revolution after a complete operative Channel failure. This shall also apply for the SDFC. **[M]**

PSR_3.2.3_4. The Contractor **shall** state in the technical documentation the number of solid-state Transmitter output stage modules that may fail before: **[M]**

a) the requirements of [Para 3.1] are no longer met,
b) a critical power level reduction (in percent) and/or other criteria are exceeded and the output stage(s) cease to function, i.e. the system BITE (Built-In Test Equipment) automatically changes the system from fail-soft to fail-safe (in this case no output power).

PSR_3.2.3_5. Each channel of the dual channel PSR **shall** operate in any of the three operating modes as follows: **[M]**

(a) Active: the equipment is used for the operation of the PSR

(b) Stand-by: the redundant equipment is switched on and normally available for operation, i.e. a reconfiguration, automatic or controlled, can take place.

(c) Maintenance: the equipment is under maintenance and is not available for operation.

PSR_3.2.3_6. For dual channel configurations any fault state **shall** be reported to CAM. **[M]**

PSR_3.2.3_7. In a dual channel system there is only one channel which **shall** be Active. **[M]**

PSR_3.2.3_8. Switching from a Stand-by mode to an Active mode **shall** be performed according to a 'cold switch-over' procedure by an operator command or by a 'hot switchover ' when the Active equipment fails. **[M]**

PSR_3.2.3_9. Switching from Active to Stand-by mode **shall** be performed by a 'cold switch-over' procedure, by an operator command. **[M]**

PSR_3.2.3_10. The normal procedure for switching to Maintenance mode **shall** be performed from the Stand-by mode, by an operator command. When exiting the Maintenance mode, switching is always performed to Stand-by. **[M]**

PSR_3.2.3_11. The 'hot switch-over' procedure **shall** correspond to a failure of an Active equipment, where an automatic reconfiguration of the processing occurs through switching. **[M]**

PSR_3.2.3_12. In case of 'hot switch over' the failing channel **shall** be automatically switched to Maintenance mode. **[M]**

PSR_3.2.3_13. In the case of failure a 'hot switch-over' **shall** be inhibited in case of additional failure of the now active channel. **[M]**

PSR_3.2.3_14. The 'cold switch-over' procedure corresponds to the controlled switching of all the processing chains (in local or remote mode). It **shall** guarantee that no data, essential for surveillance, is lost during the switching. **[M]**

PSR_3.2.3_15. The active RF channel **shall** be connected to the antenna and the standby to the dummy load. **[M]**

PSR_3.2.3_16. During switch-over the PSR **shall** provide uninterrupted service without any corruption to the output surveillance data. **[M]**

PSR_3.2.3_17. A remote indication of the RF switch-over selection **shall** be available. **[M]**

PSR_3.2.3_18. The radar's channel **shall** retain it's selected operating mode [Req. PSR_3.2.3_5] in absence of control signals and power supplies. **[M]**

PSR_3.2.3_19. An indication to determine which is the Active channel **shall** be provided. **[M]**

PSR_3.2.3_20. The switch-over equipment **shall** be of passive design and require no routine maintenance. **[M]**

3.2.4 Interface(s) to the MSSR Equipment

PSR_3.2.4_1. The primary radar system **shall** be provided with all necessary mechanical, electrical or other interfaces to accommodate the co-mounted MSSR Mode-S Antenna. **[M]**

3.2.5 Equipment Performance and Status Monitoring

PSR_3.2.5_1. Particular importance **shall** be attached to system integrity and reliability. A CAM (Control And Monitoring System) **shall** be provided so that the major system parts **shall** be monitored and controlled. **[M]**

PSR_3.2.5_2. The PSR system (including Antenna sub-system, Rotary Joint, Waveguide/cable path) **shall** include extensive performance and status monitoring equipment, using BITE techniques at all levels. **[M]**

PSR_3.2.5_3. The BITE **shall** make a continuous PSR system operation on-line verification (i.e. status and correct operation). **[M]**

PSR_3.2.5_4. The BITE output **shall** be integrated into the CAM. **[M]**

3.2.6 PSR Antenna

PSR_3.2.6_1. The PSR Antenna characteristics (mechanical and electrical) **shall** be such that all the requirements in [Para 3.1] and [Para 3.2] are fully met. **[M]**

PSR_3.2.6_2. The PSR Antenna **shall** have at least two beam patterns produced by two individual transmission/reception mechanical/electrical assemblies supported by a suitable beam switching. **[M]**

PSR_3.2.6_3. The PSR Antenna **shall** be equipped with the necessary outputs to permit Weather Data extraction, even when the Antenna is working under circular polarisation. **[M]**

PSR_3.2.6_4. The Contractor as a part of technical documentation **shall** supply copies of the horizontal and vertical polar diagrams, together with following performance characteristics: **[M]**

(a) materials used in Antenna construction,

(b) Antenna dimensions and weight,

(c) polarisation.

PSR_3.2.6_5. The Antenna tilt **shall** be adjustable to allow optimisation of performance on different sites. The tilt shall be configurable at least between –3° and +3°. **[M]**

PSR_3.2.6_6. The Antenna Tilt Mechanism **shall** incorporate a calibrated scale allowing the setting of tilt within an accuracy at least of +/- 0.5 °. **[M]**

PSR_3.2.6_7. The Antenna Tilt Mechanism **shall** be operable by one person without special tools. Suitable locking devices shall be supplied. **[M]**

PSR_3.2.6_8. The azimuth sidelobes level **shall** be better than 25 dB. **[M]**

PSR_3.2.6_9. The antenna turning rate **shall** be not less than 12.1 rpm. **[M]**

PSR_3.2.6_10. The construction of the antenna **shall** be capable to be rotated up to 15 rpm. **[M]**

PSR_3.2.6_11. The Contractor **shall** provide all facilities provided for easy and safe access for maintenance personnel to the Antenna assemblies (for repair and maintenance). **[M]**

3.2.7 Antenna Turning Gear

PSR_3.2.7_1. The Contractor **shall** describe in the technical documentation details concerning the following Antenna Turning Gear elements: **[M]**

(a) Pedestal,

(b) Antenna Support,

(c) Antenna Braking/Locking,

(d) Gearbox and motors.

PSR_3.2.7_2. The Gearbox Assembly and sub-assemblies **shall** be designed in such a manner as to facilitate corrective **and** preventive maintenance. **[M]**

PSR_3.2.7_3. The removal of major assemblies such as the main bearing of the Gearbox **shall** be possible without removal of the entire Gearbox. **[M]**

PSR_3.2.7_4. Continuous lubrication of all moving parts **shall** be ensured at all times. Facilities **shall** be provided for continuous oil level monitoring and/or generation of alarms. In case of an oil level anomaly, the Antenna **shall** cease rotation or cease to run up. **[M]**

PSR_3.2.7_5. Greasing of assemblies **shall** not be necessary more than once every six months. **[M]**

PSR_3.2.7_6. Greasing points **shall** be easy available for maintenance personnel, equipped with visual inspection facilities. Their service shall not be impeded by the other equipment. **[M]**

PSR_3.2.7_7. Suitable lifting facilities **shall** be foreseen in order to ease corrective maintenance. **[M]**

3.2.7.1 Azimuth Positional Data

PSR_3.2.7.1_1. The Azimuth Positional Data **shall** be generated by two complete and independent APGs. **[M]**

PSR_3.2.7.1_2. The drive for the APGs (Azimuth Pulse Generators) **shall** feature minimised play and jitter to allow the specified system stability figure I_T to be achieved. **[M]**

PSR_3.2.7.1_3. Each APG **shall** provide incremental Azimuth Positional Data (ACP (Azimuth Count Pulse) and NM (North Marker)), which **shall** be generated by sensing the Antenna rotating elements position. **[M]**

PSR_3.2.7.1_4. The North Marker **shall** be capable of being aligned to within 1 ACP of each other positions for both APGs. **[M]**

PSR_3.2.7.1_5. These redundant azimuth positional data sources (APGs) **shall** operate independently so that failure or removal (during maintenance) of one unit shall not interfere with proper operation of the other unit. **[M]**

PSR_3.2.7.1_6. Either APG **shall** be removable without interfering with the alignment of the other. **[M]**

PSR_3.2.7.1_7. Suitable maintenance procedures **shall** be proposed for APG alignment. **[M]**

PSR_3.2.7.1_8. APG units **shall** be easily accessible and have an MTBF of not less than 50,000 hours. **[M]**

PSR_3.2.7.1_9. The incremental information **shall** have at least the following specifications: **[M]**

(a) ACP (ε) at least 14 bit (16,384 pulses);

(b) NM: Identical in form to the ε pulses and in phase

PSR_3.2.7.1_10 The NM output **shall** be capable of being aligned within 1 ACP of the geographical North, either by electronic or by mechanical means. **[M]**

3.2.7.2 Antenna Drive

PSR_3.2.7.2_1. The system for the rotation of the Antenna at constant speed **shall** drive the Antenna at a nominal speed 12.3 ± 0.2 rpm. **[M]**

PSR_3.2.7.2_2. The Antenna rotation speed shall be user changeable parameter. Appropriate radar system equipment and procedures for changing the rotation speed **shall** be supplied. **[M]**

PSR_3.2.7.2_3. The Antenna Drive system **shall** be driven by duplicated motors. **[M]**

PSR_3.2.7.2_4. A single motor **shall** be capable of driving the Antenna **[M]**

PSR_3.2.7.2_5. If necessary for correct operation a clutch system (electrical (automatic) or mechanical (manual)) **shall** couple and/or uncouple the motor(s) to the reduction Gearbox. It shall be capable to work with a constant speed rotation between 12-15 rpm. **[M]**

PSR_3.2.7.2_6. The Contractor **shall** describe in the technical documentation the technical solution for coupling and uncoupling including outcoming constraints. **[M]**

PSR_3.2.7.2_7. The Antenna Drive System **shall** be provided with a safety switch to stop antenna rotation and to disable the RF output from the transmitter before accessing the antenna platform. **[M]**

PSR_3.2.7.2_8. A comprehensive BITE **shall** allow in depth monitoring and control of the Turning Gear and the motors status (fault, oil pressure failure, etc.). **[M]**

3.2.7.3 Rotary Joint

PSR_3.2.7.3_1. The Rotary Joint **shall** meet or exceed the electrical and mechanical requirements specified hereafter. **[M]**

(a) Number of channels

(i) PSR: at least 3, including Weather Channel(s),

(ii) MSSR Mode-S: at least 3 necessary interfaces.

(b) Minimum Power Handling Capacity

(i) PSR: For transmit/receive sections, in accordance with the operating philosophy of the PSR,

(ii) MSSR: In accordance with Enhanced Mode S requirements.

(c) Channel Isolation: Commensurate with the PSR and MSSR Mode-S detection performance requirements.

(d) Insertion Loss: Commensurate with the PSR and MSSR Mode-S power budgets.

(e) Maximum VSWR (Voltage Standing Wave Ratio): Commensurate with the PSR and MSSR Mode-S power budgets.

(f) Phase Shift (between Channels): Commensurate with the desired system stability(s).

(g) Duty Cycle

(i) PSR: dependent upon Transmitter operating philosophy

(ii) MSSR Mode-S: commensurate with Enhanced Mode S operation

PSR_3.2.7.3_2. **Mechanical Constraints**: Rotary Joint sections listed in PSR_3.2.7.3_1 (a) **shall** be constructed with non-contacting joints, and **shall** transfer energy without change of polarisation through 360 ° joint rotation. **[M]**

PSR_3.2.7.3_3. The Rotary Joint **shall** be capable of rotating at speeds up to 15 rpm and shall be self-supporting. It shall not require external components to maintain mechanical alignment. **[M]**

PSR_3.2.7.3_4. The Rotary Joint **shall** have an MTBF of not less than 50,000 hours and shall be easily maintained or replaced without specialised equipment. **[M]**

3.2.8 Transmitter Requirements

3.2.8.1 System Stability

PSR_3.2.8.1_1. The Transmitter phase stability **shall** be commensurate with the requirements of [Para 3.1]. **[M]**

PSR_3.2.8.1_2. The Contractor in the technical documentation **shall** give figures for the Transmitter phase shift and the limitation due to phase instability. **[M]**

3.2.8.2 Other Performance Characteristics

PSR_3.2.8.2_1. The Contractor in the technical doucmentation **shall** provide following details: **[M]**

a) Transmitter operating philosophy, including frequency source details,

b) Transmitter peak power and duty cycle,

c) Pulse width(s),

d) Pulse shaping,

e) Pulse Compression type and technique,

f) Transmitter spectrum characteristics and purity,

g) Normal PRI (Pulse Repetition Interval) range.

3.2.9 Receiver(s)

3.2.9.1 Dynamic Range

PSR_3.2.9.1_1. The Receiver(s) **shall** have the dynamic range at least 60 dB and linearity commensurate with the requirements of [Para 3.1]. **[M]**

PSR_3.2.9.1_2. The Receiver dynamic range **shall** be stated in the technical documentation. **[M]**

3.2.9.2 MDS (Minimum Detectable Signal)

PSR_3.2.9.2_1. The Contractor **shall** clearly state in the technical documentation the MDS level of his Receiver, together with the Receiver noise factor for this parameter. **[M]**

PSR_3.2.9.2_2. The MDS **shall** be commensurate with the requirements of [Para 3.1]. **[M]**

PSR_3.2.9.2_3. The Contractor **shall** state in the technical documentation the method of measurement used in the determination of the MDS of his Receiver. **[M]**

3.2.9.3 NF (Noise Figure)

PSR_3.2.9.3_1. The Contractor **shall** state in the technical documentation the overall NF **[M]**

PSR_3.2.9.3_2. The NF monitoring technique **shall** be described in the technical documentation. **[M]**

PSR_3.2.9.3_3. The NF **shall** be permanently monitored by the BITE. **[M]**

3.2.9.4 RF Gain Control – STC (Sensitivity Time Control)

PSR_3.2.9.4_1. The STC **shall** be programmable in range and azimuth based on a high resolution map. **[M]**

PSR_3.2.9.4_2. The Contractor **shall** describe in details in the technical documentation the STC techniques applied **[M]**

3.2.9.5 Other Performance Characteristics

PSR_3.2.9.5_1. The Contractor **shall** provide in the technical documentation following details: **[M]**

(a) Receiver operating philosophy

(b) Receiver(s) pass-band characteristics and out of band suppression

(c) Pulse compression techniques with special attention being given to the time-sidelobe levels and their influence on target resolution, especially in the upper / lower beam switching regions.

PSR_3.2.9.5_2. The compression sidelobes **shall** be stated in the technical documentation. **[M]**

3.2.10 Signal Processor

PSR_3.2.10_1. An all-digital Signal Processor of advanced design **shall** be provided for each Radar Channel and shall operate to the end of range. **[M]**

The Signal Processor: **[M]**

PSR_3.2.10_2. (a) **shall** perform the analogue-to-digital encoding of the I and Q videos if not already done at "Receiver" level, **[M]**

PSR_3.2.10_3. (b) **shall** perform MTD type digital filtering in order to eliminate ground and rain clutter. The Contractor **shall** describe in detail in the technical documentation the principles of his MTD processing and the choice of the number of MTD (Doppler) filters. To optimise the S/C (Signal to Clutter Ratio) **it is preferable** that adaptive weighting of the filter characteristics can be applied, **[M]**

PSR_3.2.10_4.	(c) **shall** perform CFAR (Constant False Alarm Regulation),	**[M]**
PSR_3.2.10_5.	(d) **shall** perform magnitude computation,	**[M]**
PSR_3.2.10_6.	(e) **shall** perform timing and generation of the RAG (Range-Azimuth Gate) Maps used,	**[M]**
PSR_3.2.10_7.	(f) **Shall** perform, where applicable, the generation of primitive target reports,	**[M]**
PSR_3.2.10_8.	(g) **Shall** perform, where applicable, positional integration and plot formatting,	**[M]**
PSR_3.2.10_9.	(h) **Shall** perform zero velocity thresholding and filtering, in particular for the detection of tangentially flying targets (super-clutter visibility),	**[M]**
PSR_3.2.10_10.	(i) **Shall** use high-resolution Range-Azimuth mapping/processing techniques to ensure the required Pd and Pfa limits.	**[M]**

3.2.11 Weather Data Processing

3.2.11.1 General Design Characteristics

PSR_3.2.11.1_1.	Weather Data **shall** be derived by an orthogonal output from the polarizer and a low power RF Channel in the Rotary Joint. In any case, even with circular polarisation applied, the detection of Weather reports down to Level 1 (NWS) **shall** be assured.	**[M]**
PSR_3.2.11.1_2.	When using circular polarization the Weather processor **shall** be fed from orthogonal output from the polarizer, when using linear polarization the Weather processor **shall** be fed from target channel.	**[O]**
PSR_3.2.11.1_3.	The Weather Data Channel **shall** be processed by a dual Weather Data Processor, each one dedicated to the corresponding receiving and processing chains.	**[M]**
PSR_3.2.11.1_4.	The output of the Weather Data Processors **shall** be cross-linked to each SDFC (i.e. each Weather Data Processor **shall** feed both SDFCs).	**[M]**
PSR_3.2.11.1_5.	The output of the Weather Data Channel **shall** provide 6 levels of weather data calibrated according to NWS Standard.	**[M]**
PSR_3.2.11.1_6.	The resolution of the weather data detection and presentation shall be at least 1 Nm in range and 3 dB beam width in azimuth in whole radar coverage envelope described in [Para 3.1.1].	
PSR_3.2.11.1_7.	The Contractor **shall** describe in the technical documentation the techniques used for weather detection and processing.	**[M]**

PSR_3.2.11.1_8. Output weather data **shall** be transmitted in ASTERIX format using Polar Vectors representation. **[M]**

PSR_3.2.11.1_9. Weather data processing chain of the radar system **shall** provide capability for radar data smoothing in order to improve reflection of real contours of the weather. **[M]**

PSR_3.2.11.1_10 The radar **shall** have the operational parameter giving the possibility enable and disable radar data smoothing function without influence on radar continuous operation. **[M]**

3.2.11.2 Compensation Techniques

PSR_3.2.11.2_1. The Contractor **shall** describe in the technical documentation the features (and their impact) used to compensate the effects of : **[M]**

(a) STC,

(b) beam selection,

(c) MTD,

(d) Pulse Compression,

(e) circular polarisation,

(f) other losses.

3.2.12 Site Dependent Parameters

PSR_3.2.12_1. Site Dependent Parameters (SDPs) **shall**, wherever practical, be set by link settings, switches or stored in a suitable non-volatile medium. **[M]**

PSR_3.2.12_2. SDPs **shall** not be hard-coded within any software of the system. **[M]**

PSR_3.2.12_3. The adjustment of any SDPs **shall** not require any alteration or recompilation of the software. **[M]**

PSR_3.2.12_4. SDPs contained in a suitable medium **shall** be easily adjustable, for example via a connected terminal, or the local display facility or CAM. **[M]**

PSR_3.2.12_5. It **shall** be possible to display and edit all operational and ‘key’ site dependent parameters. **[M]**

PSR_3.2.12_6. The CAM facility **shall** be employed to re-configure operational parameters at the radar station. **[M]**

PSR_3.2.12_7. Parameters that may be altered via a connected terminal, require **[M]** protection as follows:

(a) It **shall** only be possible to change parameters with the relevant system in 'local mode';

(b) Unauthorised or inadvertent alterations **shall** be prevented, e.g. by password entry;

PSR_3.2.12_8. The design approach **shall** be capable of ensuring that SDPs will not change in the event of a 'switch-over' of the active channel. **[M]**

4. MONOPULSE MODE-S SECONDARY SURVEILLANCE RADAR

4.1 SCOPE

4.1.1 Equipment to be Supplied

SSR_4.1.1_1. The following items **shall** be supplied with the Mode S system: **[M]**

(a) Antenna and turning gear system (collocated with PSR),

(b) Interrogator,

(c) Processing (SMF, DLF, SCF),

(d) Far field site monitor (the test transponder),

(e) All Dedicated Terminals required for parameter configuration.

SSR_4.1.1_2. The system **shall** be provided with dual channel functionality for items (b), (c) and (e) above. **[M]**

SSR_4.1.1_3. The system **shall** be designed to be located in a building/shelter which has been constructed and equipped for the purpose of containing the MSSR Mode S system and the primary radar. **[M]**

SSR_4.1.1_4. The Contractor **shall** provide all necessary interface functionality to support the MSSR Mode S system to be collocated with a primary surveillance radar (PSR). **[M]**

4.2 SYSTEM DESCRIPTION

4.2.1 General

SSR_4.2.1_1. The Mode S ground station **shall** primarily meet all the requirements of [Ref.1] and those described in the Mode S Subnetwork SARPS followed by the requirements as detailed in this document. **[M]**

SSR_4.2.1_2. Each ground station **shall** support the following functions: **[M]**

(a) interrogation, detection and acquisition of Mode S, 3/A and C to comply with [Ref.1]

(b) addressed surveillance and standard length communication transactions as described in [Ref.1]

(c) Extended length communication transactions as defined in [Ref.1]

(d) Aircraft Identification Protocol,

(e) Data link function.

SSR_4.2.1_3. The ground station **shall** manage the following: **[M]**

(a) Mode S specific services to minimise the use of the RF channel e.g. combining identical requests;

(b) The Mode S packets (e.g. prioritise packets, delay the frame processing in order to achieve maximum benefit from multiplexing);

(c) Uplink and downlink broadcasts.

SSR_4.2.1_4. The MSSR ground **shall** work in Mode S: **[M]**

(a) Elementary Surveillance (ELS);

(b) Enhanced Surveillance (EHS).

4.2.2 Cluster Operation

SSR_4.2.2_1. The capability to interrogate and set lockout for an SI code and decode and process replies from an SI capable transponder **shall** be provided in the ground station. **[M]**

SSR_4.2.2_2. A Surveillance Co-ordination Function (SCF) shall be incorporated into ground station, as described in [Para 4.7], and **shall** provide: **[M]**

(a) Network control and management including failure detection and resolution;

(b) Co-ordination procedures, as defined in [Ref.10], between coverage areas of networked ground stations to allow targets to be acquired without need for All-Call;

(c) Track data to adjacent stations upon request.

SSR_4.2.2_3. When operating as part of a cluster the stations operation is termed 'network-aided'. This operation **shall** support the following modes: **[M]**

(a) Central mode where the coverage map and II/SI code are determined by a cluster controller (CC) as described in Appendix A of [Ref.10];

(b) Distributed mode where the Ground station SCFs co-ordinate to ensure correct cluster operation, as defined in [Ref.10].

SSR_4.2.2_4. In addition to 'network-aided' operation the SCF shall also support 'stand-alone' operation where each station **shall** operate independently from cluster. **[M]**

SSR_4.2.2_5. The data format to be used over the Surveillance Co-ordination Network **shall** be as described in [Ref.6]. **[M]**

SSR_4.2.2_6. The Mode S ground station **shall** be capable of forming a cluster with any Mode S ground station whose network interface comply with [Ref.10]. **[M]**

4.2.3 II/SI code oparation

SSR_4.2.3_1. The system, when operating with an SI code and if enabled by an operational parameter, **shall** also acquire targets through all-call replies which are encoded using the "matching" II code. This transponder shall be considered as a non SI equipped transponder **[M]**

SSR_4.2.3_2. Even if the content of BDS 1,0 states that the transponder has the SI capability, if this transponder is detected as using the "matching" II code to encode the parity sequence of the replies, it **shall** be considered as a non SI equipped transponder. **[M]**

SSR_4.2.3_3. The system, if operating with an SI code and if enabled by an operational parameter, **shall** interrogate targets equipped with non SI transponders using the Mode S selective protocols foreseen for II code operation. The II code to be used shall be the "matching" II code **[M]**

SSR_4.2.3_4. The system, if operating with an SI code and if enabled by an operational parameter, **shall** be configurable by the user to either: **[M]**

(a) not lockout non SI transponders on the "matching" II code ;

(b) use intermittent lockout for this "matching" II code.

SSR_4.2.3_5. The system, if operating with an II code and if enabled by an operational parameter, **shall** be configurable by the user to either:

(a) not lockout Mode S transponders which do not report the SI capability in BDS 1,0 ; **[M]**

(b) use intermittent lockout for Mode S transponders which do not report the SI capability in BDS 1,0.

SSR_4.2.3_6. When this additional system management function is activated, the lockout maps **shall** not be taken into account for non SI equipped transponders. **[M]**

4.3 GENERAL EQUIPMENT AND PERFORMANCE REQUIREMENTS

4.3.1 Performance Requirements

SSR_4.3.1_1. The performance requirements specified in the following paragraphs are the minimum operational performance requirements. They **shall** be met with all site dependant operational parameters set following commissioning including antenna tilt, gain time control and any other variable thresholds. **[M]**

SSR_4.3.1_2. The Mode S sensor **shall** process transponders compliant with ICAO Annex 10 Amendment 69, 71 and 73. **[M]**

SSR_4.3.1_3. The Mode S sensor **shall** solicit and detect replies from Mode 3/A,C only and Mode S transponders within the specified coverage subject to the system performance requirement detailed in this paragraph. **[M]**

SSR_4.3.1_4. For aircraft tracked with selective Mode S interrogations the Mode S ground station **shall** extract Mode C information from those Mode S transponder equipped aircraft on every scan, in addition to any Mode 3/A code update subject to the system performance requirement detailed in this paragraph. **[M]**

SSR_4.3.1_5. The performance requirements **shall** be met for the operational configurations (IRF vs. range/turning rate) of the sites to be commissioned. **[M]**

4.3.1.1 Radar Coverage

SSR_4.3.1.1_1. The MSSR Mode S Radar **shall** provide continuous, gap-free cover through 360° of azimuth and over a range of 0.5 NM to at least 256 NM excluding shadings by artificial constructions and terrain obstacles. **[M]**

SSR_4.3.1.1_2. The upper limit of coverage volume **shall** be at least 66,000 ft (FL660). The lower limit of coverage shall be at least: **[M]**

(a) down to the ground level up to the RHD (Radar Horizon Distance),

(b) down to the 2000ft up to 50NM,

(c) down to the 5000ft up to 70 NM,

(d) down to the 9000ft up to 110 NM.

SSR_4.3.1.1_3. The zenithal gap, **shall** not extend below an elevation angle of 45° above the horizontal. **[M]**

SSR_4.3.1.1_4. The antennas performance shall be such that with a receiver STC of 42dB at 0.25 NM, the zenithal gap **shall not** extend below an elevation angle of 45°. **[M]**

4.3.1.2 Position Detection Performance

SSR_4.3.1.2_1. The European Surveillance Standard recommends that the SSR probability of detection for surveillance should be greater than 97% and code validations of 98% and 96% for Modes 3/A and C respectively. The above figures **shall** be met by the Mode S equipment for the overall coverage area. **[M]**

SSR_4.3.1.2_2. On a site, with the parameters used for the commissioning of the radar, the SSR probability of detection **shall** be at least 99% for the set of aircraft: **[M]**

(a) Which are in the Measurement Volume where the Measurement Volume is defined as the area below the flight level 500, above the flight level 100 until 100 NM, above the flight level 200 between 100 NM and 135 NM, above the flight level 300 between 135 NM and 170 NM;

(b) Which are not in the zenithal gap (elevation angle below 40);

(c) Which are not in close proximity (slant range > 2 NM, azimuth > 2 * nominal 3dB interrogation beamwidth).

SSR_4.3.1.2_3. On a site, with the parameters used for the commissioning of the radar, the Mode S probability of detection **shall** be at least 99% for the set of aircraft: **[M]**

(a) Which are in the Measurement Volume (as in the requirement above);

(b) Which are not in the zenithal gap (elevation angle below 40);

(c) Which are not in close proximity to each other (slant range > 5.3 NM, azimuth > 2 * nominal 3dB interrogation beamwidth).

SSR_4.3.1.2_4. On site, the probability of detection **shall** be measured when the station does not operate network aided and without using any external data from the adjacent sensors. **[M]**

4.3.1.3 Code Detection without Synchronous Garbling

SSR_4.3.1.3_1. The Mode S system **shall** detect all Mode 3/A, C, as defined in [Ref.1] and **shall** perform a credibility check to remove the possibility of delivering erroneous data to the surveillance users. **[M]**

SSR_4.3.1.3_2. All of the height codes defined in Appendix 1 of [Ref.1] **shall** be translated from the corresponding mode C responses and any codes outside the range of values in Appendix 1 shall not be translated from any mode C responses. **[M]**

SSR_4.3.1.3_3. As a minimum, the overall Mode 3/A probability of correct and valid code detection **shall** be better than 98% for large samples (min 6 hours), without any geographical restrictions, of opportunity traffic. **[M]**

SSR_4.3.1.3_4. As a minimum, the overall Mode C probability of correct and valid code detection **shall** be better than 96% for large samples (min 6 hours), without any geographical restrictions, of opportunity traffic. **[M]**

SSR_4.3.1.3_5. As a maximum the percentage of incorrect but validated Mode A codes **shall** be lower than 0.1%. **[M]**

SSR_4.3.1.3_6. As a maximum, the percentage of incorrect but validated Mode C codes **shall** be lower than 0.1%. **[M]**

SSR_4.3.1.3_7. As a minimum, the ratio of the number of times a target is detected and output with all reply data correct compared to the number of times a target is detected and output **shall** be at least 99% for all targets replying in Mode S. **[M]**

SSR_4.3.1.3_8. No more than one message segment containing false data of a Comm-B or Comm-D reply **shall** be delivered from the Mode S system in 10^7 **[M]**

messages.

SSR_4.3.1.3_9. In case of special codes the following rules **shall** apply: **[M]**

(a) The special civil codes 7500, 7600 and 7700 shall be detected and recognised, as defined in [Ref.1].

(b) The above codes shall be output immediately upon detection, and not subject to any delay.

(c) The appropriate identifier bits as specified in [Ref.5](a)shall be set in the output message.

4.3.1.4 False and Multiple Target Processing

SSR_4.3.1.4_1. The false target report ratio is the number of false target reports in relation to the number of detected target reports. The overall false target report ratio **shall** be less than 0.1%. **[M]**

SSR_4.3.1.4_2. The overall Multiple Mode S/SSR Target Rate, measured over one hour, **shall** be less than one target per scan on average. **[M]**

SSR_4.3.1.4_3. The multiple target processing **shall** discriminate between false and real, non-unique addressed Mode S targets. The latter shall be flagged in the ASTERIX data item I048/030 Warning Error/Conditions bit 16 "Duplicated or Illegal Mode S Aircraft Address". **[M]**

4.3.1.5 Surveillance Position Accuracy

SSR_4.3.1.5_1. The Mode S sensor slant range errors, for any modes (3/A, C or S), **shall** be within the following limits: **[M]**

(a) Systematic Errors

(i) The slant range bias shall be < 1/128 NM (14 metres).

(b) Random Errors

(i) All SSR Random errors shall be less than 30 m RMS (1 sigma);

(ii) All Mode S Random errors shall be less than 15 m RMS (1 sigma).

SSR_4.3.1.5_2. All detected targets within the stated coverage volume for any modes (3/A, C or S), measured using opportunity traffic or controlled test transponders **shall** be within the following limits: **[M]**

(a) Systematic Errors

(i) The azimuth bias for elevation angles between 0 and +6° **shall** be less than 1 AU (0.022°) where 1 AU represents 360/16384°).

(ii) The azimuth bias for elevation angle values between 6 and +10° **shall** be lower than 0.033° (excluding ice and wind effects on the antenna).

(b) Random Errors

(i) All azimuth random errors **shall** be less than 0.068° (one sigma)

SSR_4.3.1.5_3. The azimuth bias **shall** not increase at elevation angles more than 10°. **[M]**

SSR_4.3.1.5_4. The bias null adjustment in range and azimuth **shall** be applied by site dependent adaptation values. **[M]**

SSR_4.3.1.5_5. The bias adjustments for the redundant channels **shall** be capable of being applied separately and independently such that the system bias requirements are met irrespective of the channel in use. (e.g., the data from either channel must meet the system requirement.). **[M]**

SSR_4.3.1.5_6. Once the system bias values are nulled, the long term measured bias value (bias drift) **shall** remain within the specified limits, irrespective of the channel in use. **[M]**

SSR_4.3.1.5_7. The angular offset **shall** be adjusted in order to calibrate the angular measurement of the Mode S system to within 1AU (i.e. AU = 0.022°). **[M]**

SSR_4.3.1.5_8. Target range **shall** be reported to a precision of at least 1/128 NM at all ranges. **[M]**

SSR_4.3.1.5_9. Target azimuth **shall** be reported to a precision of at least 360/16384 (0.022)° at all ranges and azimuths. **[M]**

SSR_4.3.1.5_10. Jumps are defined in [Ref.11] as being reports with positional error higher than 1° in azimuth or 700 m in range. The overall jump rate, being the number of jumps divided by the number of detected reports, **shall** be less than 0.05%. **[M]**

4.3.1.6 Target Processing

SSR_4.3.1.6_1. The system **shall** be capable of processing up to four discrete, mutually overlapping replies simultaneously rejecting all possible phantoms produced by them, including C2/SPI phantoms. **[M]**

SSR_4.3.1.6_2. Genuine targets, including relative targets with C2/SPI spacing, **shall** not be rejected as phantoms. **[M]**

SSR_4.3.1.6_3. Within a separation window area of 0 NM to less than 0.05 NM in range and 0 to 0.6° in azimuth, the overall probability of detecting two SSR targets **shall** be at least 60%. **[M]**

SSR_4.3.1.6_4. Within a separation window area of greater than 0.05 NM to less than 2 NM in range and by less than 0.6° in azimuth, the overall probability of detecting two SSR targets **shall** be at least 98%. **[M]**

SSR_4.3.1.6_5. Within a separation window area less than 2 NM in range and by more than 0.6° and by less than 4.8° in azimuth, the overall probability of detecting two SSR targets **shall** be at least 98%. **[M]**

SSR_4.3.1.6_6. Outside the separation window areas as defined above, the SSR probability of detection **shall** be the same as described in [Para 4.3.1.2] **[M]**

SSR_4.3.1.6_7. Whatever the relative position of both targets, the radar **shall** maintain the Probability of detection specified in [Para 4.3.1.2] when using Mode-S selective surveillance interrogations. **[M]**

SSR_4.3.1.6_8. Within a separation window area of 0 NM to less than 0.05 NM in range and 0 to 0.6° in azimuth, the overall probability of detecting two SSR targets with correct and valid Mode 3/A, Mode C codes **shall** be at least 30%. **[M]**

SSR_4.3.1.6_9. Within a separation window area of greater than 0.05 NM to less than 2 NM in range and by less than 0.6° in azimuth, the overall probability of detecting two SSR targets with correct and valid Mode 3/A, Mode C codes **shall** be at least 90%. **[M]**

SSR_4.3.1.6_10. Within a separation window area less than 2 NM in range and by more than 0.6° and by less than 4.8° in azimuth, the overall probability of detecting two SSR targets with correct and valid Mode 3/A, Mode C codes **shall** be at least 98%. **[M]**

SSR_4.3.1.6_11. Whatever the relative position of both targets, the radar **shall** maintain the decoding probability and reply integrity specified in 4.3.1.3 for all Mode S selective interrogations. **[M]**

SSR_4.3.1.6_12. The radar systems offered **shall** be capable of processing at least the following number and distribution of targets (Figure 14) from 0.5 NM to **[M]**

256 NM instrumented range with a rotating antenna turning rate of at least 12 rpm:

(a) A steady state maximum of 900 transponder equipped aircraft in cover;

(b) A large sector peak of 45° containing 25% of the total number of aircraft. Only one large sector peak shall be present in each 90° quadrant;

(c) A small sector peak of 3.5° containing 6% of the total number of aircraft. Two small sector peaks, centrally located within each of two large sector peaks separated by 180° shall be the maximum number of small peaks occurring.

SSR_4.3.1.6_13 The system **shall** be able to maintain the tracks of up to 12 targets simultaneously through the "Cone of Silence" using historical data, so as to facilitate target to track correlation following the targets exit from the Cone of Silence. **[M]**

SSR_4.3.1.6_14 The Mode S station **shall** be designed to optimise the number of transactions (i.e. minimising the number of interrogations/replies required for the particular protocol whilst also making most efficient use of the available channel time) by using techniques such as interleaving, azimuth offset and interrogation combination. **[M]**

SSR_4.3.1.6_15 If the aircraft indicates in a surveillance reply that data (including Mode A code and Flight ID) is waiting to be extracted from the transponder, the ground station **shall** be able to extract the data during the same beam dwell, unless the surveillance reply is received in the last roll-call period of the beam dwell. **[M]**

SSR_4.3.1.6_16 In the case of absence of a reply to a Comm-A interrogation also used for surveillance purpose, the system **shall** re-interrogate the aircraft with separated surveillance (UF4, 5) and Comm-A interrogations (UF20, 21), and shall attempt to schedule these new interrogations in the same scan. **[M]**

SSR_4.3.1.6_17 For Mode S targets, the system **shall** extract the Mode A code and BDS 2,0 on acquisition and on change. **[M]**

SSR_4.3.1.6_18 Mode A code and BDS 2,0 **shall** automatically be extracted by the station when the last measured position of the track is older than 18 seconds. **[M]**

SSR_4.3.1.6_19 The total system delay from illumination of the target by the antenna boresight to transmission of the target report to the SDFC under full load conditions **shall** not exceed a time equivalent to 120° of an LVA antenna rotation and **shall** not exceed more than 2 seconds independent of the turning rate as defined in [Ref.11] whichever is shorter. **[M]**

SSR_4.3.1.6_20 Each part of the radar system processing **shall** be monitored for overload conditions which shall be reported on CAM locally and remotely. **[M]**

SSR_4.3.1.6_21 The system **shall** be able to cope with, and to recover to normal operations from, any overload caused by input loading plots. **[M]**

4.3.2 General Requirements

4.3.2.1 Equipment Qualification

SSR_4.3.2.1_1. The Mode S Interrogator, Receiver, Antenna, System Management Function, Surveillance Coordination Function, Data Link Function, Control Monitoring and Local Display System **shall** be supplied as a fully integrated system. **[M]**

4.3.2.2 Configuration

SSR_4.3.2.2_1. The system to be supplied **shall** be dual channel, complete with changeover capability, controlled both locally and remotely by the CAM. **[M]**

SSR_4.3.2.2_2. Each channel of the dual channel Mode S station **shall** operate in any of the three operating modes as follows: **[M]**

(a) Active: the equipment is used for the operation of the station.

(b) Stand-by: the redundant equipment is switched on and normally available for operation, i.e. a reconfiguration, automatic or controlled, can take place.

(c) Maintenance: the equipment is under maintenance and is not available for operation.

SSR_4.3.2.2_3. For dual channel configurations any fault state **shall** be reported to CAM. **[M]**

SSR_4.3.2.2_4. In a dual channel system there is only one channel which **shall** be Active at the same time. **[M]**

SSR_4.3.2.2_5. Switching from a Stand-by mode to an Active mode **shall** be performed according to a 'cold switch-over' procedure by an operator command or by a 'hot switchover ' when the Active equipment fails. **[M]**

SSR_4.3.2.2_6. Switching from Active to Stand-by mode **shall** be performed by a 'cold switch-over' procedure, by an operator command. **[M]**

SSR_4.3.2.2_7. The normal procedure for switching to Maintenance mode **shall** be performed from the Stand-by mode, by an operator command. When exiting the Maintenance mode, switching is always performed to Stand-by. **[M]**

SSR_4.3.2.2_8. Exiting the Maintenance Mode **shall** be possible by two mutually exclusive modes: 1) via the CAM; or 2) locally by operator command authorised from the front panel. **[M]**

SSR_4.3.2.2_9. The 'hot switch-over' procedure **shall** correspond to a failure of an Active equipment, where an automatic reconfiguration of the processing occurs through switching. **[M]**

SSR_4.3.2.2_10. In case of 'hot switch over' the failing channel **shall** be automatically switched to Maintenance mode. **[M]**

SSR_4.3.2.2_11. In the case of a failure a 'hot switch-over' **shall** be inhibited in case of additional failure of the now active channel. **[M]**

SSR_4.3.2.2_12. The switching **shall** be effective within one antenna revolution after the fault has been detected and comply with the requirements of [Para 4.5.5].

SSR_4.3.2.2_13. The 'cold switch-over' procedure corresponds to the controlled switching of all the processing chains (in local or remote mode). It **shall** guarantee that no data, essential for surveillance, is lost during the switching. **[M]**

SSR_4.3.2.2_14. The 'cold switch-over' **shall** take one antenna revolution to perform from operator input. **[M]**

4.3.2.3 Interference

SSR_4.3.2.3_1. The Interrogator, Receiver and the System Management Function **shall** both withstand and recover, with minimum delay, from the effects of cw interference. **[M]**

SSR_4.3.2.3_2. At no time **shall** cw interference saturate or overload any part of the Mode S Ground System. **[M]**

SSR_4.3.2.3_3. Following the removal of the detected cw interference replies **shall** be detected, decoded and processed 2ms after the end of the interference. **[M]**

4.3.2.4 Processing Capacity

SSR_4.3.2.4_1. The processing system **shall** be designed in a way to fully provide the necessary processing capacity with appropriate amount of spare resources. **[M]**

4.3.2.5 System Response Time

SSR_4.3.2.5_1. For an Mode S system, the maximum time between the start-up command of a ground station and the sending of a report on the surveillance line, regardless of the ON/OFF power states of the turning gear and electronics, **shall** not exceed one minute + two scans period after passing North. **[M]**

SSR_4.3.2.5_2. For a Mode S system, the maximum time between the start-up command of a ground station and the sending of a report on the surveillance line, with the antenna rotating at its operational rate and with no power applied to the rest of the Mode S system, **shall** not exceed 21 s + three scans period after passing North. **[M]**

4.3.2.6 System Recovery

SSR_4.3.2.6_1. Upon the restoration of any of the inputs listed below, following a failure of that input, and irrespective of the duration of the failure, the ground station **shall** be fully restored to the operating conditions that applied before the failure occurred, without the need for any manual intervention: **[M]**

(a) Azimuth data;

(b) External data clocks;

(c) Mains power supply;

(d) RF and SMF interfaces;

(e) Station CAM.

4.3.2.7 System Expansion

SSR_4.3.2.7_1. The systems load capacities **shall** be expandable to accommodate further growth in air traffic movements. **[M]**

SSR_4.3.2.7_2. The design architecture **shall** be capable of supporting the above expansion requirements. **[M]**

4.3.2.8 Target Velocity Limits

SSR_4.3.2.8_1. Mode S radar **shall** be capable of detecting and processing aircraft operating to the following performance parameters, in any combination. **[M]**

(a) A steady state speed from 0 kn to 2000 kn;

(b) A vertical rate of climb or descent, as reported by the received Mode C data from 0 ft/min to 25000 ft/min;

(c) A vertical rate of climb as in (b) with no horizontal displacement;

(d) A straight line acceleration/deceleration from any initial velocity in the range 0-2000 kn, from 0.01g to 5g, to achieve a steady state speed of between 0-2000 kn.

4.3.2.9 Site Dependent Parameters

SSR_4.3.2.9_1. Site Dependent Parameters (SDPs) **shall**, wherever practical, be set by link settings, switches or stored in a suitable non-volatile medium. **[M]**

SSR_4.3.2.9_2. SDPs **shall** not be hard-coded within any software of the system. **[M]**

SSR_4.3.2.9_3. The adjustment of any SDPs **shall** not require any alteration or recompilation of the software. **[M]**

SSR_4.3.2.9_4. SDPs contained in a suitable medium **shall** be easily adjustable, for example via a connected terminal, or the local display facility or CAM. **[M]**

SSR_4.3.2.9_5. It **shall** be possible to display and edit all operational and 'key' site dependent parameters. **[M]**

SSR_4.3.2.9_6. The CAM facility **shall** be employed to re-configure Agency designated operational parameters at the ground station. **[M]**

SSR_4.3.2.9_7. Parameters that may be altered via a connected terminal, require protection as follows: **[M]**

(a) It **shall** only be possible to change parameters with the relevant system in 'local mode';

(b) Unauthorised or inadvertent alterations **shall** be prevented, e.g. by password entry;

SSR_4.3.2.9_8. The radar system **shall** be constructed in the way that SDPs will not change in the event of a 'switch-over' of the active channel. **[M]**

4.3.3 Radar System Overview

4.3.3.1 System Interfaces

SSR_4.3.3.1_1. The Mode S system **shall** provide interfaces for: **[M]**

(a) SDFC;

(b) Networked Mode S stations;

(c) Data-Link users;

(d) The Control And Monitoring System;

(e) A playback and recording facility;

(f) An RF analysis facility.

SSR_4.3.3.1_2. In accordance with the above the Mode S system **shall** conform to the **[M]**

requirements of:

(a) [Ref.5]

(b) [Ref.6]

(c) [Ref.9]

(d) [Ref.10]

(e) [Ref.17]

SSR_4.3.3.1_3. The ASTERIX formats described in [Ref.5] and [Ref.6] are likely to evolve; the current version **shall** be used. **[M]**

4.4 ANTENNA SYSTEM

4.4.1 LVA Requirements

SSR_4.4.1_1. The Contractor **shall** provide a Large Vertical Aperture (LVA) (Figure 3) antenna, providing monopulse sum and difference channels with an additional omnidirectional control channel, suitable for SSR and Mode S, that enables the requirements of this specification to be met in all respects. **[M]**

SSR_4.4.1_2. The Support Structure and/or the Antenna Structure **shall** include provisions for tilting the Antenna Structure so that it can be raised 5° and lowered 5° with respect to the horizontal plane. **[M]**

SSR_4.4.1_3. The Antenna Tilt Mechanisms **shall** be accessible, and easily operable without special tools, by one technician. **[M]**

SSR_4.4.1_4. The Antenna **shall** be capable of rotating at any speed up to 15 rpm without structural failure. **[M]**

SSR_4.4.1_5. In order to minimise the forces and torque applied to Antenna Support Structure, the LVA **shall** be of a construction designed to reduce wind resistance. **[M]**

4.5 INTERROGATOR SYSTEM

4.5.1 General

4.5.1.1 Introduction

SSR_4.5.1.1_1. The interrogator (Figure 4) **shall** consist of: **[M]**

(a) A transmitter, providing sum and control channel output;

(b) A monopulse receiver, accepting sum, difference and control channel input;

(c) A video signal process that provides processed Sum, RSLS and OBI signals;

(d) An RF changeover unit to allow the standby channel to become the active channel.

4.5.1.2 Functions

SSR_4.5.1.2_1. The interrogator **shall** have the following capabilities: **[M]**

(a) Interrogation and reception on Modes 3/A, C, S ;

(b) Mode S only all-call preceding either a Mode 3/A or Mode C interrogation by between 45 microseconds and 128 microseconds timed from the sync phase reversal to the leading edge of the P3, Mode 3/A, C;

(c) Operation on 3 mode interlace programmes, including stochastic All-Call and lockout override;

(d) Operation in azimuth selectable improved interrogator sidelobe suppression (IISLS) for Mode 3/A,C or intermode;

(e) Operation of receiver sidelobe suppression (RSLS);

(f) Output of data suitable for plot processing;

(g) Control of all main functions of the interrogator provided locally and remotely via the CAM interface;

(h) To receive interrogation modulation commands from the RTCC or external test equipment.

SSR_4.5.1.2_2. The Contractor **shall** describe in the technical documentation interrogator necessary output signals for control and maintenance purposes. **[M]**

4.5.2 Transmitter

SSR_4.5.2_1. The transmitter **shall** issue all SSR and Mode-S interrogations in accordance with [Ref.1]. **[M]**

SSR_4.5.2_2.	The transmitter **shall** not require any adjustment or setting up following replacement of any unit.	**[M]**
SSR_4.5.2_3.	The transmitter **shall** not require any regular or preventative maintenance of any unit.	**[M]**
SSR_4.5.2_4.	As a minimum, the transmitter **shall** be capable of operating at a peak duty cycle of 63.7% over 2.4ms length of time. It is expected that the requirement can be repeated every 24ms.	**[M]**
SSR_4.5.2_5.	The transmitter **shall** be capable of operating at a duty cycle of at least 5% over a whole scan.	**[M]**
SSR_4.5.2_6.	The SSR/All-Call period **shall** be used for the surveillance of Mode A/C transponder equipped aircraft and the acquisition of Mode S transponder equipped aircraft.	**[M]**
SSR_4.5.2_7.	The Selective Interrogation period **shall** be used for the Mode S Roll-Call surveillance and data link transactions.	**[M]**
SSR_4.5.2_8.	The internal IRF for the SSR/All call period **shall** be adjustable from 50Hz to 250Hz with increments no greater than 1Hz.	**[M]**
SSR_4.5.2_9.	The SSR/All Call period **shall** be staggered.	**[M]**
SSR_4.5.2_10.	A Mode S only All-Call interrogation **shall** occur once every 'm' SSR/All-Call periods, where 'm' shall be a site configurable parameter between 1 to 9 in steps of 1.	**[M]**
SSR_4.5.2_11.	Stochastic lockout over-ride **shall** be selectable to acquire aircraft (Figure 11).	**[M]**
SSR_4.5.2_12.	The radar **shall** be designed to have sophisticated and flexible mode interlace capability in order to achieve maximum radar's performances as described in [Para 4.3.1.2] for the real traffic using Mode A/C and S including mixed mode (simultaneous Mode S and Mode A/C detection) operation.	**[M]**
SSR_4.5.2_13.	Change in interlace **shall** be applied on the North crossing.	**[M]**
SSR_4.5.2_14.	The peak transmitter power output on both the sum and control channels **shall** be determined from the max. range requirement described in [Para 4.3.1.1].	**[M]**
SSR_4.5.2_15.	It **shall** be possible to vary the interrogate and control output power, on each selective interrogation, according to the range of the target.	**[M]**
SSR_4.5.2_16.	It **shall** be possible to programme as a function of azimuth over a number	**[M]**

of unequal sectors, not less than 32, over 360°, the interrogate and control powers pertinent to both Mode S All Call and SSR operation.

SSR_4.5.2_17. A system limiting the number of interrogations **shall** protect the transmitter against overloads and **shall** guarantee that the requirements as specified in [Ref.1] para 3.1.2.11.1.2 are not exceeded. **[M]**

SSR_4.5.2_18. If the limits are exceeded then the surveillance interrogations **shall** have priority. **[M]**

SSR_4.5.2_19. IISLS **shall** be available for interrogations. **[M]**

4.5.3 Receiver

SSR_4.5.3_1. The receiver **shall** be fully compliant with [Ref.1]. **[M]**

SSR_4.5.3_2. The receiver **shall** receive all SSR and Mode-S replies in accordance with [Ref.1]. **[M]**

SSR_4.5.3_3. The receiver **shall** provide: **[M]**

(a) Sum, difference and control channels;

(b) Outputs to the receiver video process utilising data from the sum, difference and control channels.

SSR_4.5.3_4. The receiver **shall** provide sensitivity, selectivity and dynamic range in order to achieve maximum radar's performances as described in [Para 4.3.1.2] for the real traffic using Mode A/C and S. **[M]**

SSR_4.5.3_5. The Contractor **shall** state in the technical documentation above mentioned parameters. **[M]**

4.5.4 Receiver Video Processing

SSR_4.5.4_1. The azimuth data, received from the azimuth data generator, **shall** be decoded and used to determine boresight. **[M]**

SSR_4.5.4_2. Processed Sum Video, RSLS and Off Boresight Indication signals **shall** be provided to the RTCC. **[M]**

SSR_4.5.4_3. The detected pulse output, following pulse detection and quantisation, **shall** accurately reflect the received pulse. **[M]**

SSR_4.5.4_4. STC, or an equivalent thresholding method, **shall** be provided and it **shall** be possible to select either a linear or programmable action. **[M]**

SSR_4.5.4_5. The off-boresight angle (OBA) look up table **shall** be site dependent. **[M]**

SSR_4.5.4_6. The off-boresight angle precision **shall** be within 0.022°. **[M]**

SSR_4.5.4_7. Monopulse data from received pulses **shall** be accumulated and checked for long term consistency against the conversion facility, so as to detect any change or drift in the system monopulse azimuth accuracy. **[M]**

SSR_4.5.4_8. The system maintenance **shall** not require any adjustment or setting up following the replacement of a unit. **[M]**

4.5.5 RF Change-over Unit

SSR_4.5.5_1. The RF Changeover Unit **shall** enable the in service interrogator to be connected to the antenna and the standby interrogator to be connected to the dummy load. **[M]**

SSR_4.5.5_2. During changeover the system **shall** provide uninterrupted service without any corruption to the output surveillance data. **[M]**

SSR_4.5.5_3. At the remote monitoring station the indication of the RF Changeover selection **shall** be available. **[M]**

SSR_4.5.5_4. The interruption of transmissions to the antenna when changing over interrogation channels **shall** meet the requirements of [Para 4.3.2.2]. **[M]**

SSR_4.5.5_5. The RF Changeover Unit **shall** retain its selected state in the absence of control signals and power supplies. **[M]**

SSR_4.5.5_6. An indication to determine which is the Active channel **shall** be provided. **[M]**

SSR_4.5.5_7. The equipment **shall** be of passive design and require no routine maintenance. **[M]**

4.6 SYSTEM MANAGEMENT FUNCTION

4.6.1 General

4.6.1.1 Configuration

SSR_4.6.1.1_1. The System Management Function (SMF, Figure 5) controls all the activity on the RF channels and it **shall** be considered as containing the following sub-functions: **[M]**

(a) Real Time Channel Controller (RTCC) containing:

(i) a Mode A/C reply processor

(ii) a Mode S reply processor

(iii) an interrogation scheduler

(b) Link Controller (LC) containing:

(i) Plot Assignor Function (PAF)

(ii) Station Roll-Call lists

(iii) Mode S Link Management Processor (LMP)

(iv) Communications Management Processor (CMP)

4.6.1.2 General Requirements

SSR_4.6.1.2_1. The SMF **shall** be able to receive and process reply data from the interrogator. **[M]**

SSR_4.6.1.2_2. The SMF **shall** form plots for all aircraft and output them to ATC and to the monitor display. **[M]**

SSR_4.6.1.2_3. The SMF **shall** be able to take in uplink data link transactions from the DLF, process and output them to the interrogator, at a rate which equals the maximum interrogation rates specified in [Ref.1] when combined with the surveillance update interrogations. **[M]**

SSR_4.6.1.2_4. The surveillance update interrogations **shall** have had priority over the data link interrogations should the interrogation rates exceed the defined limits. **[M]**

SSR_4.6.1.2_5. The SMF **shall** also be able to process downlink data link transactions generated both by requests from the ground system and by transactions initiated by the airborne system. **[M]**

4.6.1.3 Interfaces

SSR_4.6.1.3_1. The SMF will have interfaces to: **[M]**

(a) The antenna system, to receive information on the azimuth of the boresight of the beam when replies are received;

(b) The interrogator:

(i) To send interrogation modulation commands (including power level, probability of reply and Lockout flags) and data content;

(ii) To obtain processed video and Off Boresight Information (OBI) for all reply pulses.

(c) ATCC, to provide ASTERIX. Cat 34, Cat 48 data (each interface being dual channel);

(d) The DLF to obtain data link transactions for sending to the aircraft, and to send received downlink data link transactions to the DLF;

(e) The SCF to obtain information on aircraft acquired through SCN, and details of aircraft for which the ground station is responsible for surveillance and data link;

(f) Control and Monitoring to enable the control and monitoring functions to be performed;

(g) External time source to serve as a time reference and permit time stamping of plots etc...

4.6.2 Real Time Channel Controller (RTCC)

SSR_4.6.2_1. The RTCC (Figure 6), by using interrogation algorithms, employing interleaving and azimuth off-set techniques (where message delivery azimuth is optimised with respect to interrogation type and priority) combined with the data-link and Mode S specific services interrogation requests from the LC, **shall** schedule the interrogations to be sent to the transmitter. **[M]**

SSR_4.6.2_2. The resulting replies received from the video processor function **shall** be processed by the Mode A/C reply processor and the Mode S processor to create a report for each reply before it is sent to the LC. **[M]**

SSR_4.6.2_3. The RTCC **shall** also perform automatic extraction for Air Initiated Comm B (AICB). **[M]**

SSR_4.6.2_4. As a minimum, the Mode S Reply Processing **shall** perform preamble detection and error detection and correction. **[M]**

SSR_4.6.2_5. As part of the acquisition process, the system **shall** extract: **[M]**

(a) BDS 1,0; and

(b) if bit 33 of BDS 1,0 is set then extract BDS 2,0; and

(c) if bit 25 of BDS1,0 is set then extract BDS 1,7 and BDS 1,D

SSR_4.6.2_6. The interrogation scheduler **shall**: **[M]**

(a) Control the rate and content of the Mode S only All Call interrogations;

(b) Control variable all call interrogation scheduling (which allows for the concatenation of Roll Call periods for extended datalink activities);

(c) Control the rate of output of intermode A/C/S All Call interrogations;

(d) Control the rate of output if intermode A/C only all Call interrogations;

(e) Control the rate and output of Mode 3/A and C interrogations;

(f) Control the timing of the Mode S selective interrogations;

(g) Provide an interface to record the Mode A/C and Mode S reports.

4.6.3 Link Controller (LC)

4.6.3.1 General

SSR_4.6.3.1_1. The LC (Figure 7) **shall** pass data-link and Mode S specific services requested interrogations to the RTCC for action. **[M]**

SSR_4.6.3.1_2. The Mode A/C and the Mode S replies received from the RTCC **shall** be sent to the Plot Assignor Function (PAF). **[M]**

SSR_4.6.3.1_3. Data link information **shall** be sent to the appropriate interfaces, except some GICB replies which can be passed also directly to plot formatting for delivery as Enhanced Surveillance data [Ref.5] **[M]**

SSR_4.6.3.1_4. When a reply is not required from the aircraft, the RTCC **shall** inform the LC whether an interrogation has been sent. **[M]**

4.6.3.2 Plot Assignor Function (PAF)

SSR_4.6.3.2_1. The PAF **shall** include at least the following sub-functions: **[M]**

(a) False target processing that can discriminate against reflected replies, FRUIT replies, split targets, ring around targets and distinguish between multiple occurrence of targets in the same beam dwell, with the same non-unique address;

(b) Track initialisation, maintenance and prediction;

(c) ASTERIX plot formatting which delivers Cat 48 and Cat 34 data, and for Mode S targets appends plot messages for delivery of Enhanced Surveillance data to the SDFC.

SSR_4.6.3.2_2. A track **shall** be initialised and maintained, both upon detection (SSR and Mode S aircraft) or upon receiving supplementary data (Mode S aircraft only). **[M]**

SSR_4.6.3.2_3. The PAF **shall** track all the aircraft, including aircraft with duplicated addresses and shall maintain the Roll Call list. **[M]**

SSR_4.6.3.2_4. Aircraft information **shall** be sent to the SDFC and a track initiated for a Mode A/C transponder equipped aircraft that has been confirmed to be in the surveillance responsibility area. **[M]**

SSR_4.6.3.2_5. Aircraft information **shall** be sent to the SDFC and a track initiated for a Mode S transponder equipped aircraft that has been confirmed to be in the surveillance responsibility area, and: **[M]**

(a) At least one All Call reply has been detected and confirmed by a selective surveillance reply or

(b) A selective surveillance reply has been received from a selective interrogation which was initiated by supplementary data from the SCF.

SSR_4.6.3.2_6. When a Mode S aircraft is detected in the lockout map, the station **shall** apply as soon as possible the all call lockout protocol defined in that map. **[M]**

SSR_4.6.3.2_7. The Mode C **shall** be updated on the track for each antenna revolution. **[M]**

SSR_4.6.3.2_8. Aircraft surveillance data and measured position information **shall** be sent for every antenna revolution until the track is cancelled. **[M]**

SSR_4.6.3.2_9. The position information **shall** originate, by decreasing priority, from a detection (All-Call or a selective surveillance reply), or from an extrapolation (miss). **[M]**

SSR_4.6.3.2_10. An operational configurable parameter, when enabled, **shall** force the output of extrapolated target reports to Local Display and/or SDFC in case of miss. **[M]**

SSR_4.6.3.2_11. Position information originating from extrapolation, if sent, **shall** be flagged accordingly. **[M]**

SSR_4.6.3.2_12. An operational configurable parameter, when enabled, **shall** force the output of target reports to SDFC, containing at least position (range, azimuth and altitude) and identification (Mode A and, if applicable, Aircraft ID), after a user selectable number of scans following first detection (minimum 1, i.e. on the second scan), provided the corresponding target has been confirmed to be in the surveillance responsibility area. **[M]**

SSR_4.6.3.2_13. An operational configurable parameter, when enabled, **shall** force the output of target reports to SDFC (irrespective of the detection type, e.g. 3/A, C, Roll Call and All Call), after a user selectable number of scans following first detection (minimum 0, i.e. on the first scan). **[M]**

SSR_4.6.3.2_14. This (above [Req. SSR_4.6.3.2_12] and [Req.SSR_4.6.3.2_13]) mode of operation **shall** be limited to user defined geographical areas, and the resulting “early reports” reserved to selected SDFC outputs. **[M]**

SSR_4.6.3.2_15. A track **shall** be cancelled when: **[M]**

(a) An aircraft traverses from a cell with Surveillance Responsibility to one without (there is no need to coast), or

(b) the track is not in the cone of silence and has not been updated within three antenna revolutions and no additional information has been received during that time period from neighbouring stations.

SSR_4.6.3.2_16. False targets **shall** be identified and shall not be output as genuine targets. **[M]**

SSR_4.6.3.2_17. Target reports identified as reflections **shall** not be output as genuine targets but all the tracks including those consisting of false targets shall be initiated and maintained. **[M]**

SSR_4.6.3.2_18. The processing **shall** continuously and automatically locate and identify **[M]**

the orientation and position of the reflecting objects within range of the radar by analysis of the geometry of reflection data from targets with unique codes.

SSR_4.6.3.2_19. The reflector data **shall** be used to maintain dynamic reflector surface data. **[M]**

SSR_4.6.3.2_20. It **shall** be possible to program into the PAF reflector surface position and orientation data for permanent reflectors, such as hangars. **[M]**

SSR_4.6.3.2_21. The processing **shall** employ the reflector data stored in the dynamic and permanent reflector surfaces to identify reflections by analysing the geometry of the real target, the reflections and the stored reflector data. **[M]**

4.6.3.3 Station Roll-Call List

SSR_4.6.3.3_1. The Station Roll-Call List **shall** contain at least identification and positional information on targets that the station is tracking. **[M]**

SSR_4.6.3.3_2. The PAF **shall** maintain the station Roll Call list and the SCF shall update it. The CMP and the SCF shall use the station Roll Call list to ensure that requesting applications will be able to send interrogations to the required aircraft via the ground station. **[M]**

4.6.3.4 Communication Management Processor (CMP)

SSR_4.6.3.4_1. The CMP **shall** process all requests for data link transactions which are input to it from the DLF. It is responsible for co-ordination of interrogation instructions. **[M]**

SSR_4.6.3.4_2. The data packets **shall** be passed to the scheduler for transmission and the Mode S downlink information is received from the PAF via the LMP to pass onto the DLF. **[M]**

SSR_4.6.3.4_3. An aircraft **shall** be reported to the GDLP in accordance with [Ref.9]. **[M]**

SSR_4.6.3.4_4. An aircraft **shall** be reported to the GDLP as leaving when the aircraft is leaving the datalink coverage map or if no reply to a selective interrogation reply has been received for more than three antenna revolutions. **[M]**

SSR_4.6.3.4_5. The CMP **shall** operate flow control procedures when it is unable to process the incoming requests received from the GDLP / Local User Interface. **[M]**

SSR_4.6.3.4_6. The operation of flow control **shall** be reported in the appropriate fields in the ASTERIX Cat. 18 messages of [Ref.6](b). **[M]**

4.6.3.5 Mode S Link Management Process (LMP)

SSR_4.6.3.5_1. The LMP **shall** control all the Mode S link activities except Mode S All - Call interrogations which are controlled directly by the RTCC. **[M]**

SSR_4.6.3.5_2. The LMP shall schedule the interrogations which result in the acquisition of Mode S aircraft from the replies being formed into plots and tracked in the PAF which in turn ensures that they are presented to the Roll Call List. **[M]**

SSR_4.6.3.5_3. For each target on the Station Roll-Call List that the ground station is responsible for, and for new targets input from the SCF, the LMP **shall** assemble and send interrogation instructions to the RTCC. **[M]**

SSR_4.6.3.5_4. The LMP **shall** take the Mode S frames from the queues in the CMP, highest priority queue first, and form them into interrogation instructions to send to the RTCC. **[M]**

SSR_4.6.3.5_5. They **shall** be delivered in azimuth order and with control information to ensure that a sequence of interrogations to a particular aircraft (e.g. Linked Comm A or UELM with its reservation and close out) can be maintained. **[M]**

SSR_4.6.3.5_6. The LMP **shall** take Mode S reply status information (e.g. successful or failed delivery) to enable it to perform frame repair by making new attempts at succeeding polling intervals and report the final result to the CMP. **[M]**

SSR_4.6.3.5_7. A transaction **shall** be considered as a failure if it is not completed within the time delays given below, from the moment when the first interrogation concerning it is transmitted: **[M]**

(a) Comm A (1 to 4 segments) 3 antenna rev.

(b) Comm B (1 to 4 segments) 3 antenna rev.

(c) Comm C (2 to 16 segments) 4 antenna rev.

(d) Comm D (1 to 16 segments) 5 antenna rev.

SSR_4.6.3.5_8. These values **shall** be adjusted separately for each type of transaction between 1 and 20 antenna revolutions. **[M]**

4.7 SURVEILLANCE CO-ORDINATION FUNCTION

4.7.1 Overview

4.7.1.1 Global operation

SSR_4.7.1.1_1. The ground station **shall** be capable of operating as part of a networked **[M]**

cluster of ground stations, whereby each station in the cluster will share the same code.

SSR_4.7.1.1_2. When operating as part of a cluster, each station **shall** advise other cluster stations of the arrival of aircraft in their respective coverage as defined in the ICD for Intersite Co-ordination [Ref.10] **[M]**

SSR_4.7.1.1_3. The station **shall** acquire the aircraft by placing it on the Roll-Call List and sending it a surveillance interrogation. (This aircraft is already locked out on the same II/SI code, therefore it does not respond to an All-Call). **[M]**

SSR_4.7.1.1_4. The SCF (Figure 8) **shall** provide track data to adjacent stations within a cluster upon request. **[M]**

SSR_4.7.1.1_5. The SCF **shall** be designed to minimise the amount or extent of II/SI code reconfiguration. **[M]**

SSR_4.7.1.1_6. The SCF **shall** be designed to interface with up to 5 other Mode S stations, as well as a Cluster Controller, via the Surveillance Co-ordination Network (SCN). **[M]**

4.7.1.2 Description of Cluster Operation and modes

SSR_4.7.1.2_1. In central mode (Figure 1), the station **shall** operate with the coverage map and II/SI code determined by the Cluster Controller (CC). **[M]**

SSR_4.7.1.2_2. In distributed mode, the coverage map and II/SI code **shall** be selected by the algorithm as defined in [Ref.10] operating at the radar node. **[M]**

SSR_4.7.1.2_3. In addition to network aided operation within a cluster, the SCF **shall** also support ‘Standalone’ operation, when ground stations are not connected to the Surveillance Co-ordination Network (SCN). **[M]**

4.7.1.3 Operation and Mode Transitions

SSR_4.7.1.3_1. When performed manually by operational staff, the connection or disconnection of the station to the SCN **shall** be possible either locally or through the CAM. **[M]**

SSR_4.7.1.3_2. Transitions **shall** proceed according to the rules detailed in [Ref.10]. **[M]**

SSR_4.7.1.3_3. The addition of a station to the cluster **shall** be achieved without disruption to the operational service. **[M]**

4.7.1.4 Failure recovery

SSR_4.7.1.4_1. The handling and recovery of failures **shall** proceed according to the rules detailed in [Ref.10]. **[M]**

SSR_4.7.1.4_2. If the node is NOGO (set bit ASTERIX item I034/050) then it **shall** not be **[M]**

part of the cluster.

SSR_4.7.1.4_3. The node **shall** be removed from the cluster by disabling the SCN connection. **[M]**

SSR_4.7.1.4_4. When a node's NOGO bit is subsequently cleared, its SCN connection **shall** be re-enabled. **[M]**

SSR_4.7.1.4_5. The NOGO bit **shall** be changed by the node's internal test logic 'BITE'. The NOGO bit in Cat 34/050 is automatically set to 0 whenever the system is active and therefore released for operational use. **[M]**

SSR_4.7.1.4_6. All network and nodal failures **shall** be reported to the CAM. **[M]**

4.7.2 Functionality

SSR_4.7.2_1. The SCF **shall** include the following: **[M]**

(a) Coverage maps indicating the surveillance, lockout and datalink coverage to be maintained, as defined in [Ref.13];

(b) The extent of each cell shall be as defined in [Ref.13] and the radar coverage limit shall be adapted to the border of the cell;

(c) A means to add or delete targets to the station Roll-Call list in accordance with the SCF state;

(d) A network system status list containing information on the latest SCF state;

(e) A network control and failure control process which contains the processing and protocols required to maintain the station within the cluster;

(f) A communication interface to the SCN. The interface shall support the exchange of ASTERIX messages for surveillance co-ordination as defined in [Ref.10];

(g) A track acquisition and support protocol to ensure that any interrogator is aware of any new track entering its coverage, and used by a radar to request track information from a neighbouring node when a track miss has occurred, as detailed in [Ref.10].

SSR_4.7.2_2. Provision for intermittent lock-out **shall** be made in a selected area which shall be detailed in the lock-out responsibility coverage map. In these areas the station shall send lockout instructions for an aircraft on one scan only. The station shall continue to perform surveillance on the aircraft without sending any more lockout instructions until the aircraft responds to an All-Call. Following reception of an All-Call reply, the station shall wait for a given period and then repeat the above procedure. **[M]**

SSR_4.7.2_3. The above timer value **shall** be a site dependent parameter (from 0 to 30s, with a step of 1s). **[M]**

SSR_4.7.2_4. Provision for Lockout over-ride **shall** be made in selected sectors, determined from the lock-out override coverage map, within which the station shall interrogate the Mode S aircraft during the All Call period by using a value of PR as indicated in the example of Figure 11. **[M]**

SSR_4.7.2_5. The Contractor **shall** provide a facility to allow the loading of coverage maps compliant with [Ref.13] into the secondary radar Mode-S system software. **[M]**

SSR_4.7.2_6. The Contractor as a part of radar tuning **shall** prepare, provide and install appropriatecoverage maps for the secondary radar system. **[M]**

SSR_4.7.2_7. The Surveillance Co-ordination Function **shall** provide a Co-ordinate Transformation as defined in [Ref.6](a), Annex A, to the local co-ordinate set for the track data received from the connected stations. **[M]**

SSR_4.7.2_8. The Surveillance Co-ordination Function **shall** provide a Co-ordinate Transformation as defined in [Ref.6](a), Annex A, from the local co-ordinate set for track data sent to connected stations. **[M]**

4.8 DATA-LINK FUNCTION

4.8.1 General

SSR_4.8.1_1. The DLF **shall** include the functionality of the Specific Service Entity, as defined by section 5.2.7 of Mode S Subnetwork SARPs [Ref.3]. It shall support all the Mode S Specific Services, namely Ground Initiated Comm Bs (GICBs), Broadcast Comm Bs, Broadcast Comm As and the Mode S Specific Protocol (MSP). **[M]**

SSR_4.8.1_2. The DLF **shall** also include the Frame Processing function as defined by section 5.2.2 of Mode S Subnetwork SARPs [Ref.3] to support Switched Virtual Circuit communication over the Mode S Subnetwork via the Ground Data Link Processor. **[M]**

SSR_4.8.1_3. The DLF **shall** enable the connection to Local User via HDLC Lap-B or LAN conncection. **[M]**

SSR_4.8.1_4. The Contractor **shall** describe in the technical documentation the implementation of data link functionality **[M]**

4.9 FAR FIELD MONITOR

4.9.1 General

SSR_4.9.1_1. The far field site monitor **shall** be a self contained unit acting as a Mode S at least level 2 Mode-S transponder (as defined in [Ref.1] 2.1.5.1.2) located externally to the ground station site. **[M]**

SSR_4.9.1_2. The radar processing **shall** enable the definition of multiple far field monitors and provide the capability to suppress their reports from delivery to SDFC/ATC. **[M]**

SSR_4.9.1_3. The Mode S site monitor **shall** include the following features: **[M]**

(a) Operation on Modes 3/A,C, intermode and Mode S (II and SI codes);

(b) Simulated range and flight level reporting;

(c) Robustness to failure;

(d) Modular construction with plug/socket connections on all modules;

(e) Fully solid state;

(f) User definable data as described in [Req. SSR_4.9.2_1].

SSR_4.9.1_4. The far field monitor **shall** comply with all the requirements of [Ref.1] **[M]**

4.9.2 Reply Processing

SSR_4.9.2_1. User definable data **shall** include: **[M]**

(a) The Mode S technical address shall be selectable as a 6 character Hexadecimal address.

(b) Separate altitude and identity information shall be selectable (in terms of octal Mode A code and FL respectively).

(c) Each code shall remain configured during periods of power interruption.

(d) The Flight Identity (or call-sign) shall be selectable. The change of Flight ID shall be announced by the use of the standard Mode S broadcast protocol.

SSR_4.9.2_2. The equipment **shall** function on a power supply consistent with the requirements of [Para. 5.6]. **[M]**

SSR_4.9.2_3. The equipment supplied **shall** include all ancillary equipment including antenna, cabling power supplies and any necessary mounting hardware. **[M]**

5. COMMON EQUIPMENT AND FUNCTIONALITY

5.1 Control And Monitoring System (CAM)

5.1.1 General

CAM_5.1.1_1. The CAM **shall** control and monitor at least following parts: **[M]**

(a) the PSR (Primary Surveillance Radar) and its related sub-units;

(b) the MSSR (Monopulse Secondary Surveillance Radar) Mode-S and its related sub-units;

(c) the Turning Gear/Pedestal;

(d) Internal Radar Data Distribution / Transmission system (Ethernet, etc.);

(e) Communication status;

(f) any other system elements considered essential for correct system operation.

CAM_5.1.1_2. The CAM **shall** optionally control system security sensors (fire alarm, intruder alarm, etc.) **[O]**

CAM_5.1.1_3. The main functions of the CAM **shall** be: **[M]**

(a) remote control of major system elements and parameters;

(b) remote transmission of all major equipment status parameters, equipment failure(s) and the station configuration (i.e. remote monitoring) to the designated CAM consoles;

(c) a continuous RTQC (Real Time Quality Control) of all major system elements and parameters using BITE (Built-In Test Equipment) techniques;

(d) aid technical staff in the isolation (and eventually correction) of faults (at least to LRU level in 90 % of fault cases) in the radar equipment using the aforesaid BITE facilities;

(e) to carry out automatic re-configuration of system elements in the case of major equipment failure. This shall include, if necessary, a re-configuration to a fail-soft mode of operation;

(f) to act as a centralised computer facility for station management (i.e. monitoring of station status and operating parameters plus station safety).

CAM_5.1.1_4. The monitoring and control function **shall** be available at local level (at site) and remote in a local ATMC. All CAM stations **shall** be equal concerning priority, and they **shall** share access to the sensors on an OR selection base following negotiation and cooperative action. However the monitoring functions **shall** be available continuously to all positions. **[M]**

CAM_5.1.1_5. All control functions **shall** be selectable at equipment level. In the case of maintenance action, tests, etc., the selection of "local control" shall lock out, in the interest of safety of technical personnel all other remote control consoles, positions, etc. **[M]**

CAM_5.1.1_6. The CAM **shall** reflect the operating philosophy of having PSR/MSSR equipment designed for unattended operation. Sophisticated and comprehensive BITE **shall** thus be used. **[M]**

CAM_5.1.1_7. At local level (i.e. on the equipment), the BITE **shall** provide the following information: **[M]**

(a) an indication that all major system parameters are within the pre-defined limits of nominal values;

(b) a direct indication of a faulty unit in the case of equipment failure (at least to LRU level and preferably to SRU (Shop Replaceable Unit) /PCB level);

(c) an indication that the equipment is correctly operating within the pre-defined parameter limits and can therefore be run up from a non-operative (standby) condition or is available for system re-configuration in the case of duplicated system elements.

CAM_5.1.1_8. The local and remote CAM consoles **shall** have the capability to display the PSR and MSSR radar data. **[M]**

CAM_5.1.1_9. An audible alarm **shall** be provided to bring a system fault to the attention of maintenance personnel. There shall be an online possibility to disable this function. **[M]**

CAM_5.1.1_10. The monitor and control system **shall** include the following monitor and control workstations: **[M]**

(a) One (1) (if possible redundant) monitor and control workstations installed locally in radar room acting as local monitoring station;

(b) remote monitor and control workstations with the number and localizations indicated in other adequate external document for the radar site;

CAM_5.1.1_11. Local monitor and control workstations **shall** be equipped with connected and configured network printer. **[M]**

5.1.2 Control and Monitoring Interfaces

CAM_5.1.2_1. Provision for interfaces to enable local and remote control and monitoring **shall** be provided using industry standard interface and protocol. **[M]**

CAM_5.1.2_2. The interruption in communication between radars system and the CAM **shall** not create an interruption to its operation, decrease its performance or trigger equipment reconfiguration. **[M]**

CAM_5.1.2_3. Under CAM link failure full control **shall** automatically be provided locally, either through the local terminal. **[M]**

CAM_5.1.2_4. When under control of the remote terminal, all local control of the system **shall** be inhibited except for the request for local control and transfer to local control is executed only after permission by the remote terminal. **[M]**

CAM_5.1.2_5. When under local control at the equipment itself all control via the remote terminal **shall** be inhibited, however monitoring and recording of all functions shall continue. **[M]**

CAM_5.1.2_6. When under control of the local terminal, all remote control of the system **shall** be inhibited except for the request for remote control and transfer to remote control is executed only after permission by the local terminal. **[M]**

CAM_5.1.2_7. When not under control of the terminal, monitoring and recording of all functions **shall** continue. **[M]**

CAM_5.1.2_8. The CAM interface **shall** enable the connection or disconnection of the ground station from the Surveillance Co-ordination Network (SCN). **[M]**

CAM_5.1.2_9. The CAM interface **shall** enable the connection or disconnection of the output surveillance data to ATCC. **[M]**

CAM_5.1.2_10. The Contractor **shall** supply interface control documents (ICDs) defining the interfaces, protocols and message formats used for the CAM function. **[M]**

CAM_5.1.2_11. By providing appropriate dedicated interfaces the radar system **shall** have the capability to be connected to the PANSA central monitoring system of the CNS equipment. **[M]**

5.1.3 Built in Test Equipment (BITE)

CAM_5.1.3_1. Comprehensive on-line and off-line BITE **shall** be provided in the collocated PSR/MSSR Mode S system. **[M]**

CAM_5.1.3_2. Off line (maintenance mode) BITE testing **shall** be capable of being manually initiated locally and remotely. **[M]**

CAM_5.1.3_3. BITE **shall** be provided for both on-line and off-line testing of the Mode S systems and **shall** be able to detect any fault affecting the performance of the system. **[M]**

CAM_5.1.3_4. The BITE coverage rate (part of the system [including all units, boards and components] monitored by BITE) **shall** be at least 90%. **[M]**

CAM_5.1.3_5. The BITE fault finding rate **shall** be at least 95%. That is, at least 95% of all failures shall be detected and isolated by test to within a three LRU group (In most instances a PCB is defined as a single LRU). **[M]**

CAM_5.1.3_6. The on-line and off-line testing of the system **shall** work without the need for any additional external test equipment. **[M]**

CAM_5.1.3_7. The on-line fault reporting time **shall** be less than 2 seconds after detecting the fault. **[M]**

CAM_5.1.3_8. The on-line and off-line BITE **shall** register the faulty equipment (LRU) and report the information through the CAM interfaces. **[M]**

CAM_5.1.3_9. On-line testing **shall** provide radar performance data through the CAM interfaces, in particular performance degradation providing advance warning of a developing fault condition or the need for maintenance. **[M]**

CAM_5.1.3_10. The PSR radar system stability **shall** be continuously monitored by the BITE. **[M]**

5.1.4 Local PPI

CAM_5.1.4_1. The Contractor **shall** provide radar display console, which shall give the maintenance personnel the opportunity to monitor primary/secondary/combined plots/tracks and processed weather data output to ATCC. **[M]**

CAM_5.1.4_2. The data **shall** be displayed in geographical representation with appropriate changeable air picture zooming option. **[M]**

CAM_5.1.4_3. The display **shall** allow easily configure and display at least: **[M]**

(a) State's border map,

(b) Navigation aids map,

(c) Sector map,

(d) Range rings,

(e) Radar position.

CAM_5.1.4_4. The display **shall** have a configuration mean to enable configuration of different symbols for different plot types (primary/secondary/combined). **[M]**

CAM_5.1.4_5. The display **shall** be able to display in a different way all NWS levels of the weather data. **[M]**

5.2 Local display

DPL_5.2_1. An autonomous, standalone, readily moveable and transportable raster scan radar display **shall** be provided with necessary interfaces. **[M]**

DPL_5.2_2. By using the display, maintenance and commissioning engineers **shall** be able to fully assess the operational performance and serviceability of the Mode S and PSR systems. **[M]**

DPL_5.2_3. The display hardware **shall** make use of an industry standard graphics. **[M]**

DPL_5.2_4. Where specialised external processing hardware is proposed, it **shall** be interfaced to the same operating system as the display. **[M]**

DPL_5.2_5. The display **shall** be capable of handling the maximum target loads for the specified radar equipment. **[M]**

DPL_5.2_6. The display system **shall** accept and display signals or data from the Mode S radar system or PSR (live) or from the optional data recording and playback facility (if any), consisting of at least: **[M]**

(a) Turning and trigger information (for SSR Mode A/C and Mode S All Call);

(b) SSR/Mode S video signals;

(c) PSR video signals;

(d) Quantised Processed Sum Video (Analogue video converted to digital words synchronised to the monopulse plot extractor master clock timing) Signals (SSR and Mode S All-Call);

(e) Reply Report Data (messages output from the Mode A/C and Mode S reply processor);

(f) Plot data (ASTERIX Cat. 1, 48);

(g) Mode S enhanced surveillance information (ASTERIX Cat. 48);

(h) Status information (ASTERIX Cat. 2, 34);

(i) Track data exchanged on the Surveillance Co-ordination Network (content of ASTERIX Cat. 17 messages);

(j) Presentation of the currently operational local Surveillance Coverage maps, for a user-defined altitude;

(k) Data flagged as Anomalies and false plots in the PAF and NOT sent to ATCC;

(l) A list of the Mode S aircraft under surveillance (Mode S address, height & position);

(m) The data link capability of each aircraft;

(n) The last received message decoded per aircraft;

(o) The Broadcast Comm Bs received;

(p) The GICB's received;

(q) MSPs (for Dataflash);

(r) TCAS resolution advisories;

(s) PSR weather data (ASTERIX Cat. 8).

DPL_5.2_7.	Data (b), (c), (d), (f), (g), (i), (j), (k) and (s) **shall** be displayed in a geographical representation.	**[M]**
DPL_5.2_8.	The system **shall** provide the operator with the ability to select any combination from the above list for display.	**[M]**
DPL_5.2_9.	The system **shall** be able to display the content of the ASTERIX data sent on the ATCC output.	**[M]**
DPL_5.2_10.	The Contractor **shall** supply any peripherals and/or ancillary equipment that are necessary for the operation of the display.	**[M]**
DPL_5.2_11.	The symbology (and/or colour) **shall** be configurable and such as to distinguish between different plot/track types.	**[M]**
DPL_5.2_12.	A background map facility **shall** be provided for up to 300 NM radius of the origin covering territory of Poland.	**[M]**
DPL_5.2_13.	It **shall** be possible to import the map parameter co-ordinate set.	**[M]**
DPL_5.2_14.	There **shall** be a facility to record the data defined in [Req. DPL_5.2_6] and to display this stored information.	**[M]**

5.3 Surveillance data filter and combiner (SDFC)

SDFC_5.3_1.	The SDFC system **shall** generally carry out the actions of plot filtering, combining, the organisation and transmission of Radar Data to the ATMC.	**[M]**
SDFC_5.3_2.	Regardless of the system operating philosophy, all SDFC functions **shall** be physically duplicated and data **shall** be exchanged between both systems.	**[M]**
SDFC_5.3_3.	Both SDFCs **shall** be fed with full set of surveillance and weather data from both channels of both radars.	**[M]**
SDFC_5.3_4.	The SDFCs **shall** produce two independent surveillance data streams to ATMC.	**[M]**
SDFC_5.3_5.	This function, if not present in the PSR/MSSR part, **shall** reject false plots, reflections and multiple reports.	**[M]**
SDFC_5.3_6.	Tracking at the level of the SDFC **shall** be considered as an additional filtering which is expected to further improve data integrity and reliability.	**[M]**
SDFC_5.3_7.	The SDFC **shall** not apply plot position data smoothing.	**[M]**
SDFC_5.3_8.	For plots/tracks **shall** be assigned the corresponding ASTERIX format prior to transmission.	**[M]**

SDFC_5.3_9. The plot/track combination function **may** be carried out at either PSR or MSSR level or clearly at the SDFC level and **shall** satisfy the performance requirements below: **[M]**

- Overall probability of association :≥ 95 %
- Overall false association ratio :≤ 0.1 %

SDFC_5.3_10. The overall system (i.e. PSR/MSSR and SDFC) **shall** be capable of processing Data for highest required PSR and MSSR performances. **[M]**

SDFC_5.3_11. The processing delay is the total processing time from the moment a target is scanned (illuminated) by the Antenna up to the transmission of the Track Data of that target to the ATMC **shall** not exceed 2 seconds. **[M]**

SDFC_5.3_12. The SDFC **shall** at least provide the following types of output radar data:

(a) PSR plots,

(b) MSSR plots,

(c) Combined plots, **[M]**

(d) Weather data,

(e) Other system messages.

SDFC_5.3_13. Each SDFC output interface **shall** be on-line configurable (without interruption in data provision) in order to provide any combination of data listed in [Req. SDFC_5.3_12] up to full (100%) set of listed data. **[M]**

SDFC_5.3_14. SDFC **shall** provide radar data configuration capabilities allowing to choose ASTERIX categories to be sent to ATCC for following data types:

(a) Surveillance data – Cat1 or Cat48 **[M]**

(b) Radar service messages – Cat2 or Cat34

(c) Weather data Cat8.

SDFC_5.3_15. Radar data time stamping **shall** be done using the information supplied by a time function [Para. 5.5] used on site. **[M]**

SDFC_5.3_16. The PSR, MSSR or combined plots/tracks **shall** contain the TOD (Time of Detection) in a separate field. Time stamping maximum error shall be less than 100 ms. **[M]**

SDFC_5.3_17. The availability requirements (i.e. maximum outage time and cumulative outage time for a period of one year) for SDFC **shall** be consistent with **[M]**

the figures of PSR and MSSR.

SDFC_5.3_18. Each SDFC **shall** provide at least 2 (two) LAN interfaces and at least 2 (two) serial RS422/V.11, RS232/V.24 data output interfaces. **[M]**

SDFC_5.3_19. The SDFC **shall** be capable to interchange listed in [Req. SDFC_5.3_12] data with RMCDE's equipment using: HDLC, TCP/IP and UDP/IP. **[M]**

SDFC_5.3_20. The SDFC interfaces parameters **shall** be easily configurable. **[M]**

SDFC_5.3_21. Each of the implemented in SDFC surveillance data format, protocol and physical interface **shall** be compliant with its implementation in Eurocontrol's RMCDE equipment. **[M]**

SDFC_5.3_22. The SDFC **shall** provide data filtering at least for the suppression of test PSR and MSSR targets. **[M]**

SDFC_5.3_23. Any radar channel failure **shall** not result in any SDFC channel unavailability. **[M]**

5.4 Communication

COM_5.4_1. The communication infrastructure **shall** enable simultaneous transmission of the following data: **[M]**

(a) Surveillance data (Asterix CAT 1,2,34,48);

(b) Weather data (Asterix CAT 8);

(c) Surveillance coordination - SCN (Asterix CAT 17);

(d) Control and monitoring;

(e) GDLP/Data-Link transmissions (Asterix CAT 18);

(f) Time synchronization in accordance with [Req. TIM_5.5_4].

COM_5.4_2. The Contractor **shall** fully assure consistency and correct working of all interfaces between equipment and subsystems within the complete radar systems, including all the interfaces and remote control subsystems as specified within this document. **[M]**

COM_5.4_3. The communication status of radar data lines to ATCC **shall** be monitored on CAM. **[M]**

5.5 Time function

TIM_5.5_1. The radar system **shall** include a redundant Time Function to provide time to the system (including CAM) for the purpose of synchronisation and **[M]**

time-stamping.

TIM_5.5_2.	The Time Function **shall** time-stamp the information using the information provided either by an external source or by an internal clock.	**[M]**
TIM_5.5_3.	The site **shall** be fitted with redundant GPS receiver acting as the external source in order to provide time synchronisation for PSR, MSSR and related site equipment.	**[M]**
TIM_5.5_4.	The radar system **shall** be capable to synchronize from external NTP (RFC1305) time source (PANSA central time server) using additional, dedicated built-in Ethernet (100 lub 1000 Mbps)/RJ45/IP.	**[M]**
TIM_5.5_5.	The system **shall** be capable to be interfaced simultaneously with at least two external time sources (e.g. GPS receiver and PANSA central time server).	**[M]**
TIM_5.5_6.	In the event that the external time sources fail to deliver a time reference, the Time Function **shall** revert to the internal clock. This condition shall be reflected in the Time Source Status on CAM as part of the Station Configuration.	**[M]**

5.6 Power

POW_5.6_1.	All site equipment **shall** be capable of operating from a commercial , three-phase AC mains supply of 230 V phase-to-neutral and 400V phase-to-phase with 50 Hz frequency. All performance requirements shall be met without readjustment of the radar system when voltage varies in scope of valid limits.	**[M]**
POW_5.6_2.	In case when commercial power failure occurs appropriate warning message **shall** be issued on CAM (on local positions and remote positions).	**[M]**

5.7 Radome

RDM_5.7_1.	The radome function **shall** offer protection to the Antennas and Turning Gear from severe weather conditions.	**[M]**
RDM_5.7_2.	The radome **shall** produce only an **absolute minimum** of perturbation to the main electrical characteristics of the Antenna(s) housed within.	**[M]**
RDM_5.7_3.	The radome **shall** consist of panel sections joined together to form a truncated sphere.	**[M]**
RDM_5.7_4.	The radome **shall** be provided with suitable internal lighting in order to facilitate equipment maintenance in low light or night-time conditions.	**[M]**

RDM_5.7_5. The radome structure **shall** be provided with suitable attachment points for lifting equipment capable of carrying loads such as the Antennas. **[M]**

RDM_5.7_6. All specialised tools and material necessary for the radome maintenance **shall** be provided. **[M]**

RDM_5.7_7. The radome **shall** neither support fungus nor algae growth. **[M]**

RDM_5.7_8. The radome **shall** be of such a construction that no deterioration of its mechanical integrity and form **shall** occur due to snow and/or ice accumulation. Formation of ice on the radome top **shall** be prohibited. **[M]**

RDM_5.7_9. The radome **shall** be capable of operation with a minimum of maintenance for a period of at least 20 years. **[M]**

RDM_5.7_10. The radome shall resist and maintain its shape and parameters under external weather conditions specified in [Req. GEN_2.4.1_1]. **[M]**

5.8 Spare parts

SPT_5.8_1. The Contractor shall provide basic spare parts set containing the minimum of subunits, units and modules being single (not redundant) in the radar system excluding its antenna system. **[M]**

SPT_5.8_2. For the Warszawa site the Contractor shall provide extended spare parts set. This extended spare parts set shall include at least one unit of each type in radar system being LRU excluding waveguides, coaxials lines, cabling, construction parts of the radar racks, antennas, and mechanical parts of the antenna driving. **[M]**

SPT_5.8_3. The spare parts set for Warszawa site shall include: antenna driving motor (1 unit), azimuth pulse generator (1 unit), rotary joint (1 unit), antenna motor component drive unit - inverter (1 unit), far field monitor compliant with Para [5.9] (1 unit). **[M]**

5.9 Measurement and service equipment

SVC_5.9_1. The Contractor **shall** provide set of service equipment essential for maintenance and inspections of the radar system. **[M]**

SVC_5.9_2. Provided set of service equipment **shall** be complete in order to support execution of all necessary corrective and preventative maintenance procedures by the Purchaser's staff, including necessary signal measurements. **[M]**

SVC_5.9_3.	The Contractor **shall** provide meters and equipment for Warszawa and Zabierzow sites as listed in Annex D of this specification. Provided equipment shall be equal or better than its specification/parameters described in Annex D.	**[M]**
SVC_5.9_4.	The Contractor **shall** provide set of specialized equipment in order to support easy service of antenna and pedestal including lifting of its heavy components.	**[M]**

6. ANNEX A - GLOSSARY

℃	-	Degree Celsius
ACC	-	Area Control Centre (En-route Control)
ACP	-	Azimuth Count Pulses
AICB	-	Air Initiated Comm B
ANSP	-	Air Navigation Service Provider
APP	-	Approach Control
ASTERIX	-	All Purpose Structured Eurocontrol Radar Information Exchange
ATM	-	Air Traffic Management
ATMC	-	Air Traffic Management Center in Warszawa (equal to ATCC)
ATC	-	Air Traffic Control
ATCC	-	Air Traffic Control Centre in Warszawa
AU	-	Azimuth Unit
BDS	-	Comm B Data Selector
BITE	-	Built In Test Equipment
CC	-	Cluster Controller
CFAR	-	Constant False Alarm Rate
CMP	-	Communication Management Process
DLF	-	Data Link Function
EATCHIP	-	European ATC Harmonisation and Integration Programme
EMS	-	European Mode-S Station
FL	-	Flight Level (1FL = 100 ft)
FRUIT	-	False Replies Unsynchronised In Time
FTS	-	Functional Technical Specifications
GDLP	-	Ground Link Data Processor
GICB	-	Ground Initiated Comm B
GPS	-	Global Positioning System
HDLC	-	High level Data Link Control
ICAO	-	International Civil Aviation Organisation
ICD	-	Interface Control Document
IFF	-	Identification Friend or Foe
II	-	Interrogator Identifier
IISLS	-	Improved Interrogator SideLobe Suppression
IRF	-	Interrogation Repetition Frequency
Kbps	-	Kilo bit per second
kn	-	Knot ($NM.h^{-1}$, 1 kn = 0.514444 $m.s^{-1}$)
LC	-	Link Control
LMP	-	Link Management Process
LRU	-	Lowest Replaceable Unit
LVA	-	Large Vertical Aperture (rotating antenna)
MSP	-	Mode S Specific Protocol
MSSR	-	Monopulse Secondary Surveillance Radar
MTBF	-	Mean Time Between Failures
MTTR	-	Mean Time To Repair

NM	-	Nautical Mile
NWS	-	National Weather Standards
OBI	-	Off Boresight Indication
PAF	-	Plot Assignor Function
Para	-	Reference to the point in this or external document.
PC	-	Pulse Compression
PCB	-	Printed Circuit Board
Pd	-	Probability of Detection
POEMS	-	Pre Operational European Mode S Station
PRANET	-	PANSA Radar NETwork
PRF	-	Pulse Repetition Frequency
PRI	-	Pulse Repetition Interval
PSR	-	Primary Surveillance Radar
RAPS III	-	Recording, Analysis, Playback & Simulation System for Surveillance Data III
RCS	-	Radar Cross Section
RDIF	-	Radar Data Interchange Format
RF	-	Radio Frequency
RHD	-	Radar Horizon Distance
RMCDE	-	Eurocontrol's Radar Message Conversion and Distribution Equipment
RMS	-	Root Mean Square
rpm	-	Revolutions per Minute
RSLS	-	Receiver SideLobe Suppression
RTCC	-	Real Time Channel Control
RTQC	-	Real Time Quality Control
SARPs	-	Standards And Recommended Practices
SASS	-	Surveillance Analysis Support System
SCF	-	Surveillance Co-ordination Function
SCN	-	Surveillance Co-ordination Network
SDP	-	Site Dependent Paramenters
SMF	-	Systems Management Function
SPI	-	Special Position Identification pulse
SSR	-	Secondary Surveillance Radar
STC	-	Sensitivity Time Control
SUR	-	Surveillance
TMA	-	Terminal Control Area
USB		Universal Serial Bus

7. ANNEX B - REFERENCE DOCUMENTS

[Ref.1] ICAO Annex 10, third edition of Volume IV (latest edition).

[Ref.2] STANAG 4193 NATO Technical characteristics of IFF MK XA and MKXII Interrogators and Transponder.

[Ref.3] Mode S Subnetwork SARPs described as Volume III, Part 1, Chapter 5 to Amendment 77 of ICAO Annex 10, including appendices, November 2002

[Ref.4] Manual of SSR Systems, third edition (2004): ICAO Doc.9684.

[Ref.5] Standard STFRDE ASTERIX documents:

(a) EUROCONTROL Standard Document for Radar Data Exchange Part 1 ASTERIX, SUR.ET1.ST05.2000-STD-01-01, Edition: 1.26, November 2000

(b) EUROCONTROL Standard Document for Surveillance Data Exchange Part 2b Transmission of Monoradar Service Messages, SUR.ET1.ST05.2000-STD-02b-01, Edition: 1.26, November 2000

(c) EUROCONTROL Standard Document for Surveillance Data Exchange Part 4 Transmission of Monoradar Target Reports, SUR.ET1.ST05.2000-STD-04-01, Edition: 1.14, November 2000

[Ref.6] [Ref.6.]European Mode S ASTERIX Documents:

(a) EUROCONTROL Standard Document For Surveillance Data Exchange Part 5 Category 017 Mode S Surveillance Coordination Function Messages, SUR.ET2.ST03.3111-SPC-02-00, Edition: 1.0, October 2004 + Annex A: Co-ordinate transformation algorithms for the hand-over of targets between POEMS interrogators

(b) EUROCONTROL Standard Document For Surveillance Data Exchange Part 6 Category 018 Mode S Datalink Function Messages, SUR.ET2.ST03.3112-SPC-01-0, Edition: 1.5, March 1999

[Ref.7] RDIF 'Radar Data Interchange Format' CAA Paper 87002, November 1991.

[Ref.8] Regional Supplementary Procedures (SUPPs) – ICAO. Doc.7030/4, EUR, Part 1 (Carriage and Operation of SSR Mode S airborne equipment)

[Ref.9] EATCHIP GDLP/Local User ICD for POEMS, SUR.ET2.ST03.3112-SPC-02-00, Edition: 1.7, Edition Date, 17 March 1999, Status: Working Draft.

[Ref.10] European Mode S Station Intersite Surveillance Co-ordination Interface Control Document, SUR/MODES/EMS/ICD-01 (form. SUR.ET2.ST03.3110-SPC-02-00), 2.06, 9 May 2005.

[Ref.11] EUROCONTROL Standard Document for Radar Surveillance in En-Route Airspace and Major Terminal Areas, Edition 1.0, March 1997 RELEASED issue.

[Ref.12] ICAO "Manual on Testing of Radio Navigation Aids: Volume III (Testing of Surveillance Radar Systems): ICAO Doc.8071

[Ref.13] European Mode S Station Coverage Map Interface Control Document, SUR/MODES/EMS/ICD-03 (form. SUR.ET2.ST03.3113-SPC-01-00)), 1.16, 9 May 2005.

[Ref.14] ICAO AIR NAVIGATION PLAN - EUROPEAN REGION DOC 7754/24 Corrigendum 17/2/99

[Ref.15] International Standard ISO/IEC 8208: 1995 (E): Information Technology-Data communications-X25 Packet Layer Protocol for Data Terminal Equipment.

[Ref.16] International Standard ISO/IEC 7776: 1995 (E): Information Technology-Telecommunications and information exchanges between systems-High level data link control procedures-Description of the X.25 Lap-B compatible data link procedures.

[Ref.17] [European Mode S Station Surveillance Output Interface Control Document, SUR/MODES/EMS/ICD-04, 1.02, 19 April 2001.

[Ref.18] ICAO Annex 10 up to the latest amendment

[Ref.19] Dz.U. nr 135 poz. 1444 z dn. 17 maja 2004.

[Ref.20] EUROCONTROL Document for Radar Sensor Performance Analysis (Document Reference SUR.ET1.ST03.1000-STD-01-01, Edition 0.1, dated June 1997 (Working Draft)), hereafter called the "RSPA Document"

[Ref.21] [Ref.20][Ref.21] „European Mode S Station Functional Specification” version 3.11 z dated 9 may 2005.

8. ANNEX C - FIGURES

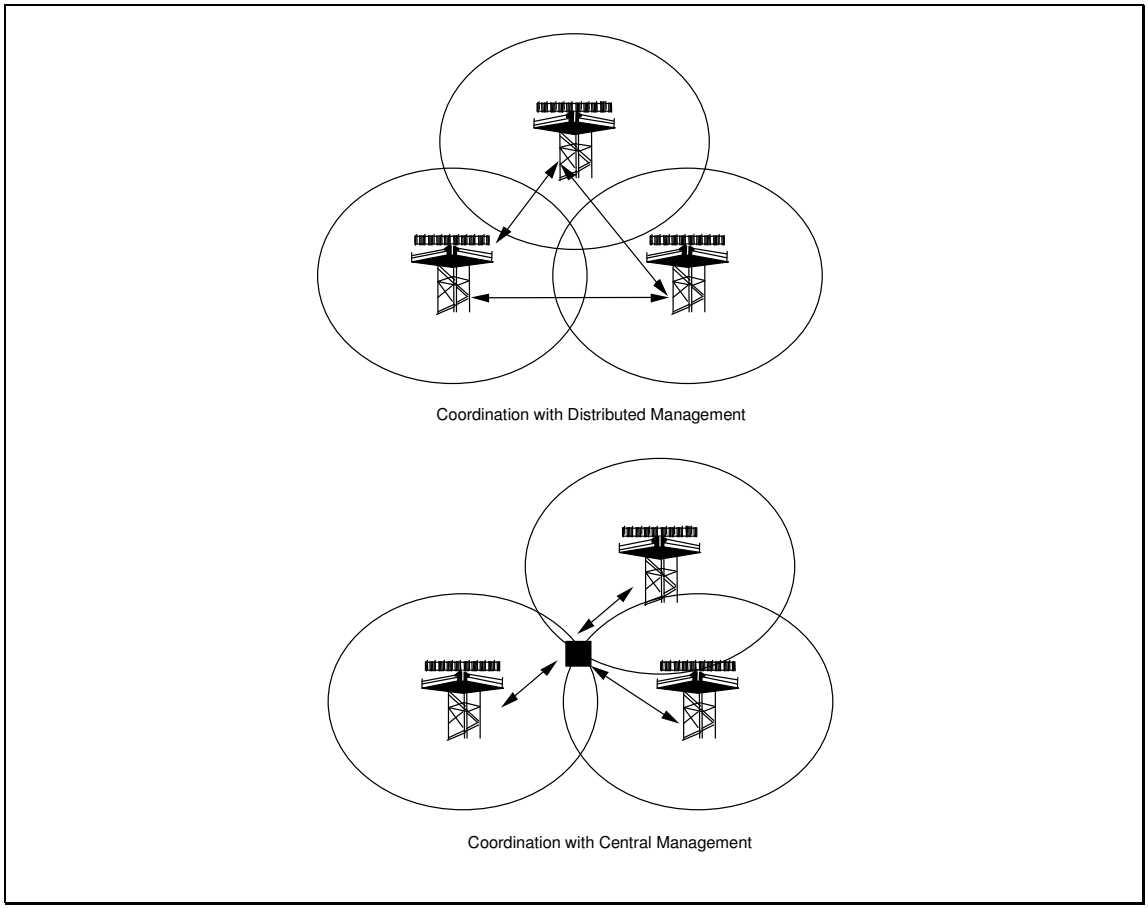

Figure 1 Cluster Co-ordination Options

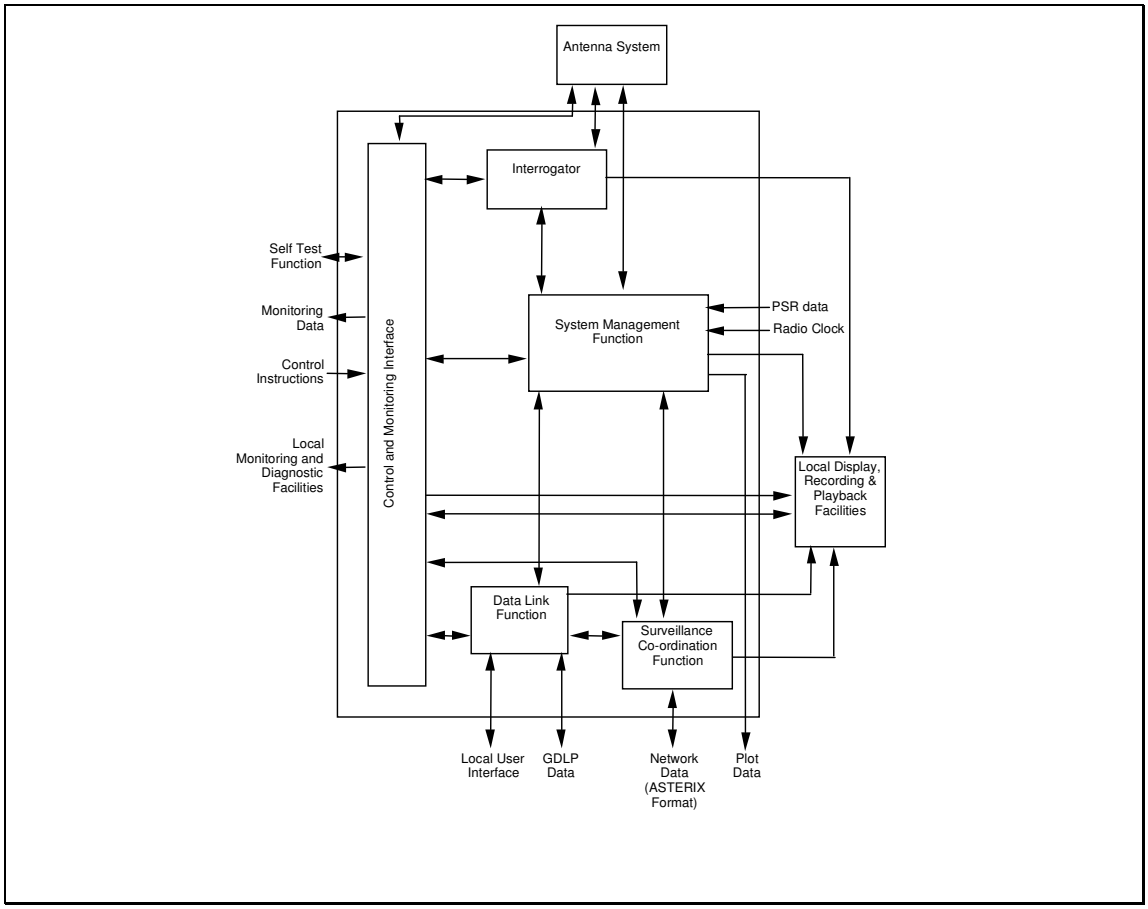

Figure 2 Mode S Ground Station Functional Overview

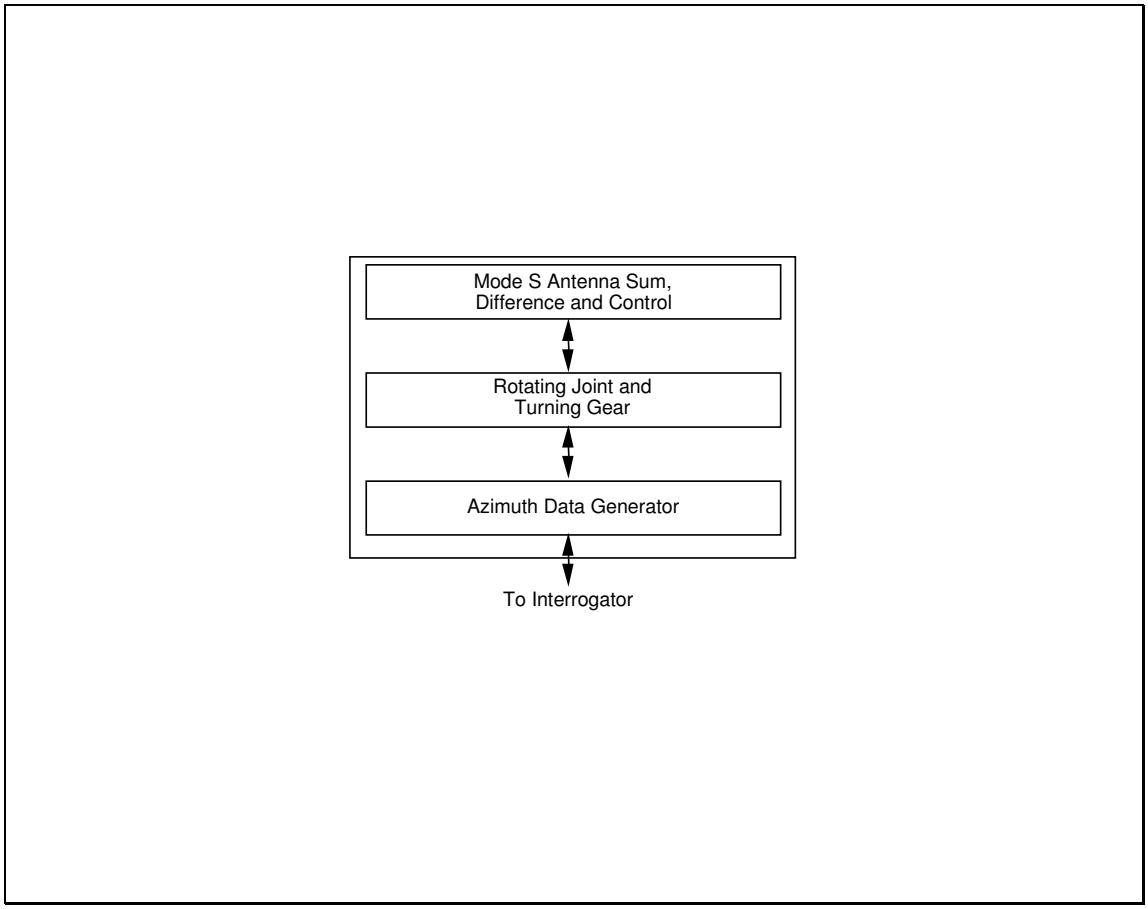

Figure 3 Antenna Functional Overview

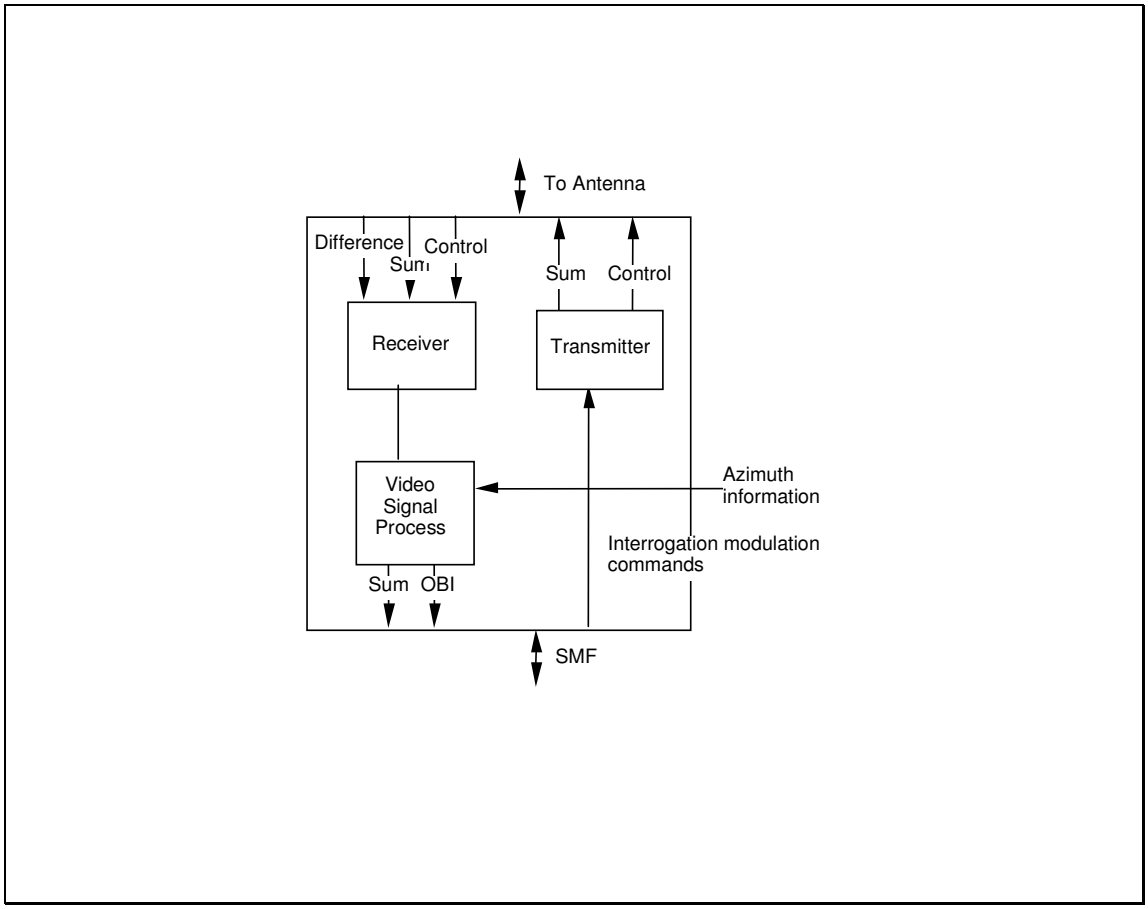

Figure 4 Interrogator Functional Overview

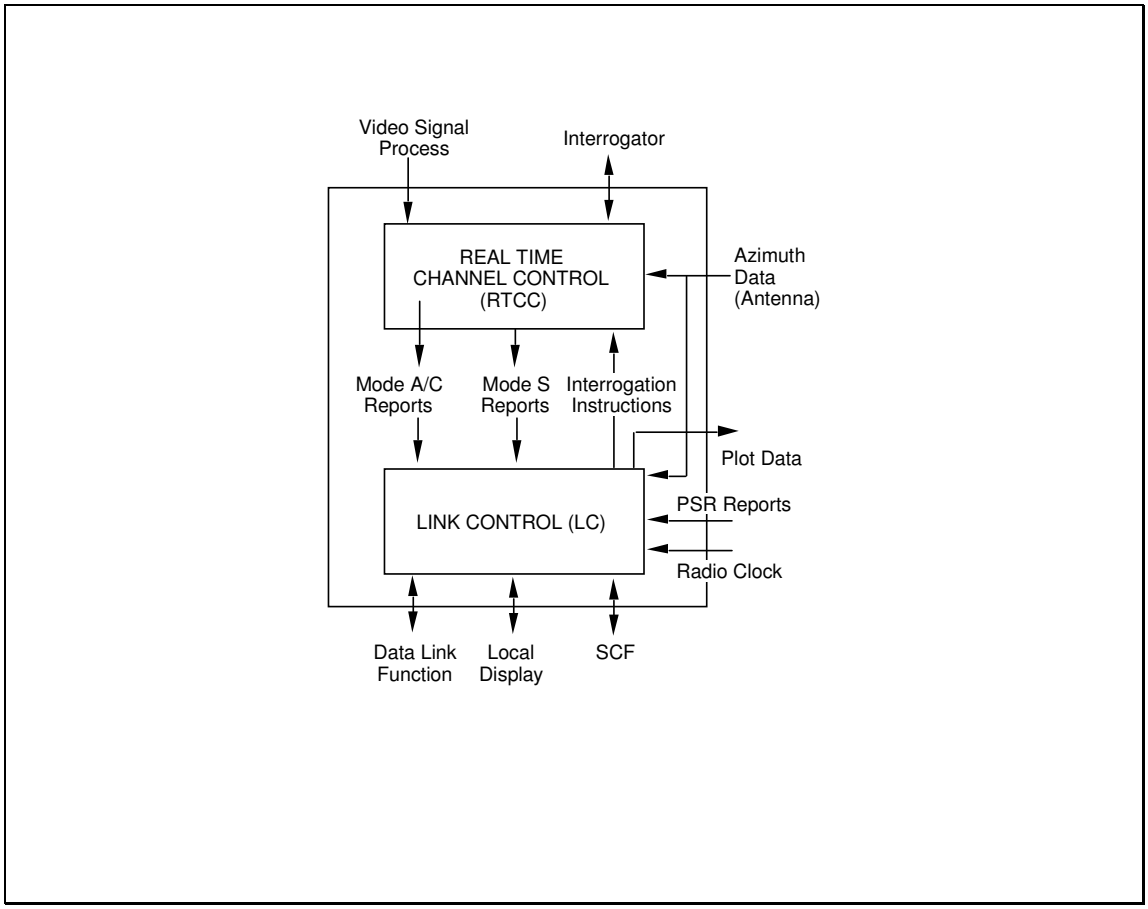

Figure 5 System Management Function (SMF) Overview

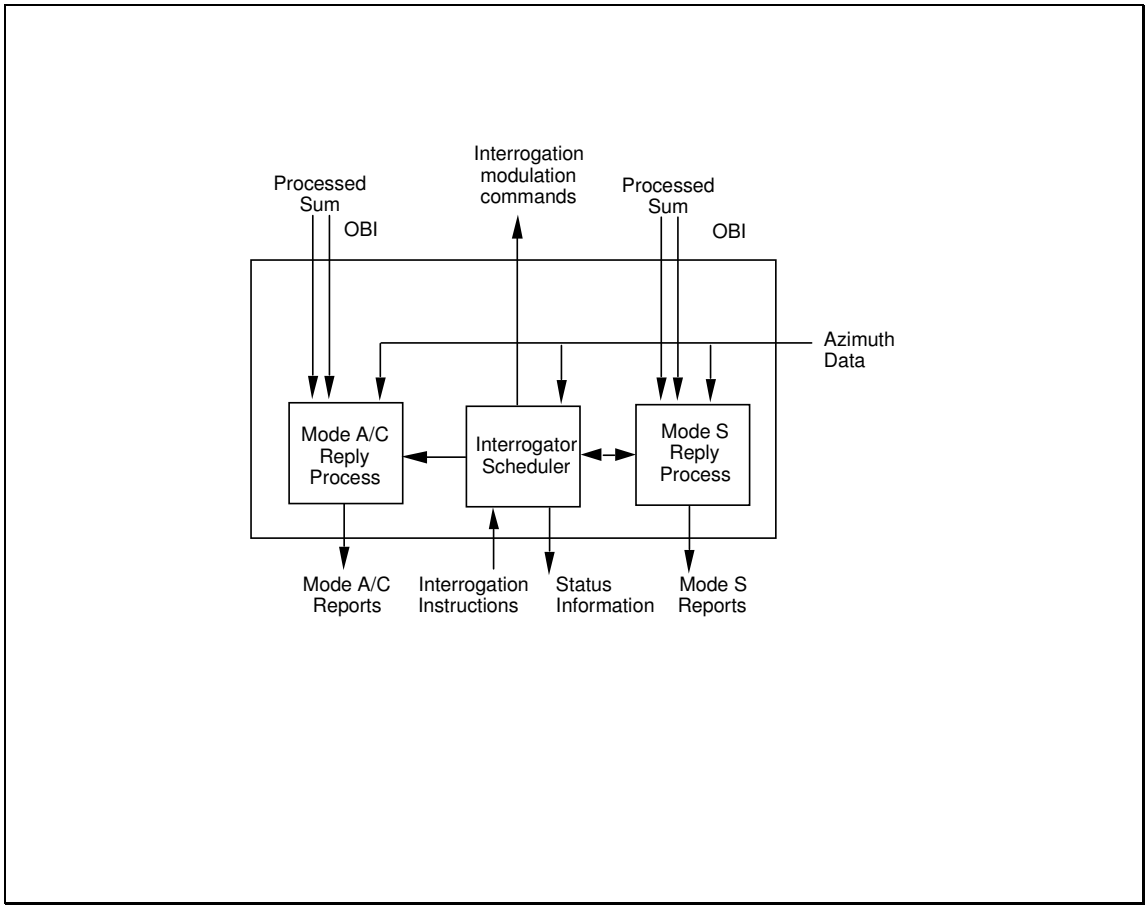

Figure 6 Real Time Channel Controller (RTCC) Functional Overview

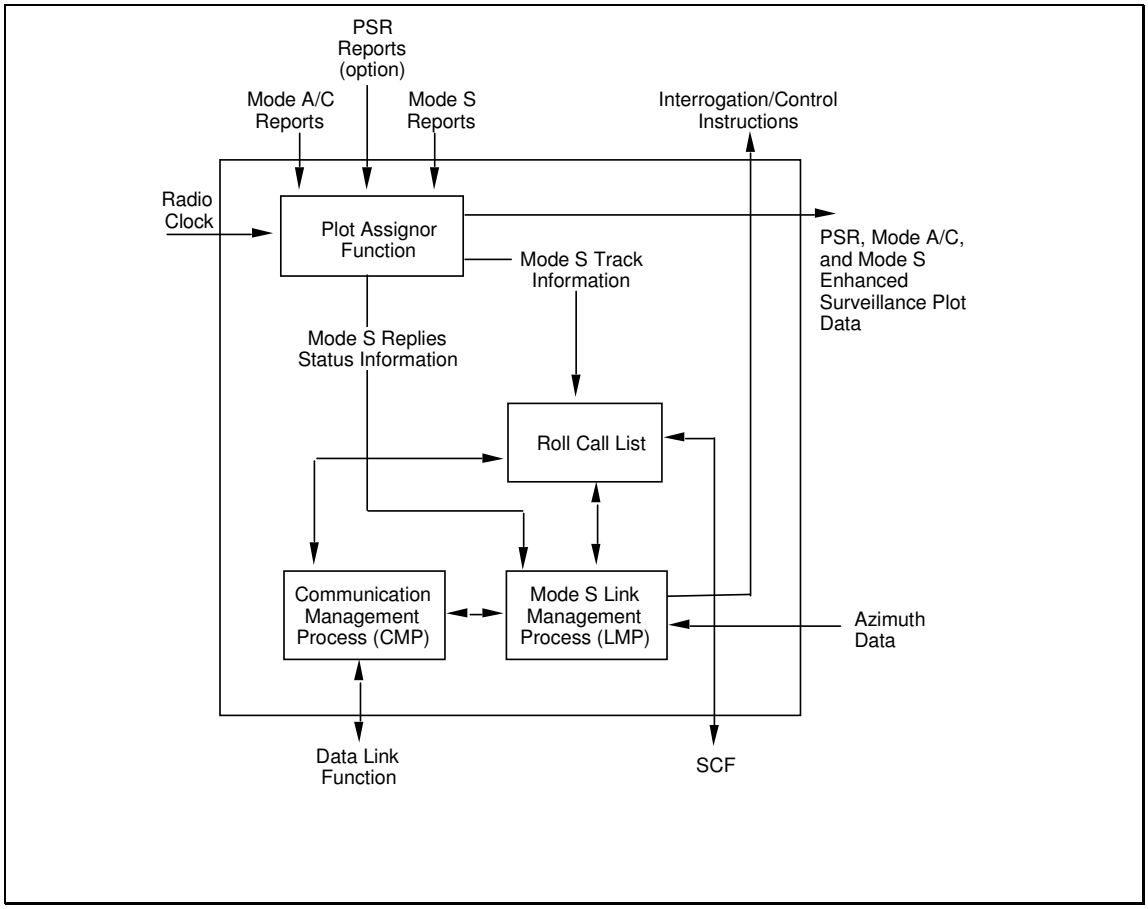

Figure 7 Link Control Functional Overview

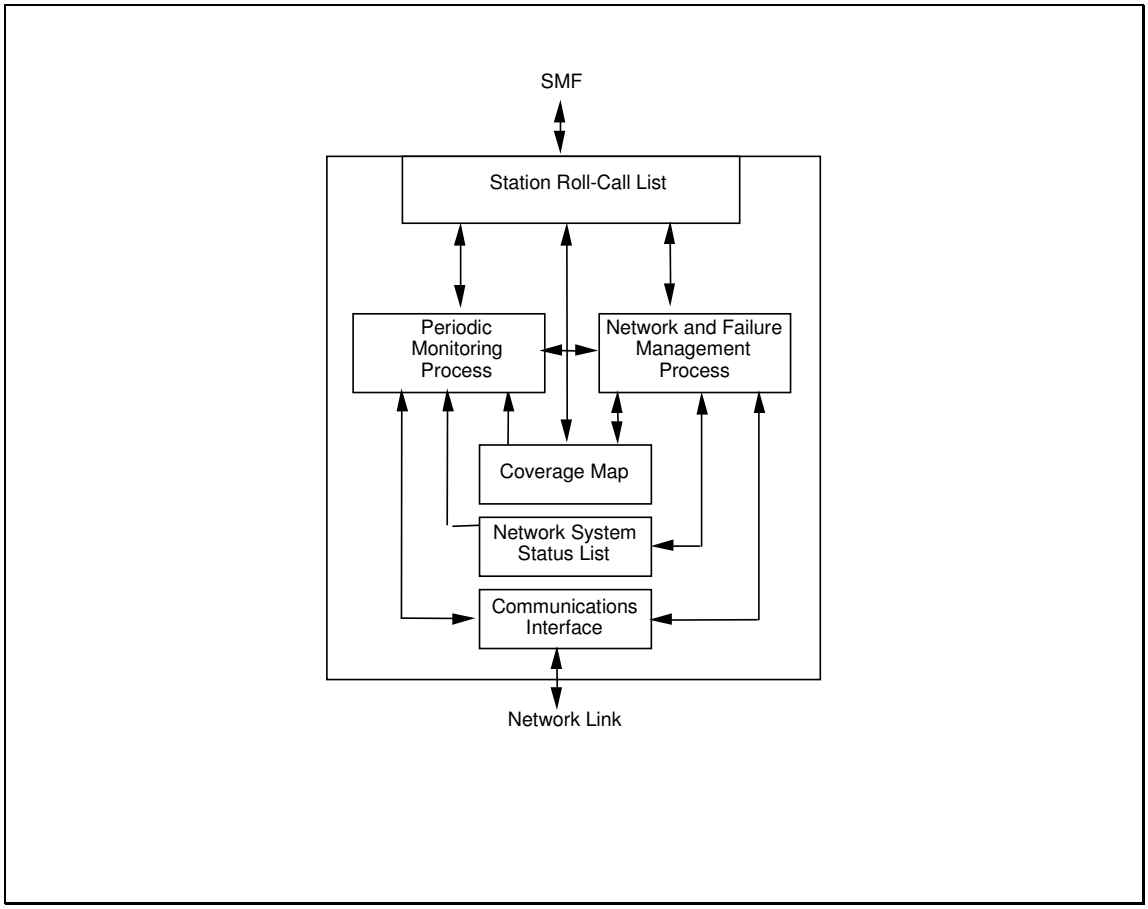

Figure 8 Surveillance Co-ordination Function (SCF) Overview

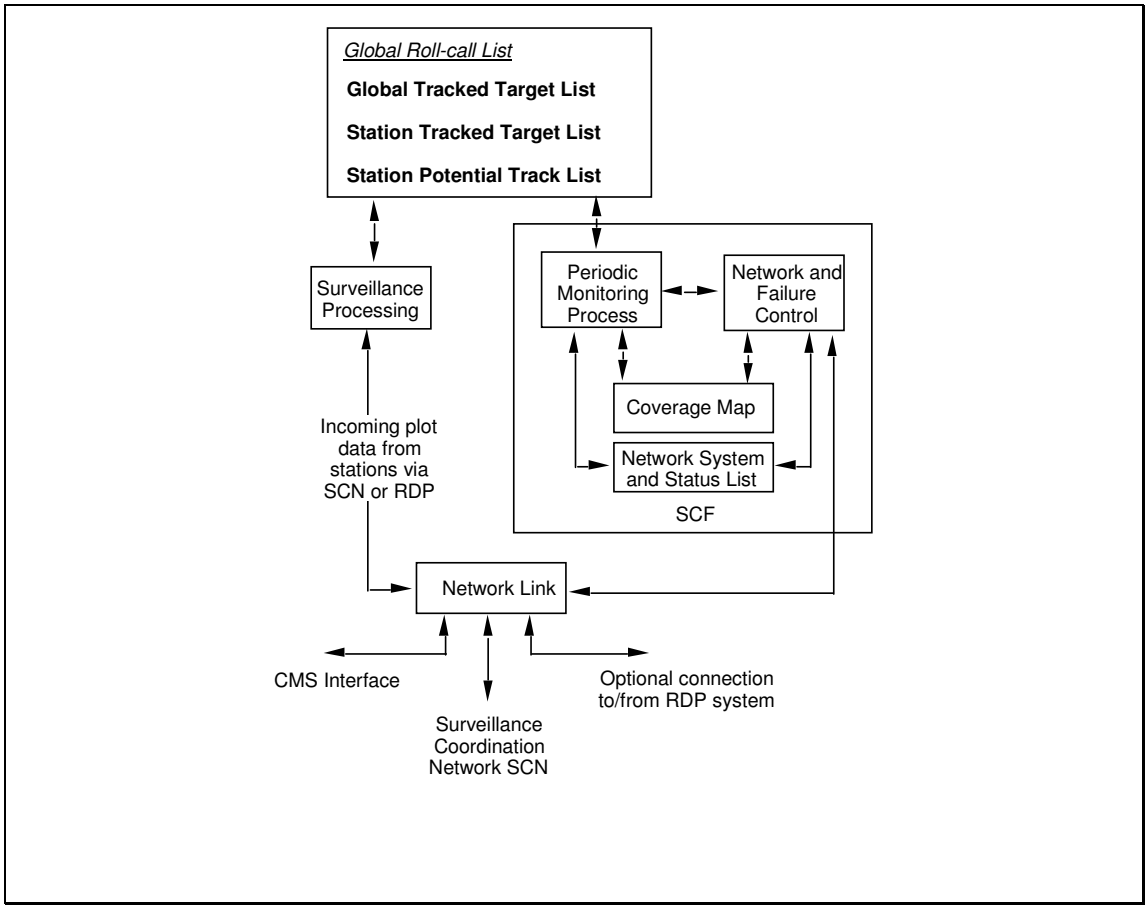

Figure 9 Cluster Controller (CC) Functional Overview

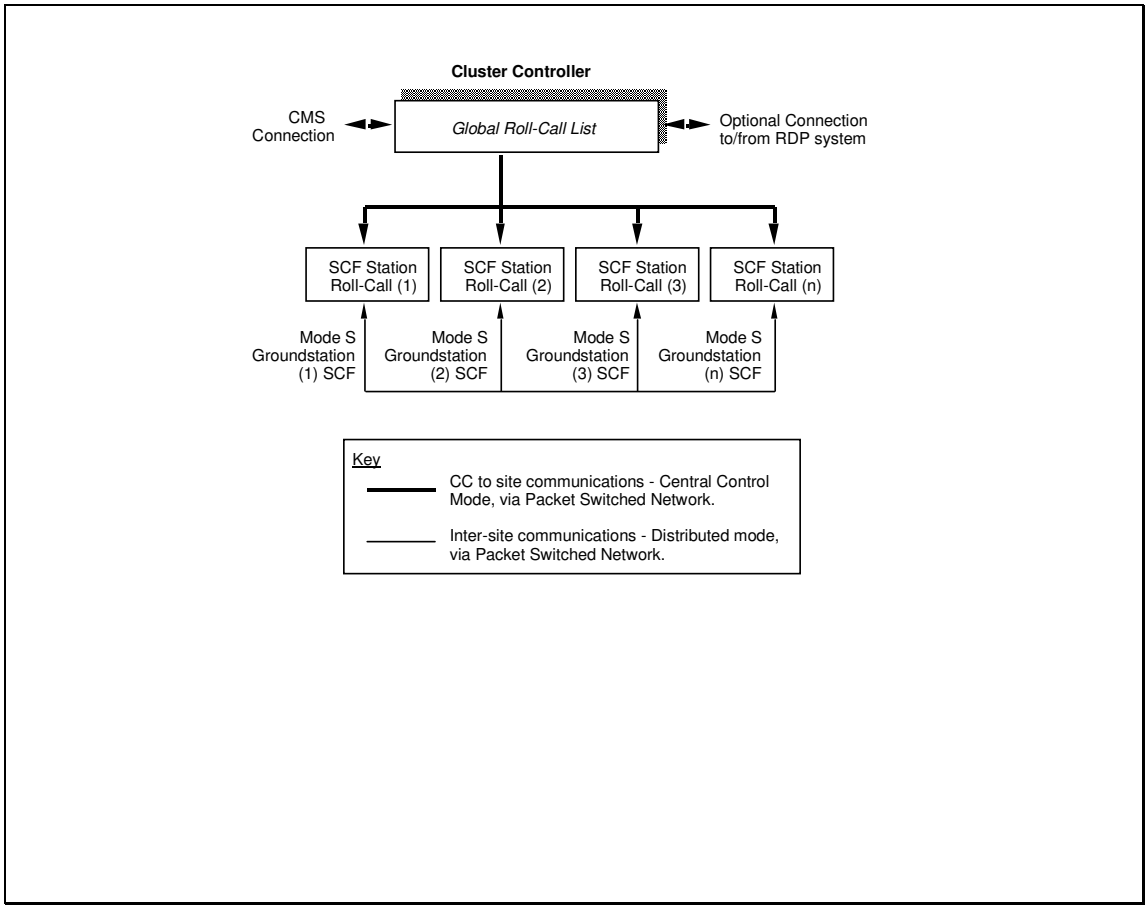

Figure 10 Surveillance Co-ordination Network (SCN)

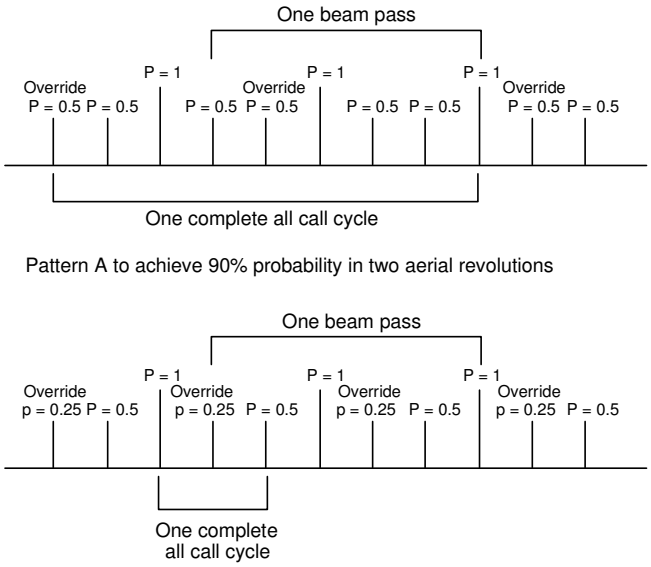

Figure 11 Stochastic All Call Example

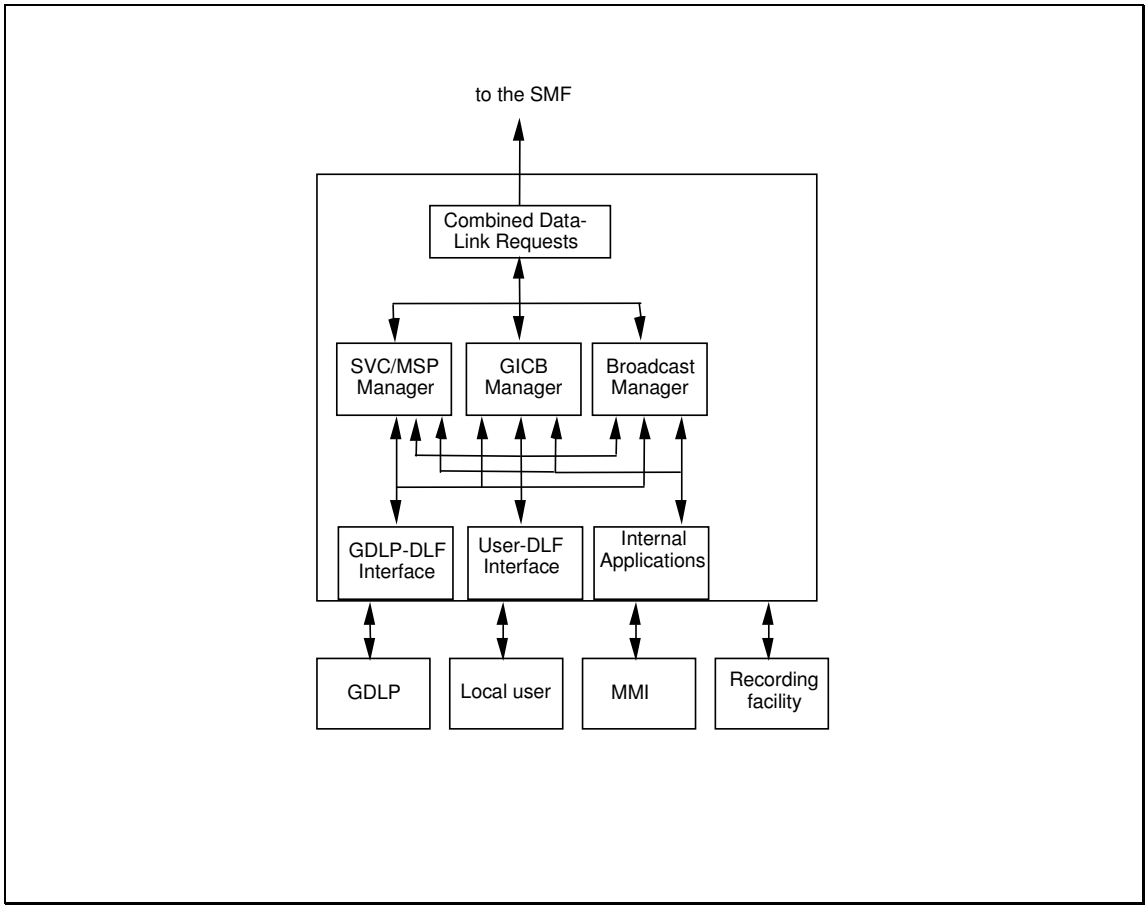

Figure 12 Datalink Function (DLF) Overview

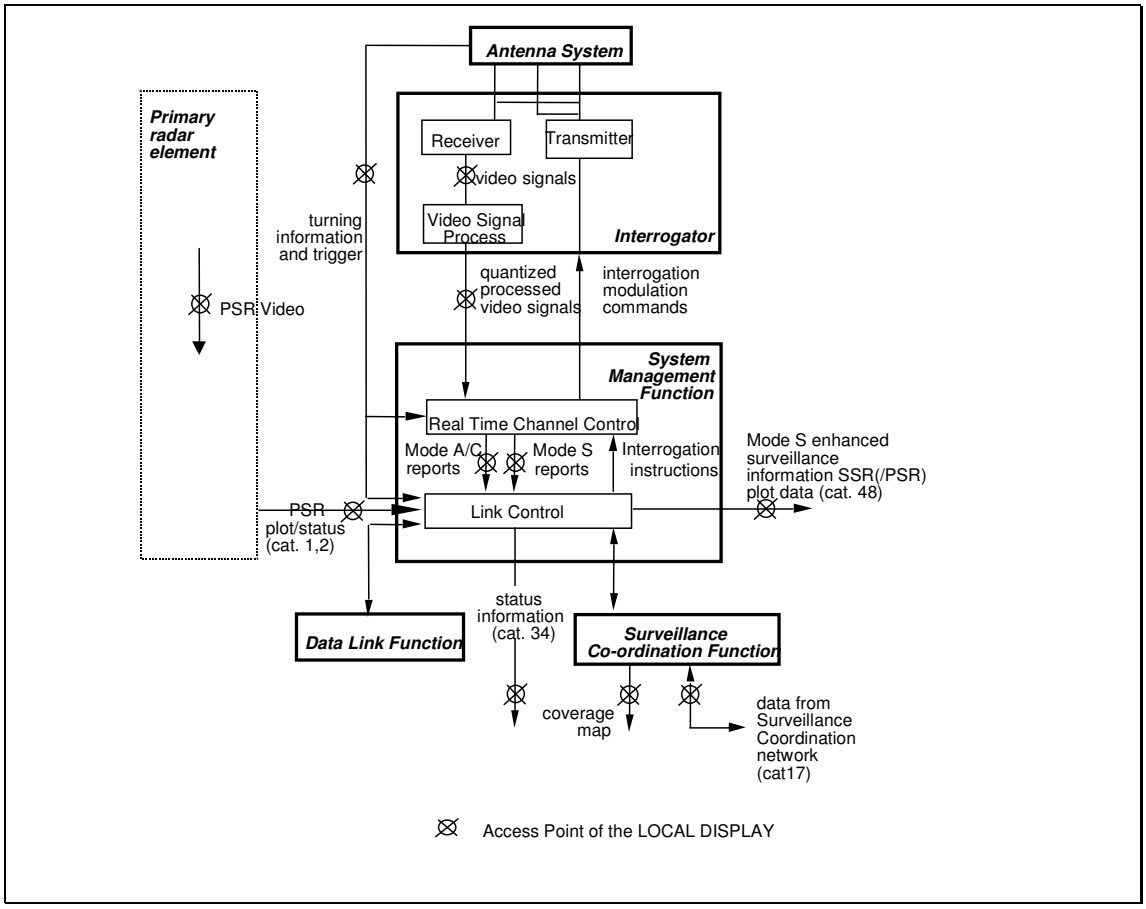

Figure 13 Local Display (LD) Acces Points

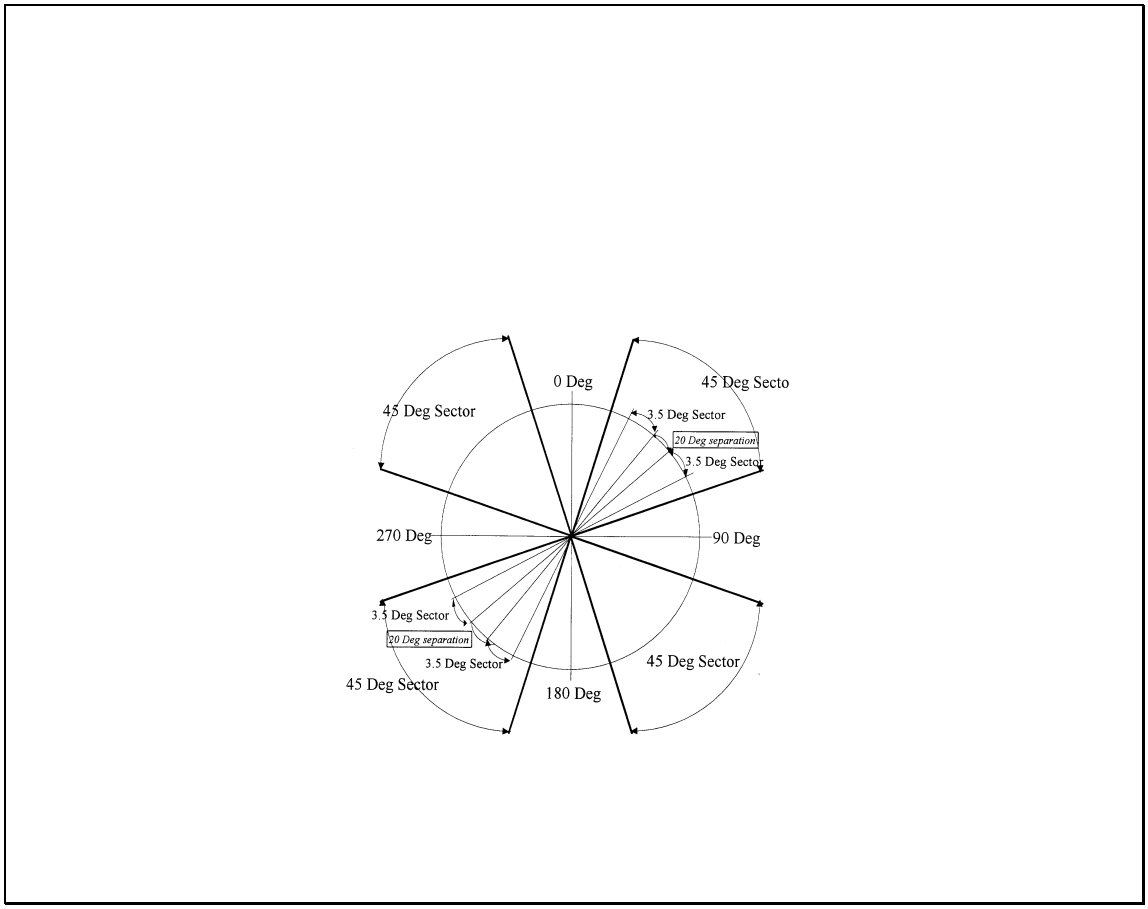

Figure 14 Illustration of Sector Distribution

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9. ANNEX D – METERS

a) Warszawa site

Item	Name	Description	Pcs
1	CW Signal Generator	- bandwidth 1MHz - 4GHz - external pulse triggering with a pulse-with from 300ns - adjustable output power level from + 20dBm to -100dBm - power lever and frequency display	1
2	Arbitrary waveform generator	- bandwidth 125MHz - sampling 1GSa/s[1] - data buffering 2Mpts / channel - 16 bits resolution - function PWM - 2 or 4 channels - with a display or driver by the Personal Computer connection	1
3	Pulse Generator	- bandwidth 10Hz - 200MHz - external pulse triggering form 100ns / TTL - output signal level 10V / 50 ohm - display	1
4	Digital Oscilloscope series DPO or TDS	- DC bandwidth - 1GHz - sampling 5GSa/s[1] - 4 channels - LCD type colour display	1
5	Microwave circulator	bandwidth 0,95GHz - 1,15GHz	1
6	Microwave coupler	- bandwidth 1GHz - 3GHz - average power 250W - direct and reflected power measurement - coupling 30dB	1
7	Adjustable step attenuator	- bandwidth 0 - 12GHz - power 2W CW - step 1dB - range 0 - 70dB	1
8	Measurement cables set	- length 1m - N male - N male - 4 pieces - SMA male - SMA male - 4 pieces - BNC male - BNC male - 4 pieces	1

b) Zabierzów site

Item	Name	Description	Pcs
1	Peak Power meter including probe	- compliant with radar maintenance procedures - power range compliant with sampling points output level, - frequency bandwidth compliant with the radar signals frequencies - sampling at least 20MSa/s[1] - time-gated Power measurements - digital display - measure units Watt and dBm - absolute accuracy +/-0.02, +/-0.5% - equipped with power reference source	1
2	Digital oscilloscope (AT east series DSO),	- compliant with radar maintenance procedures - power range compliant with sampling points output level - frequency bandwidth compliant with the radar signals frequencies - bandwidth at least up to 500 MHz, - 4 channels - sampling do 4GSa/s[1] - USB interface for computer	1
3	Electromagnetic field meter with a probe	- microwave leakage measurements - free space field measurements - digital display - electromagnetic field measurement units W/m2, V/m, A/m etc. - frequency bandwidth compliant with the radar signals frequencies - power density measurement range: min. 0.01 mW/m2 up to min. 0.5 W/m2 - calibration certificate - mobile device (weight below 1 kg.) - equipped with rechargeable batteries and battery charger - suitcase	1