EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION

EUROCONTROL

European Mode S Station Functional Specification

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Abstract

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CONTACT PERSON: Nicolas EERTMANS	**TEL:** 3363	**UNIT:** DIS/SUR

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This version (3.11) of the Mode S Ground Station specification represents the best-available state of requirements at the time of issue and it may be used for the purposes of procurement at the risk of the procuring agency only. In the event of changes to this specification, every effort will be taken to ensure that such changes are brought to the attention of those who have formally been issued with a copy.

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

AUTHORITY	NAME AND SIGNATURE	DATE
Author	Nicolas ~~EERTMANS~~	9/05/05
Mode S System TF Chairman	Eric POTIER	18/05/05
Mode S Programme Manager	John LAW	10/08/05

DOCUMENT CHANGE RECORD

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

EDITION	DATE	REASON FOR CHANGE	SECTIONS PAGES AFFECTED
2.00	13 Dec 1996	POEMS Functional Specification, baseline version for POEMS contract (was SUR.ET2.ST03.3110-SPC-01-00).	
2.01-2.19	12/96-10/99	POEMS TSC internal working drafts of European Mode S Station Functional Specification.	All
2.99	21 Oct 1999	Proposed Issue of European Mode S Station Functional Specification.	All (mostly editorial)
3.00	25 Oct 1999	Inclusion of comments from DFS, NATS and STNA.	
3.01	13 Dec 1999	Released Issue	
3.02	24 Jul. 2000	Technical additions from POEMS TSC	All
3.03	27 Sep 2000	Review of 3.02 and additional modifications during TSC13.	4,7,8,9
3.04	22 Nov 2000	Additional modifications resulting from TSC13	All
3.05	29 Nov 2000	Additional modifications resulting from TSC14	All
3.06	29 Jan 2001	Additional modifications resulting from TSC15	All
3.07	6 Mar 2001	Inclusion of comments from STNA.	All
3.08	19 April 2001	Released issue. References updated.	
3.09	30 March 2005	Correction of typos. Addition of optional SPI, position reports processing & Internet Protocols.	4.2.4.2.3, 4.9.2.1, 4.9.4.2, 7.2.1, 7.3.2.8, 13.2.2.5, Annex B new sections 13.18 and 13.19.

3.10	27 April 2005	Proposed issue following review by MSTF#22. SPI processing becomes advisory. GICB extraction limited to datalink map removed.	7.2.1 changed and 13.19 removed.
3.11	9 May 2005	Released Issue.	-

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EXECUTIVE SUMMARY

The present document describes the functional specification for the European Mode S Ground Station.

European Administrations who wish to take part in the initial implementation programme may use this document as a kernel for their procurement specification.

CHAPTER 1

INTRODUCTION

1.1 Overview

1.1.1 This chapter provides an overview to the implementation of an European Mode S ground station.

1.1.2 Europe currently operates Secondary Surveillance Radar (SSR) stations for the surveillance function. These stations act autonomously, each providing a radar service to the Air Traffic Control Centre (ATCC). The radar systems are required to operate unattended and must therefore rely on control and monitoring information via a Control And Monitoring (CAM).

1.1.3 The Mode S ground station detailed in this document is described as a 'PILOT' system. 'PILOT' systems may be procured by Administrations in the core area who wish to take part in the initial implementation programme. The term 'PILOT' is used to describe a production standard equipment offered for operational implementation. This implementation will introduce Enhanced Surveillance Services to ATC through use of data link services known as the Mode S Specific Services.

The necessary functionality to support the Mode S Specific Services shall be resident in the ground station. These shall be capable of automatically extracting aircraft derived data which may be selected by programmable criteria (e.g. periodic, on initiation of track, within an azimuth window etc.). Extracted aircraft data shall be transmitted to the requesting application and could be included in Mode S extended report messages. Examples of such data are aircraft address, capability, altitude, aircraft identity, ACAS resolution data and aircraft intention data.

The Airborne Data Link Processor (ADLP) will link various aircraft systems to the Mode S transponder and will provide a means for avionics data to be transmitted to the ground via 'Mode S Specific Services'. The ADLP also provides the necessary functionality to support the full Mode S sub network.

1.1.4 A further stage of development in Mode S implementation is expected to be the addition of the Ground Data Link Processor (GDLP) to provide the full functionality of the Mode S Subnetwork.

The Mode S subnetwork provides a reliable point-to-point Switched Virtual Circuit (SVC) communication service across the Mode S air-ground link. It is fully compatible with the Aeronautical Telecommunication Network which provides complete inter-operability between alternative air-ground data-links. The SVC service of the Mode S Subnetwork may also be used by stand-alone applications outside or alongside the ATN environment (see Figure 1).

The Mode S interrogator includes the necessary functionality to interface to the GDLP (including the frame processing function of the Subnetwork).

1.1.5 The Mode S station can operate in a co-operative way with other Mode S stations (see Figure 2).

This makes it possible:

(a) To reduce the Mode S FRUIT rate, by allocating the same II code to all the stations of a cluster; in this case, the aircraft acquisition can be performed, via the ground network;

(b) To compensate for a possible detection miss, by getting additional Mode S data originating from neighbouring stations.

This mode requires an interconnection between the involved stations.

In the event of a radar failure, the adjacent stations can re-configure their coverage area, according to a pre-programmed scheme, so as to limit the uncovered areas.

1.2 Specification Status

1.2.1 Compliance with the specification is required unless departure from the specification requirements can be demonstrated during the call for Tenders to provide advantages technically or to provide advantages in cost terms without any degradation of performances.

1.2.2 The response to the specification is required to be comprehensive with a completed Compliance Summary as set out below.

The identification or referencing of each paragraph or set of paragraphs is standardised to enable a concise compliance status summary to be provided in the proposals. Each paragraph or set of paragraphs has a suffix in square brackets which is one of:

(a) [An] indicating that the immediately preceding paragraphs contain information for the Contractor and is therefore ADVISORY;

(b) [En] indicating that the requirements of the immediately preceding paragraphs are considered ESSENTIAL;

(c) [On] indicating that the requirements of the immediately preceding paragraphs are considered OPTIONAL;

(d) [In] indicating that the immediately preceding paragraphs are requesting essential INFORMATION.

1.2.3 The compliance summary provided shall be completed and returned with the proposal. This compliance summary is in the form of a table, constructed from the following column headings:

Chapter:	Paragraph:	Item:	Compliance:	Proposal Ref:

Each row of the table uniquely identifies each paragraph requiring response in this specification by the Chapter, Paragraph (and sub paragraph) and Item references in the consecutive order in which they appear in this specification, where the Item reference is in the specification paragraph suffix in square brackets referred to above.

The Tenderer compliance status shall be indicated against each paragraph and Item of this specification in the 'Compliance' column with a C for Compliance or an N for Not Compliant. No other response will be recognised during the evaluation and absence of C or N will be counted as Non-Compliant, as will statements such as 'Read and Understood'. This includes Item references [An], [En], [On] and [In] where:

(a) For [An] 'C' indicates that the paragraph has been read, understood, agreed and accepted;

(b) For [En] 'C' indicates that the requirement is fully met in all respects, exactly as stated in this specification;

(c) For [On] 'C' indicates that the option is offered, it will meet the requirements in all respects, exactly as stated in the specification, and is itemised and priced separately in the commercial response and

(d) For [In] 'C' indicates that the information is supplied complete as requested in the specification and the information shall become contractual after the signature of the contract.

Each response to any of [An], [En], [On] or [In] requires a readily identifiable full qualification in the proposal, otherwise it will be counted as unconditionally Non-Compliant.

If an option [On] is offered as a standard without additional cost, and is fully compliant with the requirement as specified, then this must be clearly stated by 'C STANDARD' in the compliance summary, and itemised as a zero cost option in the commercial response.

All reference to cost implications and specific cost details shall be confined to the Commercial response and shall not appear in the technical response. **[E1]**

The information or the data provided in the proposal descriptions and specifications pertinent to each of the paragraphs of this specification shall be cross referenced via the Proposal Ref column in the Compliance summary. **[E2]**

It should be noted that compliance information not included, or included but in error, in the compliance status summary will be counted as a Non-Compliant statement. **[A1]**

1.2.4 The operational and technical facilities defined by this Specification shall be regarded as essential. Within the defined limits of the specification the Contractor has the freedom of design on the condition that the Eurocontrol Agency and the participating States agree that the system meets the requirements. **[E1]**

1.2.5 In the event of conflict between any of the requirements expressed for the Mode S ground station in any reference documents, the requirements expressed in ICAO Annex 10 ([Ref.1.]), and STANAG 4193 ([Ref.2.]) and the Mode S subnetwork SARPS ([Ref.3.]) shall take priority, followed by the requirement in this Specification. **[E1]**

Where conflict occurs between this specification and any other specification or document, the Agency shall be notified. **[E2]**

1.3 Specification Language

1.3.1 Throughout this document, the word 'shall' denotes a mandatory requirement, 'may' a preferred requirement and 'will' a statement of intent. **[A1]**

'The Tenderer' means the company submitting the Tender and 'the Contractor' means the successful Tenderer to whom the contract arising from the Tender has been awarded. **[A2]**

1.3.2 The Contractor shall be wholly responsible for the consistency and correct working of all interfaces between equipment and subsystems within the complete radar systems, including all the interfaces between and within SSR, Mode S and remote control subsystems as specified within this document. **[E1]**

Therefore, as part of the Tender response, the Tenderer shall advise the Agency of any amendments to any of the interface specification material included in this document which is either considered desirable or necessary. **[E2]**

1.3.3 In the absence of any agreed amendments or relaxations, the specification and associated attachments and other documents or specifications referred to, herein shall be the definitive document(s) for all equipment supplied. **[E1]**

1.3.4 Note that throughout this document the term ‘Agency’ is used to mean EUROCONTROL or the National Administration responsible for procurement. **[A3]**

CHAPTER 2

SCOPE

2.1 General

2.1.1 The Contractor shall develop, supply, install and commission a working system that is complete in every respect, provides specified outputs and meets the performance requirements to the full specification detailed in this document and referenced documents. **[E1]**

Acceptance of the ground station equipment will comprise the full system up to and including all the interfaces described in this specification. **[A1]**

For guidance the following issues are anticipated to be confirmed during the 12 month Interoperability Validation exercise:

(a) Interoperability with an ATCC for Enhanced Surveillance services (data requests and delivery) **[A2]**

(b) Interoperability with an ATCC during Network-Aided cluster operation (surveillance integrity) **[A3]**

(c) Interoperability with an adjacent station during cluster co-ordination (failure modes and effects) **[A4]**

2.1.2 The station shall be functionally modular and include facilities to evaluate the performance of individual processes (as described in [Ref.12.]) for the specified operating conditions of Annex G. **[E1]**

2.1.3 Tenderer shall provide a proposal and separate quotation for all options specified in this document. **[E1]**

2.1.4 The Tenderer shall provide all proposal material on a CD-ROM and in a hard copy form. **[E1]**

2.2 Equipment to be Supplied

2.2.1 The Mode S system will be installed on a site to be decided. **[A1]**

2.2.2 The following items shall be supplied with the Mode S system:

(a) Antenna and turning gear system (optional) **[O5]**

(b) 20m tower (optional) **[O1]**

(c) Shelter (optional) **[O2]**

(d) Interrogator **[E2]**

(e) Processing (SMF, DLF, SCF) **[E3]**

(f) Local display **[E4]**

(g) Local playback and recording (optional) **[O3]**

(h) Control and Monitoring **[E5]**

(i) Far field site monitor **[E6]**

(j) Cluster Controller (optional) **[O4]**

(k) Dual GPS Receiver (optional) **[O7]**

(l) All Dedicated Terminals required for parameter configuration **[E8]**

2.2.3 The system shall be provided with dual channel functionality for items (d),(e) and (i) above. **[E1]**

The Tenderer shall advise where an alternative approach to dual functionality may be more appropriate. **[E2]**

2.2.4 The system shall be designed to be located in a building which has been constructed for the purpose of containing the Mode S system. **[E1]**

2.2.5 The Tenderer shall provide the necessary interface functionality to support the Mode S system to be collocated with a primary surveillance radar. **[E1]**

"Collocated" includes both co-mounted and off-mounted configurations. **[A1]**

2.2.6 The Tenderer shall provide in the proposal details of the ground station's modularity. This shall include the design philosophy regarding technological updates and functional upgrade of the hardware and software. **[I1]**

The Tenderer may refer to Ref 13 regarding modular design. **[A1]**

In particular the Tenderer shall indicate how their design approach can accommodate subsequent updates to [Ref.5.] and [Ref.6.]. **[I2]**

CHAPTER 3

SYSTEM DESCRIPTION

3.1 General

3.1.1 As expressed in 1.2.5, 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. **[E1]**

The Mode S ground station shall meet the requirements of Military SPI, Military Emergency train and Mode 3 as defined in STANAG 4193 [Ref.2.]. **[E2]**

The Tenderer shall provide equipment as described in [Ref.2.] which includes Mode 1 and 2. **[E3]**

There is no requirement to include Mode 4. **[A1]**

3.1.2 Each ground station shall support the following functions:

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

(i) Mode 3/A,C,S All-Call interrogation;

(ii) Mode A/C only All-Call;

(iii) Mode S only All-Call. **[E1]**

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

(i) Surveillance, altitude request;

(ii) Comm A altitude request;

(iii) Surveillance identity request;

(iv) Comm A identity request;

(v) Surveillance altitude reply;

(vi) Comm B altitude reply;

(vii) Surveillance identity reply;

(viii) Comm B identity reply;

(ix) Lockout protocols;

(x) Basic data protocols including:

- Flight status;
- Capability reporting.

(xi) Standard length communication protocols:

- Comm A
- Comm A broadcast
- Ground initiated Comm B
- Air initiated Comm B
- Comm B broadcast
- Enhanced Comm-B protocol for Level 5 transponders **[E2]**

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

(i) Comm C

(ii) Comm D

(iii) Multisite uplink ELM protocol

(iv) Non selective uplink ELM

(v) Multisite downlink ELM protocol

(vi) Non selective downlink ELM

(vii) Enhanced ELM protocol for Level 5 transponders **[E3]**

(d) Aircraft Identification Protocol including:

(i) Aircraft identification reporting

(ii) Aircraft capability reporting

(iii) Change of aircraft identification **[E4]**

(e) Data link function including:

(i) Frame processing;

(ii) Mode S specific services processing. **[E5]**

3.1.3 The station shall manage the following:

(a) Mode S specific services to minimise the use of the RF channel e.g. combining identical requests; **[E1]**

(b) The Mode S packets (e.g. prioritise packets, delay the frame processing in order to achieve maximum benefit from multiplexing); **[E2]**

(c) Uplink and downlink broadcasts. **[E3]**

3.1.4 The grouping of functional elements as described in chapters 6 through 9 does not impose any physical implementation. **[A1]**

3.2 Cluster Operation

3.2.1 The number of interrogator identity (II) codes available is limited and therefore unique codes cannot be allocated to each Mode S ground station. A Surveillance Co-ordination Network (SCN) will allow a common II code structure to be implemented for clusters of ground stations. **[A1]**

The Surveillance Identifier (SI) codes described in [Ref.1.] provide additional codes that can be allocated to interrogators which only perform a surveillance function. **[A2]**

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. **[E1]**

3.2.2 The objective of Surveillance Co-ordination is to allow any Mode S ground station to operate effectively within any radar siting plan while keeping the levels of RF pollution as low as possible. This means preventing interference between stations by the correct use of II/SI codes, Mode S protocols, transponder all-call lockout, coverage map configuration and target handover. **[A1]**

3.2.3 A Surveillance Co-ordination Function (SCF) shall be incorporated into each ground station, as described in chapter 8, and shall provide:

(a) Network control and management including failure detection and resolution; **[E1]**

(b) Co-ordination procedures, as defined in [Ref.1.], between coverage areas of networked ground stations to allow targets to be acquired without need for All-Call; **[E2]**

(c) Track data to adjacent stations upon request. **[E3]**

3.2.4 When operating as part of a cluster the stations operation is termed ‘network-aided’. This operation shall support the following modes which are described more precisely in subsequent chapters:

(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.1.]; **[E1]**

(b) Distributed mode where the Ground station SCFs co-ordinate to ensure correct cluster operation, as defined in [Ref.1.]. **[E2]**

In addition to ‘network-aided’ operation the SCF shall also support ‘stand-alone’ operation where each station shall operate independently from cluster. **[E3]**

3.2.5 The data format to be used over the Surveillance Co-ordination Network shall be as described in [Ref.6.]. **[E1]**

3.2.6 The Mode S ground station shall be capable of forming a cluster with any Mode S ground station whose network interface comply with [Ref.1.]. **[E1]**

The Surveillance Ground Network will provide the infrastructure to support communications between the Mode S ground stations and the Cluster Controller. **[A1]**

CHAPTER 4

GENERAL EQUIPMENT AND PERFORMANCE REQUIREMENTS

4.1 Scope

4.1.1 This chapter details the equipment functional and performance requirements which shall be met to satisfy the requirements for the provision of the Mode S system. **[A1]**

4.1.2 Where performance parameters are specified as a standard deviation, this shall always refer to the standard deviation of a Normal Distribution, unless it is specifically stated otherwise. Also the terminology root mean square shall be taken as synonymous with standard deviation (σ1), unless it is specifically stated otherwise. **[A1]**

4.2 Performance Requirements

4.2.1 General

The following paragraphs specify the coverage requirements and specify the system performance parameters. **[A1]**

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. **[E1]**

To ensure that the performance requirements are met the system will be subjected to Factory Acceptance Tests (FAT), Site Acceptance Tests (SAT) along with system performance evaluations, flight trials and live traffic performance evaluations to cover Mode 3/A,C operation and Mode S operation prior to acceptance. In addition to coverage confirmation, targets of opportunity will be used to establish accuracy performance. **[A2]**

Tools approved by the Agency shall be used to check compliance to the required performances. In particular, the Contractor shall obtain and use, where appropriate, the PTE tools for acceptance testing. Characteristics of this equipment are included in Annex I, and a fuller description is available from the Agency. **[E2]**

Supplementary or alternative tools may be proposed to satisfy the compliance and safety requirements of the individual member states, the use of which shall be agreed by the Agency. **[E3]**

The contractor shall fund all costs associated with the provision and use of whichever test tool is selected. **[E7]**

Full coverage and performance details compliant with this specification shall be supplied with the proposal. **[I2]**

It is assumed that SSR Mode 3/A, C and S transponders conform to all the requirements of [Ref.1.]. **[A3]**

The Mode S sensor shall process transponders compliant with ICAO Annex 10 Amendment 69, 71 and 73. **[E4]**

The Tenderer shall clearly describe how he intends to fulfil the previous requirement, and more specifically the determination of transponder's communication capability. **[I3]**

The Tenderer shall in particular indicate the effects on the acquisition processing, internal application list, DLF,GDLP/LU, the use of the continuation subfield/flag, on RAs, and on Asterix reporting. **[I4]**

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 Chapter. **[E5]**

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 Chapter. **[E6]**

In addition to the general operating model of Annex G, the performance requirements shall be met for the operational configurations (IRF vs. range/turning rate) of the sites to be commissioned. **[E8]**

The Tenderer shall define how many re-interrogations, in function of range, are assumed to achieve the Mode S performance requirements for all configurations given in Annex G, and target velocity limits specified in 4.6.10. This shall be supported by field data. **[I5]**

It is a goal for the system to minimise the re-interrogation rate while meeting all required performances. **[A4]**

The Tenderer shall describe in detail how non-discrete Mode A codes are handled by the station. **[I6]**

4.2.2 Radar Coverage

4.2.2.1 The 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. **[E1]**

The upper limit of cover shall be at least 66,000 ft. **[E2]**

It is expected that, due to site conditions and earth curvature the lower limit of coverage shall not be horizontal all the way to 256 NM. **[A1]**

The Tenderer shall state the lower limit of coverage in elevation and under what conditions this lower limit shall be achieved. **[I1]**

The zenithal gap, shall not extend below an elevation angle of 45° above the horizontal. **[E3]**

4.2.2.2 The Tenderer shall provide horizontal and vertical polar diagrams for the ICAO defined transponder frequency bands to achieve the accuracy and detection performance of 4.2.3 and 4.2.6 throughout cover. **[I1]**

The vertical polar diagrams shall include the following conditions:

(a) Free space; **[E1]**

(b) Antenna height 20m, medium dry ground with a Relative Permittivity of 15 and Conductivity of 0.04 Siemens per metre; **[E2]**

(c) Antenna height 20m, sea water with a Relative Permittivity of 70 and Conductivity of 5 Siemens per metre. **[E3]**

For the purposes of calculation the reflection surfaces of (b) and (c) may be assumed to be spherical and optically smooth and conform to the WGS 84 Earth Model. **[A1]**

The Mode S equipment provided by the Contractor shall meet the requirements detailed in the polar diagrams as agreed by the Contractor and the Agency prior to the award of the Contract. **[E4]**

The Tenderer shall state in their proposals any non compliance with the performance requirements of 4.2.3 and 4.2.7 within the first null above the horizontal. **[I2]**

4.2.2.3 The Tenderer shall also clearly explain the technique used and the effects on the performance of sensitivity time control (STC) and any other thresholding in the system (e.g. short pulse elimination and received signal strength), specifically stating the STC levels assumed. **[I1]**

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°. **[E1]**

4.2.2.4 During the commissioning phase, the Contractor shall analyse the radar sensor performance in order to define the Commissioning Volume where the radar sensor can provide radar services according to local environmental and operational constraints. This Commissioning Volume shall be agreed between the Contractor and the Agency. **[E1]**

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. **[A1]**

The Measurement Volume is defined for a normal site, however in certain cases (e.g. area of mountains) this volume should be adapted by using the Eurocontrol RASCAL tool in order to define the volume which is not subject to terrain screening. **[A2]**

Annex G provides the volumes (Commissioning or Measurement Volume) against which the site performances requirements shall be tested. **[E2]**

All theoretical or required site performances can be verified in factory with simulated targets and without any volume restriction. **[A3]**

4.2.3 Position Detection Performance

4.2.3.1 General

The Probability of Detection (Pd) shall be determined by the ratio of the number of target reports with measured position to the number of total expected reports. **[A1]**

The expected reports are the reports contained between the first and the last report from the same aircraft before it leaves the volume to be analysed. The method of chaining will be that which is defined in PTE tool. **[A2]**

The Tenderer should anticipate that the verification of probability of detection will be undertaken using the PTE tool set for a monoradar analysis. **[A3]**

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. **[A4]**

The above figures shall be met by the Mode S equipment for the overall coverage area. **[E1]**

'Overall' means that the measurement method shall be applied without further geographical restrictions to the whole sample of the recorded data obtained from opportunity traffic within the Commissioning Volume. **[A5]**

The performance characteristics for existing operational Monopulse sites shall be the benchmarks against which the detection and code validation of Mode S operational stations will be validated. **[A6]**

The Tenderer shall state, for each performance justification, the values for All Call and Roll Call period durations, Mode 3/A,C and Mode S All Call IRF using the values for antenna rotation speed given in the Annex G. **[I1]**

The Tenderer shall provide, as part of the Tender response, evidence that his proposed system can fully meet the performance requirements, and stating under what conditions (e.g. site, garbling, FRUIT rate). **[I2]**

The Tenderer shall detail in the proposal the effect of an increase of FRUIT rate to 20 000 FRUIT/s in the 3dB beamwidth on the Probability of Detection **[I3]**

In order to provide an adequate sample size for performance verification, the data collected for peak traffic hours will include at least 50000 reports. **[A7]**

The Tenderer shall state and justify the round trip reliability for all surveillance Mode S transactions. **[I5]**

The Tenderer shall state all assumptions made in response to paragraphs 4.2.3.1 to 4.2.3.3, and shall also indicate any circumstances where the values given will be modified. **[I6]**

4.2.3.2 SSR Detection without synchronous garbling

4.2.3.2.1 SSR Theoretical Detection

The Tenderer is advised that in addition to transponders which operate with 21dBW, SSR transponders having power outputs of 18.5 dBW are permitted for aircraft not flying above 15000 ft. **[A1]**

The Tenderer shall provide a downlink power budget for transponders having a power output of 18.5 dBW, stating the maximum detectable range at 15000 ft. **[I1]**

The Tenderer shall state any deviation from the accuracy and detection performance of 4.2.3 and 4.2.6 for transponders having power outputs of 18.5 dBW. **[I2]**

The Tenderer shall provide detection analysis, including uplink and downlink budgets for 256 NM range; 150 Hz IRF, vertical polar diagrams for the conditions of Annex G and for each of the following transponder reply frequencies:

(a) 1090 MHz

(b) 1087 MHz

(c) 1093 MHz **[I3]**

The Tenderer shall state, for each detection analysis, the All Call and Roll Call period durations, Mode 3/A,C and Mode S All Call IRF. **[I4]**

The Tenderer shall state the achievable plot detection and correct code validation figures for each transmitted mode (3/A, C) for the conditions stated in **[I3]**, assuming that the transponder code responses conform to [Ref.1.] and [Ref.2.]. **[I5]**

The Tenderer shall also include in the proposal details of the minimum number of replies required at the receivers' inputs to detect a target and output a report with an agreed accuracy and level of confidence when interrogating on the following:

(a) Mode 3/A only; **[I6]**

(b) Mode C only; **[I7]**

(c) 3/A, C mode interlace. **[I8]**

For the above, assume that the detected target is subjected to the full target processing in the system, and that it shall be output as a confirmed report. **[A2]**

The Tenderer shall provide in the proposal an analysis of how the system will achieve a theoretical SSR probability of detection better than 99%, for aircraft which are not close (slant range > 2 NM, azimuth > 2 * nominal 3dB interrogation beamwidth), with the following hypotheses:

- 4 interrogations in the 3 dB beam (2 mode A and 2 mode C);
- a transponder probability of reply equal to 90%;
- a target and FRUIT rate as defined in Annex G;
- Mode A/C transponder. **[I9]**

The Tenderer shall detail in the proposal how this probability of detection will be tested in FAT. **[I10]**

4.2.3.2.2 SSR Site Performance

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:

(a) Which are in the Measurement Volume;

(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). **[E2]**

The definition of the above filter is made in order to avoid taking into account problems due to the site or due to the distribution of the traffic between this clear area and the remainder of the radar coverage. **[A1]**

The probability of detection shall be verified at FAT & SAT as defined in section 14.15 **[E4]**

4.2.3.3 Mode S Detection in Selective mode

4.2.3.3.1 Mode S Theoretical Detection

The Tenderer shall provide detection analysis, including uplink and downlink budgets for 80, 150, 200 and 256 NM ranges, vertical polar diagrams for the conditions of Annex G and for each of the following transponder reply frequencies:

(a) 1090 MHz

(b) 1087 MHz

(c) 1093 MHz **[I1]**

The Tenderer shall state, for each detection analysis, the values for antenna rotation speed, range, All Call and Roll Call period durations, Mode 3/A,C and Mode S All Call IRF. **[E1]**

The Tenderer shall state the achievable plot detection and correct Mode S address validation figures for each transmitted Mode S surveillance/SLM replies (Downlink Formats 4, 5, 20 and 21). **[I2]**

The Tenderer shall provide in the proposal an analysis of how the system will achieve a theoretical Mode S probability of detection better than 99%, with the following hypotheses:

- A transponder probability of reply equal to 90%,
- A target and FRUIT rate as defined in Annex G,
- Mode S transponder. **[E2]**

The Tenderer shall explain how, during handover, the probability of detection will be maintained in a cluster whereby each station will share the same II/SI code. **[I4]**

The Tenderer shall detail in the proposal how the probability of detection and the number of re-interrogations will be tested in FAT. **[I5]**

The Tenderer shall detail in the proposal how the probability of detection, during handover, will be tested in the case of operation as part of a cluster whereby each station will share the same II/SI code. **[I6]**

4.2.3.3.2 Mode S Site Performance

For Mode S targets, track reports using external data coming from an adjacent sensor will be considered as extrapolated data and shall not be taken into account as a target report with measured position. **[E1]**

On site, the probability of detection shall be measured when the station does not operate network aided. **[E2]**

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:

- Which are in the Measurement Volume;
- Which are not in the zenithal gap (elevation angle below 40);
- Which are not in close proximity to each other (slant range > 5.3 NM, azimuth > 2 * nominal 3dB interrogation beamwidth). **[E4]**

The definition of the above filter is made in order to avoid taking into account problems due to the site or due to the distribution of the air traffic between this clear area and the remainder of the radar coverage. **[A1]**

The 99% of probability of detection (defined in **[E4]**) shall be achieved in roll call with, on average, 2 GICB requests per aircraft. **[E6]**

With the probability of detection measured in the volume described above, the Contractor shall provide the average number of interrogations per aircraft. **[I1]**

The probability of detection shall be verified at FAT & SAT as defined in section 14.15. **[E7]**

The Tenderer should anticipate that the verification of probability of detection as defined above will be undertaken for each site using a long duration recording (more than 50,000 reports) and the PTE tool set. **[A3]**

4.2.4 Code Detection without Synchronous Garbling

4.2.4.1 Code Detection and Validation for SSR

4.2.4.1.1 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. **[E1]**

4.2.4.1.2 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. **[E1]**

4.2.4.1.3 The special civil codes 7500, 7600 and 7700 shall be detected and recognised, as defined in [Ref.1.]. **[E1]**

The special Military Emergency reply train, as defined in [Ref.2.], shall be detected, recognised and the appropriate fields set in the target report. **[E2]**

The special Military Identity reply train, as defined in [Ref.2.], shall be detected, recognised and the appropriate fields set in the target report. **[E3]**

The above codes shall be output immediately upon detection, and not subject to any delay. **[E4]**

The appropriate identifier bits as specified in Ref 5a shall be set in the output message. **[E5]**

4.2.4.1.4 The probability of code detection is defined as, at each scan, for a given target, a radar target report with correct and validated code data, corresponding to the interrogation modes, is produced. **[A1]**

The probability of Mode A/Mode C code detection is determined by the ratio of the number of target reports with correct Mode A/Mode C code data to the number of target reports used to calculate the target position detection. **[A2]**

As a minimum, the overall Mode 3/A probability of correct and valid code detection shall be better than 98% for large samples, without any geographical restrictions, of opportunity traffic. **[E1]**

As a minimum, the overall Mode C probability of correct and valid code detection shall be better than 96% for large samples, without any geographical restrictions, of opportunity traffic. **[E2]**

4.2.4.1.5 It is expected that achieved performance figures will be higher than in 4.2.4.1.4 above. The Tenderer shall provide in the proposal details of the performance figures which the equipment shall be able to meet and state under what conditions. **[I1]**

4.2.4.1.6 The Tenderer should anticipate that the verification of code detection and validation as defined above will be undertaken for each site using large live traffic samples and the PTE tool set. **[A1]**

4.2.4.1.7 As a maximum the percentage of incorrect but validated Mode A codes shall be lower than 0.1%. **[E1]**

4.2.4.1.8 As a maximum, the percentage of incorrect but validated Mode C codes shall be lower than 0.1%. **[E1]**

4.2.4.2 Code Detection and Validation for Mode S

4.2.4.2.1 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. **[E1]**

4.2.4.2.2 The Tenderer shall provide in the proposal details of the performance figures which the equipment shall be able to meet and state under what conditions. **[I1]**

The Tenderer should anticipate that the verification of code detection and validation as defined above will be undertaken for each site using large live traffic samples and the PTE tool set. **[A1]**

4.2.4.2.3 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 messages. **[E1]**

4.2.4.2.4 The special civil codes 7500, 7600 and 7700 shall be detected and recognised, as defined in [Ref.1.]. **[E1]**

The above codes shall be output immediately upon detection, and not subject to any delay. **[E2]**

The appropriate identifier bits as specified in Ref 5a shall be set in the output message. **[E3]**

4.2.5 False and Multiple Target Processing (Mode 3/A,C,S)

4.2.5.1 False Target Processing

SSR Target reports generated by one or more of the following shall be classified as false target reports:

(a) FRUIT;

(b) Second time around echoes. **[E1]**

The false target report ratio is the number of false target reports in relation to the number of detected target reports. **[A1]**

The overall false target report ratio shall be less than 0.1%. **[E2]**

The Tenderer shall provide full analysis of the false target processing subject to the FRUIT rates and distribution of Annex G and state the maximum False Target Rate likely to be incurred under the operating conditions described in Annex G paragraphs G.2 and G.4. **[I1]**

The Tenderer shall anticipate that the verification of the false target rate as defined above will be undertaken for each site using the PTE tools set. **[A2]**

4.2.5.2 Multiple Target Processing

Multiple Mode S/SSR target reports shall include all those target reports generated by:

(a) Replies from an aircraft interrogated by the radar via an indirect path (reflection);

(b) Replies from an aircraft interrogated through a sidelobe of the directional antenna pattern and which are not inhibited by the sidelobe suppression antenna pattern (sidelobes);

(c) Target split in several sequences either in azimuth or in distance (splits). **[E1]**

The overall Multiple Mode S/SSR Target Rate, measured over one hour, shall be less than one target per scan on average. **[E2]**

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". **[E3]**

The Tenderer shall provide details in the proposal of candidate methods to achieve such discrimination when targets are detected in the same beam-dwell. **[I1]**

The Tenderer shall provide full analysis of the multiple target processing subject to the FRUIT rates and distribution of Annex G and state the maximum

Multiple Target Rate likely to be incurred under the operating conditions of Annex G. **[I2]**

The Tenderer shall anticipate that the verification of the Multiple Target Rate as defined above will be undertaken for each site using the PTE tools set. **[A1]**

4.2.6 Surveillance Position Accuracy

4.2.6.1 General

The range and azimuth accuracy requirements specified herein shall be the minimum requirements. The Tenderer shall provide as part of the technical proposal:

(a) Detailed accuracy performance characteristics of the proposed equipment; **[E1]**

(b) Any conditions which impact the proposed performance characteristic; **[E2]**

(c) Detailed system level accuracy error budget analysis as described in Annex H. **[E3]**

Existing monopulse SSR system performance characteristics will be used as a benchmark for evaluating the Tenderers proposal. **[A1]**

The conditions, under which the random errors (azimuth and slant range error standard deviation) and systematic errors (azimuth and slant range bias) will be measured, shall be: **[E4]**

(a) Plot position data measured at the output interface to the Surveillance users;

(b) Non garbled pulse reply conditions;

(c) Aircraft within the Commissioning Volume;

(d) Interrogation conditions, received power and frequency levels as stated in Annex G;

(e) Separate measurements for:

  (i) Mode 3/A, C reports;

  (ii) Mode S all call reports;

  (iii) Mode S roll call reports.

(f) Long term effects (i.e., stability with time);

(g) Any combination of units/subsystems which are configured to meet redundancy requirements;

(h) Measurements using the conditions for accuracy test requirements stated elsewhere in this document and as stated by the Tenderer in his proposal.

The Tenderer should anticipate that the verification of accuracy as defined above will be undertaken for each site using some combination of live traffic, the fixed far field monitor, a Target/FRUIT generator and the PTE tool set. **[A2]**

4.2.6.2 Range Accuracy

The Mode S sensor slant range errors, for any modes (3/A, C or S), shall be within the following limits:

(a) Systematic Errors

(i) The slant range bias shall be < +1/128 NM (+14 metres). **[E1]**

(b) Random Errors

(i) All SSR Random errors shall be less than 30 m RMS (1 sigma) **[E2]**

(ii) All Mode S Random errors shall be less than 15 m RMS (1 sigma) **[E3]**

The speed of light value shall be a Site Dependant Parameter programmable, providing 2 values:

(a) The vacuum value (the only internationally recognised one): c = 299,792,458 $m.s^{-1}$;

(b) Another value (to be specified by the Agency) **[E4]**

The programming of this site-dependant parameter shall be possible at the CAM or at the Dedicated Terminal to be delivered. **[E5]**

The Tenderer shall clearly describe the effects of this SDP on the systematic and random range errors. **[I1]**

4.2.6.3 Azimuth accuracy

All detected targets within the stated coverage volume for any modes (3/A, C or S), measured using live traffic or controlled test transponders shall be within the following limits:

(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°). **[E1]**

(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). **[E2]**

(b) Random Errors

(i) All azimuth random errors shall be less than 0.068° (one sigma) **[E3]**

The azimuth bias shall not increase at elevation angles more than 10° by an amount attributable to the antenna (e.g. beam widening effects -normally the inverse cosine of the elevation angle). **[E4]**

The system azimuth bias elevation changes attributable to the antenna beam widening at large elevation angles shall be stated by the Tenderer in his proposal. **[I1]**

This value shall be verified by tests of the antenna as part of the overall system test. **[E5]**

4.2.6.4 Bias Adjustment and Stability

The bias null adjustment in range and azimuth shall be applied by site dependent adaptation values. **[E1]**

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.). **[E2]**

Operationally compatible calibration procedures, employing these capabilities, shall be developed and used as part of accuracy tests. **[E3]**

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. **[E4]**

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°) **[E5]**

4.2.6.5 Range and Azimuth precision

Target range shall be reported to a precision of at least 1/128 NM at all ranges. **[E1]**

Target azimuth shall be reported to a precision of at least 360/16384 (0.022)° at all ranges and azimuths. **[E2]**

The Tenderer should anticipate that the verification of range and azimuth precision as defined above will be undertaken for each site using a Target/FRUIT generator and the PTE tool set. **[A1]**

4.2.6.6 Jumps

Jumps are defined in [Ref.11.] as being reports with positional error higher than 1° in azimuth or 700 m in range. **[A1]**

The overall jump rate, defined in [Ref.11.] as being the number of jumps divided by the number of detected reports, shall be less than 0.05%. **[E1]**

4.2.7 Target Processing

4.2.7.1 Performance with Garbling Targets

4.2.7.1.1 General

4.2.7.1.1.1 It is expected that the achieved performance figures will be higher than the following minimum requirements of 4.2.7.1.2 to 4.2.7.1.5. **[A1]**

It is anticipated that the figures below are achieved for all operational ranges and associated turning rates and IRF specified in Annex G. **[A2]**

The Tenderer shall provide in the proposal details of the performance figures which the equipment shall be able to meet and state under what conditions. **[I1]**

4.2.7.1.1.2 The Tenderer shall include in the proposal a detailed analysis of the resolution and garble performance of their system (including Mode 3/A, C codes and Mode S addresses), stating any conditions for which the requirements of 4.2.7.1 will not be achieved including the limits of relative amplitudes and relative off boresight angles of interfering replies. **[I1]**

4.2.7.1.1.3 The Tenderer shall detail in the proposal how the azimuth's accuracy of the reply is determined. **[I1]**

4.2.7.1.1.4 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. **[E1]**

Genuine targets, including relative targets with C2/SPI spacing, shall not be rejected as phantoms. **[E2]**

The Tenderer shall provide details in the response on his proposed method of handling phantom replies. **[I1]**

4.2.7.1.1.5 The Tenderer shall include in the Power Up Checks a test with simulated targets generated by the TTG function (Test Target Generator). This function shall generate artificial plots within a complete scan to test the basic functionalities of the Link Control (LC). This test process will not result in a plot delivered off the site. **[E1]**

The Tenderer shall provide details in the response of the proposed method of TTG. **[I1]**

4.2.7.1.2 SSR Positional Detection with Garbling Target

4.2.7.1.2.1 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%. **[E1]**

4.2.7.1.2.2 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%. **[E1]**

4.2.7.1.2.3 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%. **[E1]**

4.2.7.1.2.4 Outside the separation window areas as defined in 4.2.7.1.2.1 to 4.2.7.1.2.3, the probability of detection shall be the same as described in paragraph 4.2.3.1. **[E1]**

The Tenderer should employ a Target/FRUIT Generator and the PTE tool set to verify the average Pd of two SSR Mode 3/A,C targets as defined above. **[A1]**

The Tenderer shall provide guaranteed values for the probability of detecting an SSR target for each of the above defined areas. **[I1]**

4.2.7.1.3 Mode S Detection with Garbling Reply

4.2.7.1.3.1 Whatever the relative position of both targets, the radar shall maintain the Probability of detection specified in 4.2.3 when using selective surveillance interrogations. **[E1]**

The Tenderer shall state in the proposal the expected acquisition performance for both targets when using stochastic acquisition. **[I1]**

4.2.7.1.3.2 If two replies were to be received simultaneously by the radar, The Tenderer shall provide in the proposal details of the probability of detection for a Mode S short and long reply garbled over an overlapping time ‘ t’ as listed below with an SSR or Mode S reply.

(a) t =< 20 microseconds **[I1]**

(b) 20 < t =< 32 microseconds **[I2]**

(c) 32 < t < 64 microseconds **[I3]**

(d) t => 64 microseconds **[I4]**

The Tenderer should anticipate that the verification of Mode S detection with a garbling target as defined above will be undertaken for each site using a Target/FRUIT generator and the PTE tool set. **[A1]**

4.2.7.1.4 SSR Correct Code Detection with Garbling Targets

4.2.7.1.4.1 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%. **[E1]**

4.2.7.1.4.2 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%. **[E1]**

4.2.7.1.4.3 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%. **[E1]**

The Tenderer should anticipate that the verification of SSR code validation with a garbling target as defined above will be undertaken for each site using a Target/FRUIT generator and the PTE tool set. **[A1]**

4.2.7.1.5 Mode S Decoding Performance with Garbling Replies

4.2.7.1.5.1 Whatever the relative position of both targets, the radar shall maintain the decoding probability and reply integrity specified in 4.2.4.2 for all Mode S selective interrogations. **[E1]**

4.2.7.1.5.2 If two replies were to be received simultaneously by the radar, The Tenderer shall provide in the proposal details of the decoding probability for a Mode S short and long reply garbled over an overlapping time 't' as listed below with an SSR or Mode S reply.

(a) t =< 20 microseconds **[I1]**

(b) 20 < t =< 32 microseconds **[I2]**

(c) 32 < t < 64 microseconds **[I3]**

(d) t => 64 microseconds **[I4]**

The Tenderer should anticipate that the verification of Mode S code validation with a garbling target as defined above will be undertaken for each site using a Target/FRUIT generator and the PTE tool set. **[A1]**

4.2.7.2 Target Loads

4.2.7.2.1 The number of targets to be processed will depend on the operational range of the radar and the range distribution of the targets. For modelling and test purposes the target load shall be assumed to vary with range as shown in G.4. **[A1]**

4.2.7.2.2 The radar systems offered shall be capable of processing at least the following number and distribution of targets from 0.5 NM to 256 NM instrumented range with a rotating antenna turning rate of at least 10 rpm:

(a) A steady state maximum of 900 transponder equipped aircraft in cover; **[E1]**

(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; **[E2]**

(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. **[E3]**

The numbers of targets specified above are considered to be numbers of real targets and do not include false target replies. **[A1]**

The distribution of sectors, described above, is illustrated in Figure 16. **[A2]**

The Tenderer shall state in the proposal details of the minimum processing capabilities for the sectors defined above for each of the scenarios of the following:

(a) All transponders shall be Mode S. **[I1]**

(b) 50% of transponders shall be Mode 3/A,C and 50% shall be Mode S. **[I2]**

(c) 25% of transponders shall be Mode 3/A,C and 75% shall be Mode S. **[I3]**

4.2.7.2.3 The Interrogator-Receiver and System Management Function shall EACH be demonstratively capable of processing without data loss or corruption or overload, and within the maximum system delay (refer to 4.2.7.3.2), the target and FRUIT loads defined by the models in paragraph 4.2.7.2.2 and Annex G with the following additional condition:

(a) 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; **[E1]**

The Tenderer shall provide in the proposal an outline test specification and procedure as part of the Test Strategy, including a description of load models to demonstrate the load capability, taking account of both main beam and sidelobe received replies. **[I1]**

Equipment acceptance testing will be required to demonstrate load processing capability based on the models of this section. **[A1]**

4.2.7.2.4 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. **[E1]**

The Tenderer shall provide in the proposal details of the methods used in the scheduler to optimise the number of transactions. **[I1]**

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. **[E2]**

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. **[E3]**

The Tenderer shall describe how the above function will be implemented. **[I6]**

For Mode S targets, the system shall extract the Mode A code and BDS 2,0 on acquisition and on change. **[E4]**

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. **[E5]**

The Tenderer shall include in his proposal details of the Mode S radar's processing capabilities for the uplink and downlink transfer of SLM and ELM, including details of how messages are prioritised. **[I4]**

For the purposes of modelling it shall be assumed that:

(a) The target load distribution conforms with that described in G.4

(b) The interrogation limits for Mode S interrogators are at the maximum as defined in [Ref.1.].

(c) The performance level of Mode S transponders is as defined in [Ref.1.]. **[A2]**

The Tenderer shall clearly state any assumptions made in the response. **[I5]**

4.2.7.3 Processing Delays and Overload Conditions

4.2.7.3.1 The Mode S system shall combine PSR, SSR and Mode S target reports for all instrumented ranges up to 256 NM. **[E1]**

The Input Angle is defined as the angle at which the antenna is pointing when a plot is received by the PAF. **[A1]**

The Output Angle is defined as the angle at which the antenna is pointing when a plot is queued for output to the data transmission system. **[A2]**

The Overload Angle is defined as the maximum angular delay between the input and output angle that can be tolerated. Plots still queued for output to line after the overload angle are subject to data rate control. **[A3]**

The Tenderer shall provide all necessary information about the combination processing:

(a) Criteria used (proximity, quality,.....)

(b) Correlation window (size,....)

(c) Measured position definition for combined plots (weighting,.....)

(d) Processing time **[I1]**

The Tenderer shall state how many SSR/Mode S targets and PSR targets can be combined per second. **[I2]**

The Tenderer shall state how the following cases are processed:

(a) There are multiple PSR targets candidates for combination with one SSR/Mode S target;

(b) There is only one PSR target candidate for combination with several SSR/Mode S targets;

(c) There is one SSR target report candidate for combination with one Mode S target. **[I3]**

4.2.7.3.2 The target delays from the time of illumination by the antenna boresight to the input of the target report to the PAF under full load conditions shall be, for normal continuous scanning, in azimuth order within the equivalent of 45° scanning time. **[E1]**

The total system delay from illumination of the target by the antenna boresight to transmission of the target report from the PAF 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.]. **[E2]**

The overall Mode S system delay for a co-located system, defined as the overload angle shall be programmable between 0°-120°, but it shall not exceed more than 2 seconds independent of the turning rate. **[E3]**

This will enable the waiting time to be programmed. A larger value will increase the probability of combination. **[A1]**

The Tenderer shall state in the proposal the maximum target and system delays accounting for plot processing delays and full loads, but not accounting for data delays due to output clock rates. **[I1]**

4.2.7.3.3 The Tenderer shall provide in the proposal a budget of the delays incurred by each part of the processing for the load conditions of paragraph 4.2.7.2, Annex G. **[I1]**

4.2.7.3.4 The system shall be able to 'manage' overload or potential target processing delays in excess of the target and reply rates specified in paragraph 4.2.7.2, and Annex G, in particular minimising loss and preventing corruption of target data at the output. **[E1]**

4.2.7.3.4.1 Plot Output Overload

A priority scheme has been defined, from the highest priority information (a) to the lowest (e):

(a) Any Real Time Quality Control* messages, Status, Sector messages, Military and SSR emergencies (7500, 7600, 7700), Mode S alert flags, Military Identity;

(b) Mode S/SSR plots (combined plots if the primary option has been chosen) in the area of interest;

(c) Mode S/SSR plots (combined plots if the primary option has been chosen) not in an area of interest;

(d) Primary only data (if the primary option has been chosen);

(e) Enhanced Surveillance transactions only (inclusive ACAS broadcast). **[A1]**

* Real Time Quality Control messages are delivered each scan to report the system status and health to the Air Traffic Control Centre.

When these Real Time Quality Control messages (test targets) are output to the ATCC users, the corresponding Asterix Category 48 target reports shall be labelled accordingly with the bit "TST" set within the field I048/020" Target Report Descriptor ". **[E1]**

A site-dependant parameter shall enable:

(a) Either to output the RTQC (test targets) to the ATCC users;

(b) Or not to output these RTQC (test targets). **[E2]**

The programming of this site-dependant parameter shall be possible either at the CAM locally or remotely **[E3]**

If processing delays or overloads occur due to limitations at the plot output (eg data transmission link) then reduction shall use the above priority scheme. **[E4]**

The above priority scheme shall reference to an area of interest which shall be defined in data rate control maps. **[E5]**

'Areas of Prime Interest' (a maximum of 1 per sector) are defined in the system in which plots are raised to a higher priority level than those plots not in the 'Area of prime Interest'. The plots which attain the highest priority will be selected for transmission first. **[A2]**

The Tenderer shall describe in the proposal operationally acceptable methods of overload management employed and detail the effects of overload, in particular on the performance of the system, and state the conditions under which data may be lost. **[I1]**

4.2.7.3.4.2 Internal Overloads

Each part of the system processing shall be monitored for overload conditions which shall be reported locally and remotely. **[E1]**

On completion of overload conditions the event shall be reported locally and remotely. **[E2]**

When conditions are such that an overload of the system occurs, the subsequent removal of the overload shall allow the system to recover and to function normally without the need for any manual intervention. **[E3]**

The system shall be able to cope with, and to recover from, any overload caused by an out of specification input loading of PSR plots. **[E4]**

The Tenderer shall describe in the proposal any form of dynamic thresholding or limiting employed to manage overloads by reducing the detection and output of pulses, replies or target reports including:

(a) The point of application of the threshold ie receiver output, reply output. **[I1]**

(b) The conditions under which the threshold is activated. **[I2]**

(c) The effect of the threshold on target detection. **[I3]**

(d) The indications that are provided to show that the threshold is in operation. **[I4]**

(e) The effect on the Surveillance Co-ordination Function **[I5]**

4.2.7.4 Datalink Scenarios

4.2.7.4.1 General

The radar system offered shall be capable of processing the two following data link models. **[E1]**

The Tenderer shall include in the response details of the proposed methods to test the models outlined below, detailing all the assumptions and calculations. **[I1]**

4.2.7.4.2 Datalink Model ‘A’

The aim of this model is to prove the capabilities of the Interrogator Transmitter. **[A1]**

12 aircraft are to be serviced by 5 Mode S scheduling periods in a 40 ms beamwidth. Each schedule is allocated a 5 ms period. The data link transactions which occur are as follows:

(a) Schedule 1: 12 short interrogations (i.e. an UELM reservation is transmitted to each aircraft and assume that the reply from each aircraft includes the DELM announcement);

(b) Schedule 2: 48 Comm Cs are transmitted (i.e. 4 Comm-Cs to each aircraft);

(c) Schedule 3: 12 short interrogations (i.e. a combined DELM reservation and surveillance to each aircraft);

(d) Schedule 4: 12 Comm C (i.e. Extract a single DELM from each aircraft);

(e) Schedule 5: 12 short interrogations are transmitted (i.e. an interrogation combining Comm C and Comm D closeout functions for each aircraft). **[A2]**

The Contractor shall test the above scenario for a defined number of random runs (minimum 250) each using a different time distribution. **[E1]**

The minimum probability of success for each scenario shall be 90%. **[E2]**

Between each of the above Roll-Call schedules, there shall be an All-Call period with a UF11 and a Mode A or C interrogation. **[A3]**

4.2.7.4.3 Datalink model 'B'

The aim of this model is to prove the ability of the RTCC to optimise the scheduling sequence for interrogations and replies subject to constraints of [Ref.1.] on Mode S transponders and Mode S interrogators. **[A1]**

In order to reflect the current strategy for Mode S, to perform Enhanced Surveillance in the early years, the scenarios assume a background rate for GICB on each aircraft. **[A2]**

For each scenario the traffic shall be considered as equally distributed in azimuth, and distributed in range as follows:

(a) Scenario 1

Range NM	5-10	10-20	20-40	40-60	60-80	80-90	90-130	130-150
Distribution	1	3	12	7	7	2	6	10

(b) Scenario 2,3,4

Range NM	5-10	10-20	20-40	40-60	60-80	80-90	90-130	130-150
Distribution	1	1	6	4	3	1	3	5

(c) Scenario 5

Range NM	5-10	10-20	20-40	40-60	60-80	80-90	90-130	130-150
Distribution	0	1	3	2	2	1	1	2

Note: The above definition shall be applicable for a random distribution in each range band. **[A3]**

The site parameters are assumed to be:

(a) Min range: 5 NM

(b) Max range:150 NM

(c) Scan rate: 4 seconds **[A4]**

The normal (background) traffic density is 6 aircraft distributed in all 3.5° sectors, except in two adjacent peak sectors, for scenario 2-5 and a single peak sector for scenario 1. The density of these peak sectors is defined in each scenario. The peak sectors are met only once per scan. The background load can be considered as 1 aircraft every 0.6° **[A5]**

The aircraft involved in the datalink transactions shall always be those aircraft encountered in the first peak sector. **[A6]**

The station operates in multisite mode and each datalink transaction includes all consequent protocol (reservation, closeout etc.). **[A7]**

All requested BDS registers end in '0', and all interrogations elicit a decodable reply. **[A8]**

(a) Scenario 1

  (i) Traffic density: 48 aircraft in 3.5° sector;

  (ii) GICB rate: 1 GICB per aircraft;

  (iii) Datalink transactions: 4 Comm-C and 4 Comm-D on three of them.

(b) Scenario 2

  (i) Traffic density: 24 aircraft in 3.5° sector;

  (ii) GICB rate: 3 GICBs per aircraft.

(c) Scenario 3

  (i) Traffic density: 24 aircraft in 3.5° sector;

  (ii) GICB rate: 2 GICBs per aircraft;

  (iii) Datalink transactions: 16 Comm-C on only two aircraft.

(d) Scenario 4

  (i) Traffic density: 24 aircraft in 3.5° sector;

  (ii) GICB rate: 2 GICBs per aircraft;

  (iii) Datalink transactions: 16 Comm-D on one of them.

(e) Scenario 5

  (i) Traffic density: 12 aircraft in 3.5° sector;

  (ii) GICB rate: 3 GICBs per aircraft;

  (iii) Datalink transactions: 16 Comm-C on three aircraft and 16 Comm-D on three other aircraft.

The Contractor shall test each scenario for a defined number of test runs (minimum 250) with a different range distribution for each test run. **[E1]**

These tests will provide an overall probability of success for the scenario. **[A9]**

A test run will be considered as successful if all the transactions are achieved in one scan. **[A10]**

The minimum probability of success to complete transactions in one scan for each scenario shall be 90%. **[E2]**

4.2.8 Data Link Delays

4.2.8.1 All SVC/MSP packets delivered by an aircraft shall not be delayed more than 2/16th of a scan period (i.e. 44°) from the time of receipt i.e. the reception of the last segment of a frame at the receiver input until the contents of the frame is ready to be transmitted through the GDLP/Local User interface. **[E1]**

The Tenderer shall include in the proposal details of the calculations of what delays would be incurred for the transmission of downlink messages. **[I1]**

All SVC/MSP packets arriving at the GDLP/Local User interface, and not subject to any congestion due to priority management, shall not be delayed for more than 2/16 of a scan period (i.e. 44°) from receiving the last bit in the message from the GDLP/Local User interface, until they are available in the transmitter for transmission to the aircraft. **[E2]**

The Tenderer shall include in the proposal details of the calculations of what delays could be incurred for the transmission of uplink data messages, i.e. from the time of receipt from the GDLP/Local User interface until they are available for transmission to the aircraft. **[I2]**

4.2.8.2 The Mode S station shall be capable of performing the extraction of the ACAS broadcast, not later than one antenna revolution after its announcement subject to the probability of detection described in 4.2.3.1. **[E1]**

4.2.8.3 The Mode S station shall be capable of retrieving the new Mode A code not later than one antenna revolution after detecting the alert flag subject to the probability of detection described in 4.2.3.1. **[E1]**

4.3 SSR Monopulse upgrade

4.3.1 Some states might choose to go to Mode S by upgrading their existing monopulse ground stations. **[A1]**

The Tenderer shall provide details in the proposal of their development plans to upgrade their monopulse systems to Mode S. **[I1]**

The Mode S system shall be designed in such a modular way that by using part of the Mode S system it will be possible to upgrade an SSR monopulse sensor. **[E1]**

4.4 Spare

4.5 Provision for E-SCAN communication only antenna collocation

4.5.1 It is anticipated that E-SCAN will not be used for the first step of the Mode S implementation. **[A1]**

4.6 General Requirements

4.6.1 Equipment Qualification

4.6.1.1 The Mode S Interrogator Receiver, Antenna, System Management Function, Surveillance Co-ordination Function, Data Link Function, Control Monitoring and Local Display System shall be supplied as a fully integrated system. **[E1]**

4.6.1.2 Information shall be included in the proposal on current operational identical equipments and/or field trials previously carried out on the same type and functionally identical equipments to those offered. **[I1]**

4.6.1.3 The statement of compliance and the proposal shall indicate the development stage of the relevant item against the Specified paragraph number. **[E1]**

The Tender Response shall include a complete description of the equipment design along with a development plan for completion of the equipment design. **[E2]**

The Tenderer shall identify in the Tender Response the main elements of the proposed system and whether they are readily available. **[I1]**

The subsystems and equipment which are to be developed shall be identified in the Tender Response and the proportion of development, hardware and software, shall be indicated with timescales in the development plan. **[I2]**

The appointed Contractor shall be required to prove the equipment by factory and site acceptance testing (times and frequency to be decided). **[E3]**

4.6.1.4 The Tenderer shall provide full information on:

(a) The stability of the proposed system, particularly with regard to amplitude and phase variations. **[I1]**

(b) The maintenance requirements of the proposed system **[I2]**

4.6.1.4.1 The Tenderer shall describe in the proposal the setting up and calibration procedures to obtain range and azimuth registration (i.e. north alignment and range zero relative to P3 or P6 synch phase reversal) and quote the accuracy obtainable. **[I1]**

4.6.2 Configuration

4.6.2.1 The system to be supplied shall be dual channel, complete with changeover capability, controlled both locally and remotely by the CAM. **[E1]**

4.6.2.2 Each channel of the dual channel Mode S station shall operate in any of the three operating modes as follows:

(a) Active: the equipment is used for the operation of the station **[E1]**

(b) Stand-by: the equipment is switched on and normally available for operation, i.e. a reconfiguration, automatic or controlled, can take place. **[E2]**

(c) Only the redundant equipment can be in the stand-by mode. **[A1]**

(d) Maintenance: the equipment is under maintenance and is not available for operation. **[E3]**

For dual channel configurations any fault state shall be reported to CAM. **[E4]**

4.6.2.3 In a dual channel system there is only one channel which shall be Active. **[E1]**

Switching from a Stand-by mode to an Active mode is performed according to a 'cold switch-over' procedure by an operator command or by a 'hot switchover ' when the Active equipment fails. **[E2]**

Switching from Active to Stand-by mode is performed by a 'cold switch-over' procedure, by an operator command. **[E3]**

The normal procedure for switching to Maintenance mode is performed from the Stand-by mode, by an operator command. When exiting the Maintenance mode, switching is always performed to Stand-by. **[E4]**

Exiting the Maintenance Mode shall be possible by two mutually exclusive modes: 1) remotely via the CAM; or 2) locally by operator command authorised from the front panel. **[E5]**

4.6.2.4 The 'hot switch-over' procedure shall correspond to a failure of an Active equipment, where an automatic reconfiguration of the processing occurs through switching. **[E1]**

In case of 'hot switch over' the failing channel shall be automatically switched to Maintenance mode. **[E2]**

In the case of failure a 'hot switch-over' shall be inhibited in case of additional failure of the now active channel. **[E3]**

The Tenderer shall include in the proposal details of how the automatic configuration occurs and the effect on the overall system performance. **[I1]**

The switching shall be effective within one antenna revolution after the fault has been detected and comply with the requirements of 6.5.2. **[E4]**

The tenderer shall describe how the failures from the different LRUs and/or functions (Surveillance, SCF, DLF) are managed by the BITE and taken into account for switching decision. **[I2]**

4.6.2.5 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. **[E1]**

The 'cold switch-over' shall take one antenna revolution to perform from operator input. **[E2]**

The Tenderer shall provide details in the proposal how the 'cold switch-over' is performed and how it affects the operation of the system. **[I1]**

4.6.3 Equipment Cabinets

4.6.3.1 The Tenderer shall describe in the proposal the means of maintenance and cable access. **[I1]**

Installed cabinets will generally be grouped on a channel basis. **[A1]**

4.6.3.2 The Tenderer shall state in the proposal the height, width, depth and weight of all the major equipment units, including equipment cabinets, identifying their location with respect to each other. **[I1]**

The Tenderer shall state in the proposal the height, width, depth and weight of all additional peripheral devices required to support the system. **[I2]**

The Tenderer shall give power consumption and heat dissipation figures for all the preceding equipment units. **[I3]**

4.6.3.3 The equipment installation shall be such that access to any equipment cabinet, the removal of any sub-unit, PCB, and the use where required of extender cards, external test equipment etc. is not impeded by any adjacent cabinets, units etc. **[E1]**

4.6.3.4 The Tenderer shall state in the proposal where forced air cooling is employed. **[I1]**

4.6.4 Interference

4.6.4.1 The Interrogator Receiver and the System Management Function shall both withstand and recover, with minimum delay, from the effects of cw interference. **[E1]**

At no time shall cw interference saturate or overload any part of the Mode S Ground System. **[E2]**

The receiver shall be capable of operating in the presence of cw (from -95dBm to -20dBm) and pulsed cw interference (illustrated as two overlapping pulse trains (with characteristics of Mode 3/A replies and Mode S preambles, except

pulse width from 0.50 to 0.55 us). The first at -40dBm at the RF port, the second at -60dBm and lagging the first with a 0.7 us delay. The quantised output due to the second pulse train must be present); both types of interference may be received over the range 1080 MHz to 1100 MHz. **[E3]**

Following the removal of the detected cw interference replies shall be detected, decoded and processed, 2ms after the end of the interference. **[E4]**

The Tenderer shall provide information on the level and effects of interference that the Mode S ground system can tolerate. **[I1]**

The Tenderer shall state the modes accommodated and specify the level of protection from both ground and airborne IFF/SSR frequency systems that will be achieved. **[I2]**

The Tenderer shall state the reaction and recovery times of the protected system. **[I3]**

4.6.5 Peripheral Devices

4.6.5.1 The number of peripheral equipments required to support the system shall be minimal. **[E1]**

4.6.5.2 The Tenderer shall provide in the proposal a list of the peripheral equipments required to support the system. **[I1]**

All peripheral equipment required to support the operation of the system shall be included in the delivered equipment. **[E1]**

The Tenderer shall provide in the proposal details of all peripheral equipments, including any required for commissioning of the system such as PROM Programmers, special measurement tools, data recording devices etc. **[I2]**

The Specification for any peripheral equipment requirements (e.g. MMI, printer etc) shall be agreed with the Agency. **[E2]**

4.6.5.3 Common and internationally recognised interface standards shall be employed for all peripheral devices. **[E1]**

Wherever possible, the use of common peripheral equipments between different functions is preferred. **[A1]**

4.6.6 Processing Capacity

4.6.6.1 For the maximum loading conditions and for the FRUIT and reflection rates specified in Annex G,

(a) each single processor shall not be utilised for more than 50% of the time when this time stands for a complete antenna revolution. **[E1]**

(b) each single processor shall not be utilised for more than 80% of the time when this time stands for a small sector peak of 3.5°. **[E2]**

The Tenderer shall describe the maximum utilisation of each single processor for a scanning time corresponding to a large sector peak of 45°. **[I1]**

The Tenderer shall state in the proposal the processor utilisation contingencies over and above the maximum loading defined in Annex G **[I2]**

4.6.6.2 The system software shall not take up more than 50% of the available memory allocated for the system software. **[E1]**

The Tenderer shall state in the proposal the available storage contingency for the software for each part of the system. **[I1]**

4.6.6.3 For the maximum loading conditions of Annex G, the amount of Random Access Memory and disc storage in use at any time shall not exceed 50% of that available. **[E1]**

The spare random access memory above shall apply independently to global memory, and all individual processors within the proposed system. **[E2]**

The contingencies above shall be demonstrated and proved to be met during Factory Acceptance Testing of the systems, under maximum load conditions. **[E3]**

The Tenderer shall provide in the proposal an outline of how the achievement of the above contingencies will be demonstrated. **[I1]**

4.6.7 System Response Time

4.6.7.1 The response times of the Mode S system and any associated control and changeover equipment shall be as follows:

(a) For an off-mounted 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. **[E1]**

(b) For a off-mounted 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. **[E2]**

The Tenderer shall provide in the proposal the maximum system response time for each of the requirements a) to b) above, where "passing North" is assumed to mean "first North crossing after azimuth data is reported as correct by CAM". **[I1]**

4.6.8 System Recovery

4.6.8.1 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:

(a) Azimuth data; **[E1]**

(b) External data clocks; **[E2]**

(c) Mains power supply; **[E3]**

(d) RF and SMF interfaces; **[E4]**

(e) Station CAM. **[E5]**

The Tenderer shall state in the proposal the maximum duration of any interruption of the above external inputs that can occur without affecting or impairing the operational status of the system. **[I1]**

The Tenderer shall state in the proposal for every external input, the effect on the plot assignor function of failure of that input, and the recovery state and recovery time following restoration. **[I2]**

4.6.9 System Expansion

4.6.9.1 It is essential that any proposed system is not only capable of fully meeting the load requirements defined in this Chapter but is also capable of meeting the indicated increases in loading during the life of the equipment. **[A1]**

The Tenderer shall state in his proposal the cost and the possible additional boards that are required to achieve the safety margin described in all the following requirement. **[I1]**

The systems load capacities shall be expandable to accommodate further growth in air traffic movements. **[E1]**

Traffic growth to 120% of the SSR and Mode S target figures specified in the model for target processing capacity shall be attainable without extension of the system delays of 4.2.7.3 and 4.2.8. **[E2]**

The design architecture shall be capable of supporting the above expansion requirements. **[E3]**

The Tenderer shall advise how the above expansion can be achieved. **[I2]**

This increase in capacity shall be attainable for a conventional rotating antenna scan rate of up to 15rpm or background surveillance update rate of 4 secs. **[E4]**

The Tenderer shall state in the proposal the maximum Mode S target, secondary target, and combined target capacities of the proposed system for delays not exceeding those above. **[I3]**

It is assumed that primary echo returns, secondary transponder replies, FRUIT and false target rates should increase in the same proportion as the traffic expansion. **[A2]**

4.6.10 Target Velocity Limits

4.6.10.1 The aircraft population to be controlled includes rotary winged and high performance fixed wing aircraft. Therefore the Mode S radar shall be capable of detecting and processing aircraft operating to the following performance parameters, in any combination. **[E1]**

(a) A steady state speed from 0 kn to 2000 kn; **[E2]**

(b) Spare;

(c) A vertical rate of climb or descent, as reported by the received Mode C data from 0 ft/min to 25000 ft/min; **[E4]**

(d) A vertical rate of climb as in (c) above with no horizontal displacement; **[E5]**

(e) 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 e.g. from 300 kn steady state, accelerating at 2g to 2000 kn. **[E6]**

The Tenderer shall advise what impact a combination of these parameters will have on the Mode S surveillance and datalink performance, particularly for aircraft at less than 25 NM range. **[I1]**

Provision shall be made for the values of the above parameters to be set to any value within the ranges specified. **[E7]**

Civil traffic is defined with the vertical rates and maximum speed defined above and accelerations (transversal and/or longitudinal) up to 2g. **[A1]**

Military traffic is defined with the vertical rates and maximum speed defined above and accelerations (transversal and/or longitudinal) up to 5g. **[A2]**

By default, all performance verifications shall be performed with a station configured to track at least civil traffic **[E8]**

The Contractor shall demonstrate, when configured for military traffic, that the system is capable of meeting the Probability of detection and the accuracy requirements for trajectories covering the military traffic velocity limits. **[E9]**

The Tenderer shall describe in the proposal how this range of aircraft performance will be accommodated and how the values of the above parameters are preset. **[I2]**

4.6.11 Power Up Checks

4.6.11.1 The following requirements will ensure that the radar system is not knowingly returned to service without the correct software/hardware build state or site default parameter settings. **[A1]**

(a) The Mode S system shall confirm the serviceability of RAM on power-up **[E1]**

(b) Each sub-system shall verify that the software issue of each board and prom on power up or reset is current. **[E2]**

(c) The Tenderer shall advise how each sub-system can verify that the hardware issue of each board on power up or reset is current. **[I1]**

(d) The Tenderer shall advise how each sub-system can verify that the site dependent default parameters on power up or reset is current. **[I2]**

In each of the requirements above an error message shall be produced if the test fails, but not cause a reset or shutdown. **[E3]**

The Tenderer shall include in the proposal details of the power up and reset checks. **[I3]**

4.6.12 Site Dependent Parameters

4.6.12.1 Site Dependent Parameters (SDPs) shall, wherever practical, be set by link settings, switches or stored in a suitable non-volatile medium (eg PROM). **[E1]**

SDPs shall not be hard-coded within any software of the system. **[E2]**

The adjustment of any SDPs shall not require any alteration or recompilation of the software. **[E3]**

SDPs contained in a PROM or other suitable medium shall be easily adjustable, for example via a connected terminal, or the local display facility. **[E4]**

It shall be possible to display all operational and ‘key’ site dependent parameters. **[E5]**

The CAM facility shall be employed to re-configure Agency designated operational parameters at the ground station. **[E6]**

Parameters that may be altered via a connected terminal, such as described in 4.6.5, require protection as follows:

(a) It shall only be possible to change parameters with the relevant system in ‘local mode’; **[E7]**

(b) It shall not be possible to configure to ‘remote’ mode with temporary changes present, except by special action which shall ensure that the ATCC is advised of this special status via the CAM for as long as the condition exists; **[E8]**

(c) Unauthorised or inadvertent alterations shall be prevented, e.g. by password entry; **[E9]**

Details of the protection method shall be supplied in the Tender response. **[I1]**

The design approach shall be capable of ensuring that SDPs will not change in the event of a 'switch-over' of the active channel. **[E10]**

4.7 Environmental Conditions

4.7.1 Internal Conditions

4.7.1.1 Any equipment housed within the radar station equipment room(s) shall operate and maintain its full operational performance under the following conditions:

(a) Temperature: 0°C to +40°C **[E1]**

(b) Relative Humidity: 90% (non-condensing at +25°C) **[E2]**

Where it is agreed that COTS equipment may be employed in the radar station equipment room, the following condition is considered acceptable for that equipment:

(a) Humidity 80% (non-condensing at +25°C);

(b) Temperature +10 to +40°C. **[A1]**

4.7.2 External Conditions

4.7.2.1 Any equipment not housed within the radar station equipment room(s) or remote equipment shelter including Far Field Monitor, LVA antenna, turning gear together with any pedestal mounted electronics shall operate and maintain its full operational performance under the following conditions:

(a) Ambient Air Temperature: -40°C to +50°C; **[E1]**

(b) Relative Humidity: Up to 100% (Lower than 90% at 40°C); **[E2]**

(c) Driving Rain: Up to 60 mm/h; **[E3]**

(d) Snow load: Up to 200 kg/m^2 (in or out of operations and in transport); **[E4]**

(e) Solar radiation: 1135 W/m^2h during 4 hours; **[E7]**

(f) Hail: Up to 10 mm at 18 m/s; **[E5]**

(g) 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. **[E6]**

4.7.2.2 All external equipment antennas and turning gear shall be resilient to salt atmospheres. **[E1]**

DEF-STAN 07-55 Test C6 provides guidance to the salt resilience to be attained. **[A1]**

4.7.2.3 The Tenderer shall provide in the proposal information on the effects on the detection and accuracy performance of 4.2.3 and 4.2.6 for a Mode S radar subject to severe fresh and salt water rime ice formation on the antenna. **[I1]**

The Tenderer shall provide in the proposal information on the effects listed above on the array gain and beam patterns. **[I2]**

The Tenderer shall provide in the proposal information on prevention of rime ice formation and/or recommendations to reduce the effects of these climatic conditions. **[I3]**

4.7.2.4 Full, individual environmental specifications for all external equipment shall be provided in the proposal. **[I1]**

4.7.3 Storage Conditions

4.7.3.1 All types of equipment, including spares, shall be capable of being stored under cover for a period of up to two (2) years at varying temperatures from -40°C to +60°C with an ambient relative humidity ranging from 40% to 90%, damp heat lower than 93% at 40°C without affecting either their operation and performance to specification, or their normal expected operational life. **[E1]**

Where it is agreed that COTS equipment may be employed, the following condition is considered acceptable for that equipment: Humidity 80% (non-condensing at +25°C); Temperature -10 to +60°C. **[A1]**

4.7.3.2 Any equipment with components whose operational life could include time in storage, for example memory devices dependent upon batteries, shall be identified and the appropriate precautions to be taken shall be described in the proposal, together with the maximum storage life. **[I1]**

The equipment items shall be capable of undergoing, in their package, the constraints related to the transport by air, sea or land. **[E1]**

4.8 Radar System Overview

4.8.1 System Interconnections

4.8.1.1 The Tenderer shall provide in the proposal system diagrams for the Mode S system showing the offered system configurations, equipment types and interconnections. **[I1]**

4.8.1.2 Where appropriate, specific details shall be given for signals, data formats etc., particularly where an interface is required between the Mode S system being provided against this specification, and another system outside the scope of this specification. **[I1]**

In other areas, where interface details have yet to be decided, general information shall be given by the Tenderer. The specific details of these interfaces will be defined and agreed with the Agency after contract award. **[I2]**

4.8.1.3 For the rotating antenna the Tenderer shall provide, in the proposal, detailed specifications of the rotating joints, with drawings, to meet the Mode S performance and interface requirements. **[I1]**

4.8.2 System Interfaces

4.8.2.1 The Mode S system shall provide interfaces for:

(a) Surveillance users; **[E1]**

(b) Networked Mode S stations; **[E2]**

(c) Datalink users; **[E3]**

(d) The Control and Monitoring System remote terminal; **[E4]**

(e) Primary Surveillance Radar; **[E5]**

(f) A playback and recording facility; **[E6]**

(g) An RF analysis facility. **[E7]**

4.8.2.2 In accordance with the above the Mode S system shall conform to the requirements of:

(a) [Ref.5.] **[E1]**

(b) [Ref.6.] **[E2]**

(c) [Ref.9.] **[E3]**

(d) [Ref.1.] **[E4]**

(e) [Ref.17.] **[E8]**

The ASTERIX formats described in [Ref.5.] and [Ref.6.] are likely to evolve; the current agreed version shall be used. **[E5]**

Design precautions shall be taken to minimise the impact of, and the effort necessary, to accommodate the introduction of ASTERIX format modifications; in particular to avoid any re-compilation when upgrading these formats. **[E6]**

The contents of the PSR-related data received in Asterix Category 1 and Category 2 shall be translated into the corresponding fields of the data to be delivered to ATCC users (Asterix Category 48 and Category 34) **[E7]**

4.9 Data Transmission

4.9.1 Time Function

4.9.1.1 The equipment shall include a Time Function to provide time to the system (including CAM) for the purpose of synchronisation and time-stamping. **[E1]**

The Time Function shall time-stamp the information using the information provided either by an external source or by an internal clock. **[E2]**

The system shall be capable to be interfaced with two external time sources. **[E3]**

In the event that the external source fails to deliver a time reference, the Time Function shall revert to the internal clock. This condition shall be reflected in the Time Source Status as part of the Station Configuration Status item of the ASTERIX Category 34 messages. **[E4]**

The maximum drift of the internal clock shall be less than 20ms per month. **[E5]**

The Tenderer shall state in the proposal the accuracy, resolution and drift of the internal and external time sources which are used for time-stamping. **[I1]**

The time-stamping process accuracy shall be such that measured position accuracy requirements defined in 4.2.6 are met for all aircraft speeds specified in 4.6.10 (i.e. position errors include those due to time-stamping inaccuracies). **[E6]**

The Tenderer shall state in the proposal at which level and how the time stamping information is effectively derived and output in the following target reports:

(a) For Mode S solo targets;

(b) For SSR solo targets;

(c) For PSR solo targets;

(d) For combined targets. **[I2]**

The Tenderer shall explain clearly in the proposal how the TSV bit of the data item I034/050 will be set, in particular for the following cases:

(a) At start-up;

(b) When the external time signal (e.g. GPS satellites signal) fails;

(c) When the time receivers (e.g. GPS receivers) fail;

(d) When the internal clock fails or drifts out of specification. **[I3]**

The Tenderer shall also state the consequences on the system behaviour (switch-over, data output...). **[I4]**

The Tenderer shall provide detailed information on the protocol and data format used between the external time sources and the Interrogator. **[I5]**

4.9.2 Transmission Network

4.9.2.1 The ground station shall be capable of processing continuously:

(a) Output of ASTERIX Cat 34 and Cat. 48 messages on up to three simultaneous, independently configurable, channels at an average rate of 250 messages/second each; **[E1]**

(b) Time stamping and merging of 32 Sector Messages per 360° rotation; **[E2]**

(c) Conversion of all equipment status messages into the Station Configuration Status message; **[E3]**

(d) Exchange of ASTERIX Cat. 17 messages to/from Surveillance Co-ordination Network at an average rate of 150 messages/second; **[E4]**

(e) Exchange of ASTERIX Cat. 18 messages to/from each of the GDLP/Local User interfaces at an average rate of 150 messages/second. **[E5]**

The Tenderer shall state in the proposal the maximum number of combined plot messages per second that can be processed and output, and under what conditions. All assumptions shall be stated. **[I1]**

Each channel shall be configurable independently in terms of data rate (9.6 to at least 128 Kbps for WAN interfaces and at least 100 MB for LAN interfaces), protocol (X.25 or HDLC Lap-B for WAN and TCP/IP, UDP/IP, IP v4 and v6 for LAN) and physical interface (RS-232/V.24 and a standard supporting RS-422/V.11 balanced circuits for WAN and IEEE 802.3 100BASE-T for LAN). **[E6]**

The type of standard supporting RS-422/V.11 balanced circuits shall be agreed with Agency prior to contract let (e.g. X.21, RS-449, RS-530...). **[E15]**

Channel throughput and protocol requirements differ from application to application (ATCC output, SCN or datalink connection) and are detailed in paragraphs 7.3.2.8, 8.3.1 and 9.2.1. **[A1]**

The HDLC Lap-B data link layer protocol and X.25 packet layer protocol implementations shall comply with the ITU-T/CCITT Recommendation X.25 1988. **[E8]**

The IPv4, IPv6, TCP, and UDP protocols shall comply respectively with the IETF RFC 791, 2460, 793 and 768. **[E16]**

The following restrictions shall be applied to X.25 connections used for the PILOT station:

(a) For SCN connections, only SVCs shall be allowed; **[E9]**

(b) The system shall support SVCs for all other connections; **[E10]**

(c) The address shall conform to the ITU-T X.121 Recommendation (non-TOA/NPI format); **[E12]**

(d) No optional X.25 user facility shall be used unless otherwise agreed with the Agency. **[E13]**

The Tenderer shall provide a completed ISO/IEC PICS Proforma to the Agency for the X.25 (ISO/IEC 8208) and the HDLC Lap-B (ISO/IEC 7776) implementations as part of their proposal, according to [Ref.15.] and [Ref.16.]. **[I3]**

The Tenderer shall provide information on the adaptation of channels to other communication protocols (such as TCP/IP), and other Wide Area Networks (such as frame relay, ATM...). **[I4]**

The Contractor shall provide external conformance certificate of the X.25 and HDLC Lap-B interfaces, by an independent 3rd party, to confirm compliance to the ISO/CCITT/ITU-T standards. **[E14]**

The size of the X25 packets should preferably be up to 512 bytes. **[A2]**

4.9.3 Cross Site Data Transmission

4.9.3.1 Digital and video signals transmitted within the confines of the off-mounted collocated site shall utilise high integrity data transmission methods. **[E1]**

4.9.3.2 The immunity to lightning strike shall be specified and detailed information on the protection methods employed shall be provided in the proposal. **[I1]**

4.9.4 Output Link Management (OLM)

4.9.4.1 The Contractor shall provide each Mode S ground station with a facility to manage the following services: communication to ATCC, SCN, PSR, Local User and GDLP. **[E1]**

A number of physical interfaces, to be defined by the Agency, shall be available to the communication services. **[E2]**

The Agency may choose, for some site configurations, not to have a physical PSR interface. **[A1]**

4.9.4.2 The OLM functionality shall:

(a) Ensure that no single failure condition has a critical consequence on communication services; **[E1]**

(b) Allow physical interface switchover without any resulting radar channel switchover; **[E2]**

(c) Allow radar channel switchover without any resulting physical interface switchover; **[E3]**

(d) Be monitored and controlled by the CAM; **[E4]**

(e) Be monitored by both radar channels; **[E5]**

(f) Allow to assign any communication service to any physical interface; **[E6]**

(g) Allow to assign several communication services to the same physical interface; **[E7]**

(h) Allow to assign several physical interfaces to the same communication service:

(i) To allow diverse routing of the same ATCC data through different physical interfaces;

(ii) To offer to use either two X.25 connections or two TCP/IP connections to access to the SCN;

(iii) To allow each radar channel to be connected to both PSR channels. **[E8]**

The provisions of (g) and (h) are intended to reduce the total number of physical connections, whilst still supporting diverse routing of the ATC outputs and meeting throughput requirements. **[A1]**

When several communication services are assigned to the same physical interface (i.e. multiple SVCs on a DTE-DCE link), the routing of each communication data flow to the right application should be done according to one of the following criteria:

(a) Distant DTE address;

(b) Content of the USER DATA field in Call Requests and Incoming Calls;

(c) Content of the X.121 sub-address. **[A2]**

The Contractor shall perform the above routing according to the criteria to be chosen by the Agency. **[E9]**

The provisions of (h) would still facilitate pre-configurable mapping of DTE or IP addresses to particular services (e.g. SCN). **[A3]**

An example configuration could be:

(a) 2 ATC services (all active);

(b) 1 GDLP service (only one active communication port);

(c) 1 Local User service (only one active communication port);

(d) 1 SCN service for each other node of the cluster (only one active communication port); and

(e) 2 PSR services. **[A5]**

4.10 Test Equipment

4.10.1 The Tenderer shall provide details of all equipment considered necessary to provide analysis of the ground station functionality and interfaces that cannot be achieved using PTE or an equivalent tool. This shall identify which items are available at no cost, and those requiring development. Where development is anticipated an associated plan, describing the proposed timescales, qualification and cost (quoted separately in the Commercial Response) shall be presented in the Tender Response. **[I1]**

4.11 Power

4.11.1 The equipment items shall be connected to a power distribution network supplying a nominal line voltage of 3 phase 400V -6%, +10% of frequency 50Hz +/-2%. **[E1]**

CHAPTER 5

ANTENNA SYSTEM

5.1 LVA Requirements

5.1.1 The requirements for the LVA antenna are specified in Chapter 13. **[A1]**

CHAPTER 6

INTERROGATOR SYSTEM

6.1 General

6.1.1 Introduction

6.1.1.1 The interrogator (Figure 5) shall consist of:

(a) A transmitter, providing sum and control channel output **[E1]**

(b) A monopulse receiver, accepting sum, difference and control channel input. **[E2]**

(c) A video signal process that provides processed Sum, RSLS and OBI signals **[E3]**

(d) An RF changeover unit to allow the standby channel to become the active channel. **[E4]**

The transmitter shall issue Mode S, Mode 3/A,C and Mode 1/2 interrogations and the receiver shall accept the Mode S, Mode 3/A,C and Mode 1/2 replies. **[E5]**

6.1.2 Functions

6.1.2.1 The interrogator shall have the following capabilities:

(a) Interrogation and reception on Modes 3/A, C, S and Modes 1/2; **[E1]**

(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. **[E2]**

(c) Operation on 3 mode interlace programmes, including stochastic All-Call and lockout override as shown in Figure 12; **[E3]**

(d) Operation in azimuth selectable improved interrogator sidelobe suppression (IISLS) for Mode 3/A,C or intermode; **[E4]**

(e) Operation of receiver sidelobe suppression (RSLS); **[E5]**

(f) Output of data suitable for plot processing; **[E6]**

(g) Control of all main functions of the interrogator shall be provided locally and remotely via the CAM interface; **[E7]**

(h) To receive interrogation modulation commands from the RTCC or external test equipment. **[E8]**

6.2 Transmitter

6.2.1 The transmitter shall provide:

(a) One sum channel (Pulse P1, P2, P3, P4 and P6 (with DPSK modulation) transmissions); **[E1]**

(b) One control channel (pulse P2, and P5 transmissions). **[E2]**

The P5 shall be transmitted on the control channel, in the case of Mode S All-Call or selective interrogations. **[E3]**

A detailed description of the interrogator transmitter with block diagram and specification shall be provided in the proposal. **[I1]**

6.2.2 The transmitter shall not require any adjustment or setting up following replacement of any unit. **[E1]**

6.2.3 The transmitter shall not require any regular or preventative maintenance of any unit. **[E1]**

6.2.4 As a minimum, the transmitter shall be capable of operating at a peak duty cycle of 63.7% over 2.4ms length of time. **[E1]**

It is expected that the above requirement can be repeated every 24ms. **[A1]**

The transmitter shall be capable of operating at a duty cycle of at least 5% over a whole scan. **[E2]**

The Tenderer shall include in the proposal information on the Mode S duty cycle capability, including Mode S modes of operation, intermode interlace, power and range performance and transmitter modularity. **[I1]**

6.2.5 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. **[E1]**

The Selective Interrogation period shall be used for the Mode S Roll-Call surveillance and data link transactions. **[E2]**

The internal IRF for the SSR/All call period shall be adjustable from 50Hz to 250Hz with increments no greater than 1Hz. **[E3]**

The SSR/All Call period shall be constant or staggered. The stagger may be a fixed sequence, random or pseudo random (eg 64 stagger periods which are selectable and a deviation of 0% up to +10% in 1/2% steps from the mean IRF). **[E4]**

The Tenderer shall describe the method of stagger generation. **[I1]**

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. **[E5]**

6.2.6 Stochastic lockout over-ride shall be selectable to acquire aircraft (see Figure 12 for examples). **[E1]**

The Tenderer shall provide details on how stochastic lockout override shall be implemented in their proposal. **[I1]**

6.2.7 A number of mode programmes shall be selectable on an antenna scan basis. It shall be possible to set-up at least the following mode programmes:

(a) Single SSR Mode; **[E1]**

(b) Dual SSR Mode Interlace; **[E2]**

(c) Triple SSR Mode Interlace (eg A,A,C); **[E3]**

Antenna scan interlace, whereby different triple mode interlaces may be transmitted, each on up to three alternate antenna revolutions shall be available. **[E4]**

Change in interlace shall be applied on the North crossing. **[E5]**

The Tenderer shall state in the proposal the modes and interlace programmes available as standard and as options, including Mode S. **[I1]**

The Tenderer shall describe in the proposal how Mode S interrogations may be selected, interlaced and transmitted. **[I2]**

The triple mode interlace shall include Mode 1 and Mode 2. **[E6]**

6.2.8 A number of programmes shall be selectable on a per sector basis (each sector representing 1/32 antenna revolution). The illumination period for an aircraft by the beam shall be divided into a defined number of intervals. Each interval shall represent one All Call or one Roll Call period. The minimum number and the content of All Call periods shall be defined according to the previous selected antenna scan mode programme, i.e. for two hits per SSR mode:

(a) Single mode: two All Call periods,

(b) Dual mode: four All Call periods

(c) Triple mode interlace: six All Call periods

The interlace of the modes is defined in 6.2.7, and the minimum duration of each All Call period shall be adjustable to the operational range in the particular sector. The total number of intervals shall not exceed 12; and the duration and type of each interval shall be defined separately, but consistently. All parameters associated to the sector scan programme shall be considered as Site Dependent Parameters. **[E1]**

6.2.9 The peak transmitter power output on both the sum and control channels shall be determined from the max. range requirement described in 4.2.2.1. **[E1]**

The Tenderer shall submit uplink and downlink power budget calculations to support the above requirement. **[I1]**

The Tenderer shall state in the proposal the peak output power available. **[I2]**

It shall be possible to vary the output power of the interrogator and control pulses. **[E2]**

Variation of the interrogate and control output powers shall allow a power variation at least over the range from maximum power to 12dB below maximum power. **[E3]**

Output power variation for both interrogate and control outputs shall be in increments no greater than 2.0dB and to an accuracy of at least +1.0dB. **[E4]**

The Tenderer shall state in the proposal the minimum independent power variation between the interrogator and the control pulses, the incremental steps and the accuracy of the incremental steps. **[I3]**

The Tenderer shall provide details in the proposal of the method to vary power depending upon the range of the Mode S transponder equipped aircraft. **[I4]**

6.2.10 It shall be possible to vary the interrogate and control output power, on each selective interrogation, according to the range of the target. **[E1]**

It shall be possible to programme as a function of azimuth over a number of unequal sectors, not less than 32, over 360°, the interrogate and control powers pertinent to both Mode S All Call and SSR operation. **[E2]**

The Tenderer shall describe the method of achieving power variation with azimuth and range. **[I1]**

6.2.11 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. **[E1]**

If the limits are exceeded then the surveillance interrogations shall have priority. **[E2]**

The Tenderer shall provide in the proposal details of the protection of the transmitter. **[I1]**

6.2.12 IISLS shall be available for interrogations by transmitting both pulses P1 and P2 on the control channel. **[E1]**

When IISLS is enabled it shall be possible to manually adjust the power of pulse P1,in steps of 1.4° for the azimuth and in steps of 2dB for the power till the decrease does not exceed the level of 6dB below the power of pulse P2. **[E2]**

The Tenderer shall provide in the proposal information on IISLS to clearly show its method of implementation and performance, including the radar range over which it is available, effects on transmitted powers, detection and false targets, particularly in a congested Mode S/SSR environment. **[I1]**

6.3 Receiver

6.3.1 Configuration

6.3.1.1 The receiver shall provide:

(a) Sum, difference and control channels; **[E1]**

(b) Outputs to the receiver video process utilising data from the sum, difference and control channels. **[E2]**

The Tenderer shall provide a detailed description of the receivers with block diagrams and specification in the proposal. **[I1]**

6.3.2 Functions

6.3.2.1 The receiver shall perform the following functions:

(a) RF filtering **[E1]**

(b) RF amplification if necessary **[E2]**

(c) IF conversion, IF filtering and logarithmic IF amplification. **[E3]**

6.4 Receiver Video Processing

6.4.1 Functions

6.4.1.1 The azimuth data, received from the azimuth data generator, shall be decoded and used to determine boresight. **[E1]**

Processed Sum Video, RSLS and Off Boresight Indication signals shall be provided to the RTCC. **[E2]**

SSR and Mode S All Call Processed Sum video, together with OBI, shall be provided for local monitoring. **[E3]**

6.4.1.2 The detected pulse output, following pulse detection and quantisation, shall accurately reflect the received pulse. **[E1]**

The Tenderer is referred to the definition for quantised video for monopulse systems in [Ref.12.]. **[A1]**

6.4.1.3 STC, or an equivalent thresholding method, shall be provided and it shall be possible to select either a linear or programmable action. **[E1]**

6.4.1.4 The off-boresight angle (OBA) look up table shall be site dependent. **[E1]**

The off-boresight angle precision shall be within 0.022°. **[E2]**

6.4.1.5 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. **[E1]**

The Tenderers proposal shall include details of any on-line monitoring of monopulse accuracy. **[I1]**

6.4.1.6 The Tenderer shall provide in the proposals details on the receiver channel amplitude and phase response matching requirements of the system offered stating the required tolerances to be maintained in the matching of the channels. **[I1]**

Systems that automatically compensate for any mismatch of channels are preferred. **[A1]**

6.4.1.7 The system maintenance shall not require any adjustment or setting up following the replacement of a unit. **[E1]**

6.5 RF Change-over Unit

6.5.1 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. **[E1]**

6.5.2 During changeover the system shall provide uninterrupted service without any corruption to the output surveillance data. **[E1]**

An example of how this could be achieved is to enable the receive signal to be fed to both channels of the dual system. i.e. The standby receiver and processor sub-systems are fed with the same receive signals as the main in service receiver. **[A1]**

For the purpose of this paragraph, “uninterrupted service” is assumed to neglect the finite switching time (<100ms). **[A2]**

6.5.3 The RF Changeover Unit shall only be powered by low voltage d.c. supplies, derived from both channels of the system. **[E1]**

6.5.4 A remote indication of the RF Changeover selection shall be available. **[E1]**

This will enable verification that the channel selected for output is that actually connected to the antenna. **[A1]**

6.5.5 The interruption of transmissions to the antenna when changing over interrogation channels shall meet the requirements of 4.6.2. **[E1]**

6.5.6 The RF Changeover Unit shall retain its selected state in the absence of control signals and power supplies. **[E1]**

An indication to determine which is the Active channel shall be provided. **[E2]**

This will ensure that in the event the equipment is switched off, and there is no further controlling or switching action, the same channels will be connected to the antenna or dummy load when power is returned. **[A1]**

6.5.7 The equipment shall be of passive design and require no routine maintenance. **[E1]**

6.5.8 The design shall include a 20dB bi-directional high power precision coupler in each of the SUM / Difference and control channels to facilitate RF injection and measurement of downlink polar diagrams on Sum, Difference and Control channels. **[E1]**

6.5.9 The Tenderer shall state the Insertion Loss for Transmit and Receive frequencies **[I1]**

6.5.10 The Tenderer shall state the VSWR and Phase shift between Sum and Difference channels **[I1]**

6.5.11 The isolation between ports and channels shall be:

(a) >40dB between channel 1 and channel 2 ports; **[E1]**

(b) >70dB between ports of the same channel (i.e. with the receiver disconnected). **[E2]**

Isolation shall be measured at the RF Changeover Unit with the receiver disconnected, i.e. the test will be performed with sigma, delta and omega disconnected. **[A1]**

CHAPTER 7

SYSTEM MANAGEMENT FUNCTION

7.1 General

7.1.1 Configuration

7.1.1.1 The System Management Function (SMF, Figure 6) controls all the activity on the RF channels. **[A1]**

The SMF shall be considered as containing the following sub-functions:

(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) **[E1]**

The Tenderer shall include in the proposal a block diagram showing the functionality and input/output ports of the SMF and detail any differences and the reason for the different approach. **[I1]**

7.1.2 General Requirements

7.1.2.1 The SMF shall be able to receive and process reply data from the interrogator when it is receiving replies consistent with the requirements of G.4. **[E1]**

It shall form plots for all aircraft and output them to ATC and to the monitor display. **[E2]**

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. **[E3]**

The surveillance update interrogations shall have had priority over the data link interrogations should the interrogation rates exceed the defined limits. **[E4]**

It 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. **[E5]**

The Tenderer shall include in the proposal details of the SMF. **[I1]**

7.1.3 Interfaces

7.1.3.1 The SMF will have interfaces to:

(a) The antenna system, to receive information on the azimuth of the boresight of the beam when replies are received; **[E1]**

(b) The interrogator:

(i) To send interrogation modulation commands (including power level, probability of reply and Lockout flags) and data content; **[E2]**

(ii) To obtain processed video and Off Boresight Information (OBI) for all reply pulses. **[E3]**

(c) ATCC, to provide ASTERIX. Cat 34, Cat 48 data (each interface being dual channel); **[E4]**

(d) The DLF to obtain data link transactions for sending to the aircraft, and to send received downlink data link transactions to the DLF; **[E5]**

(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; **[E6]**

(f) Control and Monitoring to enable the control and monitoring functions to be performed; **[E7]**

(g) External time source to serve as a time reference and permit time stamping of plots etc... **[E8]**

The Tenderer shall include in the proposals details of any changes/additions/deletions etc... to the interfaces outlined above, stating the reasons for the different approach. **[I1]**

7.2 Real Time Channel Controller (RTCC)

7.2.1 The RTCC (Figure 7), 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. **[E1]**

The resulting replies received from the video processor function are 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. **[E2]**

A Mode S Reply Report is defined as a Mode S summary report with, as a minimum, Address, associated position, message data and status (eg reservation) for all successful transactions to a given target in the beam-dwell. **[A1]**

An SSR Reply Report is defined as an SSR report with, as a minimum, positional information correlated from all the decoded replies associated with the target received during the beam-dwell. **[A2]**

The tenderer shall provide information on how the system will proceed if a valid Mode 'S' reply is not decoded in the expected listening period. **[I3]**

The RTCC shall also perform automatic extraction for Air Initiated Comm B (AICB). **[E4]**

The overall rate of (re-)interrogation required to obtain a valid selective reply shall be used as a performance monitoring indicator. This indicator shall be obtained by dividing the number of roll-call interrogations actually performed by the number of expected roll-call interrogations. **[E5]**

As an example, there will be 1 expected interrogation if 0 or 1 GICB extraction per scan is programmed and 2 expected interrogations if 2 GICBs are required per scan. **[A3]**

The Tenderer shall provide detailed information on how this performance monitoring indicator will be computed and reported. **[I3]**

As a minimum, the Mode S Reply Processing shall perform preamble detection and error detection and correction **[E6]**

The Tenderer shall include in the proposal details of the operation of the RTCC, including details of the Mode A/C Reply Process, Mode S reply process, scheduler and performance monitoring indicator.. **[I1]**

As part of the acquisition process, the system shall extract:

(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 **[E7]**

The Tenderer shall provide detailed information on the Acquisition Processing of Mode S targets (in particular the delay in completing the acquisition process; algorithms used in the form of pseudo-code, extraction of CA field, BDS 1,0, BDS 2,0, BDS 1,7, BDS 1,D, and impact on the Asterix output data.....) **[I2]**

The Tenderer is advised that the following modification has been proposed, in combination with a procedure where the ATCO would request the pilot to transmit an SPI, to mitigate for the potential lack of detection of alert conditions when targets are missed for more than 18s: Upon reception of a

Mode S reply with a FS field equal to 4 or 5 (i.e.,SPI), the system shall for the corresponding target:

(a) restart the acquisition process as defined in 7.2.1 [E7] in order to re-acquire airborne information only acquired at track initialisation or on change (aircraft capabilities, Mode A code, Aircraft Identification), and

(b) optionally re-establish the data-flash contracts previously established if still supported. **[A4]**

The SPI announcement will last for 18 +/- 1s and the acquisition process may last for several scans. It is therefore recommended to complete an acquisition process before starting a new one. **[A5]**

When the SPI remains set for a long period of time the system should foresee to re-acquire data at a given configurable time interval in order to avoid to stay in a continuous acquisition process. **[A6]**

7.2.2 The interrogation scheduler shall:

(a) Control the rate and content of the Mode S only All Call interrogations; **[E1]**

(b) Control variable all call interrogation scheduling (which allows for the concatenation of Roll Call periods for extended datalink activities); **[E7]**

(c) Control the rate of output of intermode A/C/S All Call interrogations; **[E2]**

(d) Control the rate of output if intermode A/C only all Call interrogations; **[E3]**

(e) Control the rate and output of Mode 3/A and C interrogations; **[E4]**

(f) Control the timing of the Mode S selective interrogations; **[E5]**

(g) Provide an interface to record the Mode A/C and Mode S reports. **[E6]**

7.3 Link Controller (LC)

7.3.1 General

7.3.1.1 The LC (Figure 8) shall pass data-link and Mode S specific services requested interrogations to the RTCC for action. **[E1]**

The Mode A/C and the Mode S replies received from the RTCC are sent to the Plot Assignor Function (PAF) in order to track targets. **[E2]**

Correlation with the corresponding PSR shall be performed by the PAF. **[E3]**

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.]. **[E4]**

The Tenderer shall provide information on how he will achieve the enhancement of plot data in ASTERIX format. **[I1]**

7.3.1.2 When a reply is not required from the aircraft, the RTCC shall inform the LC whether an interrogation has been sent. **[E1]**

7.3.2 Plot Assignor Function (PAF)

7.3.2.1 The PAF shall include at least the following sub-functions:

(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; **[E1]**

(b) Track initialisation, maintenance and prediction; **[E2]**

(c) Track association and combination of primary and secondary radar data; **[E3]**

(d) 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 ATC. **[E4]**

7.3.2.2 A track shall be initialised and maintained, both upon detection (SSR and Mode S aircraft) or upon receiving supplementary data (Mode S aircraft only). **[E1]**

The PAF shall track all the aircraft, including aircraft with duplicated addresses and shall maintain the Roll Call list. **[E2]**

Aircraft information shall be sent to the ATCC and a track initiated for a Mode A/C transponder equipped aircraft that has been confirmed to be in the surveillance responsibility area. **[E9]**

The Tenderer shall describe how a report is localised in the coverage map when the report lacks credible altitude information (PSR or Mode S/SSR target without credible altitude code). **[I6]**

Aircraft information shall be sent to the ATCC and a track initiated for a Mode S transponder equipped aircraft that has been confirmed to be in the surveillance responsibility area, and:

(a) At least one All Call reply has been detected and confirmed by a selective surveillance reply or **[E3]**

(b) A selective surveillance reply has been received from a selective interrogation which was initiated by supplementary data from the SCF. **[E4]**

At track initiation, the first roll call reply will normally provide altitude information. As this is the first reply received, then it will not be possible to perform the credibility check. However, it can be assumed that in the majority of cases the altitude information will be valid. For this reason, the altitude information can be used to determine the surveillance responsibility. **[A1]**

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. **[E11]**

The Mode C shall be updated on the track for each antenna revolution. **[E5]**

Aircraft surveillance data and measured position information shall be sent for every antenna revolution until the track is cancelled. **[E6]**

The position information shall originate, by decreasing priority, from a detection (All- Call or a selective surveillance reply), or from an extrapolation (miss). **[E7]**

An operational parameter, when enabled, shall force the output of extrapolated target reports to Local Display and/or ATCC in case of miss. **[E14]**

Position information originating from extrapolation, if sent, shall be flagged accordingly. **[E8]**

An operational parameter, when enabled, shall force the output of target reports to ATCC, 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. **[E12]**

An operational parameter, when enabled, shall force the output of target reports to ATCC (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). **[E10]**

Such forced target output may be preferable for approach radar in order to track as soon as possible taking-off targets. **[A2]**

This mode of operation shall be limited to user defined geographical areas, and the resulting “early reports” reserved to selected ATCC outputs. **[E13]**

The rules stated in [E3] and [E9] may not always be met in the mode described in [E10]. **[A3]**

The Tenderer shall provide detailed information (in particular, algorithms used in the form of pseudo-code, impact on the ASTERIX output data…) on the processing required to initiate a track and deliver an SSR report to the ATCC. This information, supported by field data analysis results, should take the form of a probability of initialising and delivering a SSR report to the ATCC output in function of time. **[I1]**

The Tenderer shall provide detailed information (in particular, algorithms used in the form of pseudo-code, impact on the ASTERIX output data…) on the processing required to initiate a track and deliver a Mode S report to the ATCC. This information, supported by field data analysis results, should take the form of a probability of initialising and delivering a Mode S report to the ATCC output in function of time. **[I2]**

The Tenderer shall provide detailed information (in particular algorithms used in form of pseudo-code, impact on the Asterix output data.....) on the track processing in particular concerning the following points:

(a) Type of filter e.g., Alpha/Beta-filter, Kalman Filter;

(b) Algorithms used;

(c) Slant range correction;

(d) Tracking in rho/Theta or X,Y;

(e) Method of projection used. **[I3]**

The Tenderer shall provide detailed information (in particular algorithms used in form of pseudo-code, impact on the Asterix output data.....) on the following points related to the delivery of a SSR report to the ATCC:

(a) Resolution of multiple assignment;

(b) Combining of Split Plots;

(c) Code Swapping;

(d) Code Validation;

(e) Code Change;

(f) Mode C Credibility Checking. **[I4]**

The Tenderer shall provide detailed information (in particular algorithms used in form of pseudo-code, impact on the Asterix output data.....) on the following point related to the delivery of a Mode S report to the ATCC: Mode C Code Validation and Credibility Checking. **[I5]**

7.3.2.3 A track shall be cancelled when:

(a) An aircraft traverses from a cell with Surveillance Responsibility to one without (there is no need to coast), or **[E1]**

(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. **[E2]**

7.3.2.4 Reflection Suppression

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. **[E1]**

7.3.2.5 False targets due to any of the causes listed below shall be identified (marked) as false in the category indicated and shall be rejected (ie not output as genuine targets):

(a) False targets due to multipath; **[E1]**

(b) False targets at similar range to, but at different azimuths from, an originating genuine target at short range shall be identified as 'ringaround'; **[E2]**

(c) False targets at similar azimuths to, but at increasingly longer ranges from an originating genuine target shall be identified as 'in-line multipath'; **[E3]**

(d) False targets split from an originating genuine target due to antenna beam distortion or splitting as a result of multipath or local obstruction diffraction shall be identified as 'splits'; **[E4]**

(e) False targets with angular separations from an originating target due to reflection of the interrogations and/or transponder responses by reflecting surfaces in the signal paths shall be identified as 'reflections'. **[E5]**

7.3.2.6 Mode A/C Reflection Processing

The processing shall continuously and automatically locate and identify 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. **[E1]**

The reflector data shall be used to maintain dynamic reflector surface data. **[E2]**

It shall be possible to program into the PAF reflector surface position and orientation data for permanent reflectors, such as hangars. **[E3]**

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. **[E4]**

The Tenderer shall provide detailed information on the methods proposed to eliminate both permanent and dynamic reflection surfaces. **[I1]**

The Tenderer shall state in the proposal the reflector storage capacities and the method of handling both the permanent and dynamic reflecting surfaces. **[I2]**

7.3.2.7 Mode S Reflection Processing

The Tenderer shall include in the proposal details of the Mode S reflection processing. **[I1]**

7.3.2.8 Surveillance Data Output

The network protocol for transmitting the surveillance data to ATCC shall be X.25 or HDLC Lap-B, up to a 128 Kbps maximum output rate for WAN protocols or UDP/IP (unicast or multicast over IPv4 or IPv6), TCP/IP(client or server over IPv4 or IPv6) for LAN protocols. **[E1]**

The type of the protocol used shall be a site dependent parameter. **[E2]**

7.3.3 Station Roll-Call List

7.3.3.1 The Station Roll-Call List shall contain at least identification and positional information on targets that the station is tracking. **[E1]**

7.3.3.2 The PAF will maintain the station Roll Call list and the SCF will update it. The CMP and the SCF will 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. **[E1]**

7.3.4 Communication Management Processor (CMP)

7.3.4.1 The CMP processes all requests for data link transactions which are input to it from the DLF. It is responsible for co-ordination of interrogation instructions. **[E1]**

The data packets are 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. **[E2]**

An aircraft shall be reported to the GDLP in accordance with [Ref.9.]. **[E3]**

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. **[E4]**

The CMP shall operate flow control procedures when it is unable to process the incoming requests received from the GDLP / Local User Interface. **[E5]**

The operation of flow control shall be reported in the appropriate fields in the ASTERIX Cat. 18 messages of [Ref.6.]b. **[E6]**

7.3.5 Mode S Link Management Process (LMP)

7.3.5.1 The LMP shall control all the Mode S link activities except Mode S All -Call interrogations which are controlled directly by the RTCC. **[E1]**

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. **[E2]**

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. **[E3]**

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. **[E4]**

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. **[E5]**

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. **[E6]**

The Tenderer shall include details in the proposal of the functions of the LMP. **[I1]**

7.3.5.2 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. **[E1]**

Transaction Type	Typical values (in antenna revolutions)
Comm A (1 to 4 segments)	3
Comm B (1 to 4 segments)	3
Comm C (2 to 16 segments)	4
Comm D (1 to 16 segments)	5

These values shall be adjusted separately for each type of transaction between 1 and 20 antenna revolutions. **[E2]**

The Tenderer shall include in the proposal details of how the above is to be managed and implemented. **[I1]**

CHAPTER 8

SURVEILLANCE CO-ORDINATION FUNCTION

8.1 Overall Objective

The overall objective of Surveillance Co-ordination is to allow any Mode S ground station to operate effectively within any radar siting plan, while keeping the levels of RF pollution as low as possible. This means preventing interference between stations by the correct use of II/SI codes, Mode S protocols, transponder All-Call lockout, coverage map configuration and target handover. **[A1]**

The SCF function achieves this by ensuring co-operation between stations operating as part of a networked cluster. **[A2]**

The cluster modes of operation and the interfaces are defined in more detail in the SCN ICD [Ref.1.]. **[A3]**

8.2 Overview

8.2.1 Global Operation

The ground station shall be capable of operating as part of a networked cluster of ground stations as outlined in section 3.2, whereby each station in the cluster will share the same code. **[E1]**

The National Authorities will provide the main communications structure required for the operational Surveillance Co-ordination Network. II/SI code allocation schemes will ensure that Mode S will operate without interference in Europe. These schemes will provide the II/SI code and cluster configurations required to meet operational requirements and siting plans. **[A1]**

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.1.]. **[E2]**

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). **[E3]**

The SCF shall provide track data to adjacent stations within a cluster upon request. **[E4]**

The SCF shall be designed to minimise the amount or extent of II/SI code reconfiguration. **[E5]**

The SCF shall be designed to interface with up to 5 other Mode S stations, as well as a Cluster Controller, if present, via the Surveillance Co-ordination Network (SCN). **[E6]**

8.2.2 Description of Cluster Operation and modes

When operating as part of a cluster (i.e. the stations are connected to the SCN) the station's operation is termed 'Network Aided'. This operation will include two 'modes', which are central and distributed. **[A1]**

In central mode, the station shall operate with the coverage map and II/SI code determined by the Cluster Controller (CC). **[E1]**

In distributed mode, the coverage map and II/SI code shall be selected by the algorithm as defined in [Ref.1.] operating at the radar node. **[E2]**

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). **[E3]**

8.2.3 Operation and Mode Transitions

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. **[E2]**

Transitions shall proceed according to the rules detailed in [Ref.1.]. **[E5]**

The addition of a station to the cluster shall be achieved without disruption to the operational service. **[E6]**

The Tenderer shall describe, in the Tender Response, a method to achieve the above. **[I1]**

8.2.4 Failure recovery

The handling and recovery of failures shall proceed according to the rules detailed in [Ref.1.]. **[E1]**

For node failure, the Tenderer is referred to the method used to set the NOGO bit in ASTERIX item I034/050 ([Ref.5.]). **[A1]**

If the node is NOGO then it shall not be part of the cluster. **[E4]**

The node shall be removed from the cluster by disabling the SCN connection. **[E5]**

When a node's NOGO bit is subsequently cleared, its SCN connection shall be re-enabled. **[E6]**

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. **[E8]**

All network and nodal failures shall be reported to the CAM. **[E9]**

8.3 Functionality

8.3.1 The SCF shall include the following:

(a) Coverage maps indicating the surveillance, lockout and datalink coverage to be maintained, as defined in [Ref.13.]; **[E1]**

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; **[E2]**

(b) A means to add or delete targets to the station Roll-Call list in accordance with the SCF state; **[E3]**

(c) A network system status list containing information on the latest SCF state; **[E4]**

(d) A network control and failure control process which contains the processing and protocols required to maintain the station within the cluster; **[E5]**

(e) A communication interface to the SCN. The interface shall support the exchange of ASTERIX messages for surveillance co-ordination as defined in [Ref.1.]; **[E6]**

(f) 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.1.]. **[E7]**

8.3.2 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. **[E1]**

The above timer value shall be a site dependent parameter (from 0 to 30s, with a step of 1s). **[E2]**

8.3.3 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 12. **[E1]**

8.3.4 Spare.

8.3.5 The Contractor shall provide a facility to allow the loading of coverage maps compliant with [Ref.13.] into the radar system software. **[E1]**

The coverage maps will be provided, in the format defined in [Ref.13.], by the Agency. **[A1]**

8.3.6 The Tenderer shall provide details in the response of how the following processes operate:

(a) Station Roll Call list; **[I1]**

(b) Periodic Monitoring Process; **[I2]**

(c) Network and Failure Management Process; **[I3]**

(d) Coverage Map; **[I4]**

(e) Network System Status List; **[I5]**

(f) Network Link. **[I6]**

8.3.7 It shall be possible to load another solution list for the ground station without affecting its current operation. **[E1]**

It shall be possible to set the date and time at which the update of a solution list becomes effective. **[E2]**

When this new solution list becomes effective, the radar shall first operate standalone. **[E3]**

8.3.8 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. **[E1]**

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. **[E2]**

CHAPTER 9

DATA LINK FUNCTION

9.1 General

9.1.1 The Data Link Function (DLF) provides the functionality to support the air/ground data link and is illustrated in Figure 13. **[A1]**

9.1.2 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). **[E1]**

9.1.3 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. **[E1]**

9.2 DLF Functionality

9.2.1 The DLF shall have two interfaces, one to receive/send data to the GDLP and the other an interface to a Local User. **[E1]**

The data formats that shall be used are defined in [Ref.6.](b). **[E2]**

The DLF shall be able to support simultaneous operation with both a GDLP and Local User. **[E3]**

The DLF shall enable the connection to the GDLP and the Local User via X.25 and/or through HDLC Lap-B. The minimum throughput shall be 19.2 Kbps, and shall be configurable up to 128 Kbps. **[E4]**

The type of the protocol used shall be a site dependent parameter. **[E5]**

9.2.2 The DLF shall contain the following:

(a) The DLF-GDLP packet level interface that sends and receives data (i.e. SVC requests and Mode S Specific Services) from the GDLP to the DLF as defined in [Ref.9.]; **[E1]**

(b) The DLF-Local User packet level interface that sends and receives Mode S Specific Service requests from the Local User interface to the DLF as defined in [Ref.9.]; **[E2]**

(c) The Internal Applications that allow pre-configured GICB extractions and Dataflash contracts. These Internal Applications can be accessed locally/remotely via the CAM or a dedicated terminal; **[E3]**

(d) The Broadcast Manager shall process the broadcast requests from the DLF-GDLP interface, the DLF Local User Interface. **[E4]**
The Broadcast Manager shall send all downlink broadcasts to the GDLP, Local User and Internal Applications. **[E5]**

(e) The GICB Manager shall combine duplicated GICB requests onto a single data flow. The GICB Manager shall send the responses to the requesting applications. **[E6]**

(f) The SVC/MSP Manager shall manage the uplink and downlink SVC/MSP data flows, perform the frame processing and multiplexing functions and shall not perform L, M and S bit processing as defined in [Ref.3.]. **[E7]**

GICB and downlink broadcasts shall be extracted from all aircraft in the surveillance responsibility of the ground station. **[E8]**

The Tenderer shall provide details in the proposal of the above functionality and details of how they will be implemented. **[I1]**

9.2.3 The internal applications contain the following pre-configured contracts:

9.2.3.1 Internal GICB Application

The System shall be capable to extract automatically via programmed GICB requests at least 4 BDS registers for all aircraft in surveillance responsibility. **[E1]**

The System shall enable the programmed extraction of any kind of BDS register through these GICB requests. **[E2]**

These GICB requests shall be programmed on a periodic basis. **[E3]**

A priority shall be assigned to each of these GICB requests by the IAL, in consistence with the GICB priority field specified in data item I018/030 (see [Ref.9.]). **[E4]**

The BDS registers to be extracted, the periodicity of extraction of each BDS and their priority shall be site-dependant parameters programmed either at the CAM or at a dedicated terminal. **[E5]**

No GICB extraction programmed internally shall be attempted by the system if the programmed BDS register is not supported by the aircraft installation. **[E6]**

A BDS register shall be detected as supported by the aircraft installation when bit 25 of the BDS register 1,0 is set to 1 as well as the associated bit of register 1,7. **[E7]**

If a BDS register is not listed in BDS 1,7, it is assumed to be available and shall be extracted if requested. **[E8]**

No GICB extraction request received from the GDLP/LU should be accepted by the system if the programmed BDS register is not supported by the aircraft installation. **[A1]**

The Tenderer shall state whether the BDS register extracted as a consequence of an internal GICB request is used to update asynchronous GICB requests received from GDLP/LU. **[I1]**

9.2.3.2 Internal Dataflash Application

Dataflash is a protocol that enables event driven transmission of aircraft information (indicated air speed, selected heading, waypoints...). It is an efficient way for a ground application to receive data that do not change very often and in an unpredictable manner. The Dataflash protocol allows a ground application to retrieve the contents of aircraft registers (BDS). BDS transmission upon register changes is performed as a result of a request from the station. **[A1]**

Dataflash uses MSP packets (Mode S Specific Protocol). The MSP protocol provides a datagram service within the Mode S Sub-Network. The MSP service provides 63 uplink channels and 63 downlink channels. Specific channels have been allocated to the Dataflash application. Ground initiated requests use uplink channel 6 (“ground to air service request”). Aircraft Dataflash information are downlinked on channel 3 (“Dataflash”). **[A2]**

The System shall be capable to manage at least 4 Dataflash contracts for each aircraft in datalink coverage, supporting the Dataflash application. **[E1]**

No Dataflash contract shall be initiated with an aircraft if the related BDS register is not supported by the aircraft installation (see 9.2.3.1 **[E7]**). **[E2]**

The Internal Dataflash application shall determine through bit 6 and bit 31 of BDS 1,D whether the aircraft does support the Dataflash protocol. **[E3]**

When all the above conditions are met for an aircraft entering the datalink coverage, the programmed Dataflash contracts shall be initiated for this aircraft. **[E4]**

The internal Dataflash application shall be able to perform the following functions:

(a) Extract BDS embedded in any MSP Dataflash packets transmitted by aircraft; **[E5]**

(b) Transmit these BDS along with track data of the same scan to the ATCC (using the MB data item of Cat. 48 or specific items for particular BDS); **[E6]**

(c) For each Dataflash packet, transmit a GICB response to the GDLP/LU interfaces for users which requested an asynchronous update of this

particular BDS (i.e. either the GDLP or the LU had used the AU flag in a GICB request for this BDS); **[E7]**

The conditions of the contract (BDS register to be monitored, contract number, event, change or time criteria which will trigger the AICB) shall be site-dependant parameters programmed either at the CAM or at a dedicated terminal. **[E9]**

The station shall not attempt to terminate any established Dataflash contract. **[E10]**

The implementation of the Dataflash application shall be compliant with [Ref.3.]. **[E11]**

9.2.4 It is recommended to stop downlink extraction and output queued ASTERIX Cat 18 messages from the DLF before making a cold switch-over. **[A1]**

9.2.5 Spare.

9.2.6 The DLF shall indicate to the SMF whether any BDS data acquired should be appended to the report data to provide Enhanced Surveillance Data to ATCC. **[E1]**

All BDS data requested through category 18 for transmission in category 48, or requested via the IAL (through GICB requests or Dataflash contracts), shall be delivered to ATC (Surveillance Users) using the MB data item of category 48 except were a dedicated data item exists (48/240 & 48/260) and also be provided to the MMI. **[E2]**

9.2.7 The DLF shall be monitored via the control and monitoring system. **[E1]**

The Tenderer shall provide in the proposal details of what is available to the control and monitoring system. **[I1]**

9.3 Data link storage

The DLF shall be able to have a data link storage capacity equivalent to a two scans time period in both uplink and downlink direction in order to avoid immediate application of flow control in case of slight overload. **[E1]**

The Tenderer shall provide details of the data load capacity and the data link storage capability. **[I1]**

CHAPTER 10

CONTROL AND MONITORING (CAM)

10.1 General

10.1.1 The overall objective of the control and monitoring is to ensure that an unattended Mode S ground station shall provide continuous surveillance throughout its required coverage. **[E1]**

The Tenderer shall state in the proposal how the control and monitoring of the following is performed:

(a) Radar sensor, including antenna, turning gear, RF change-over and azimuth data; **[E2]**

(b) Interrogator; **[E3]**

(c) System Management Function (SMF); **[E4]**

(d) Surveillance Co-ordination Function (SCF); **[E5]**

(e) Data Link Function (DLF); **[E6]**

(f) Data transmission facilities (modem, multiplexer and network terminating units); **[E7]**

(g) Far Field site monitor; **[E8]**

(h) General site utilities (fire and intruder alarm, air conditioning equipment); [E9

10.2 Control and Monitoring Interfaces

10.2.1 Provision for interfaces to enable local and remote control and monitoring shall be provided using industry standard interface and protocol. **[E1]**

The Tenderer shall provide a detailed description of the interfaces, protocols and message formats used for the above function. **[I1]**

The Tenderer shall indicate whether the following statistical information (on a Scan or timely basis) are provided by the CAM interfaces (locally or remotely):

(a) Information about the data supplied to the ATCC users:

  (i) Number of solo Mode S reports;

  (ii) Number of solo SSR reports;

  (iii) Number of solo PSR reports;

  (iv) Number of combined SSR/PSR reports;

  (v) Number of combined Mode S /PSR reports;

(vi) Number of Splits plots;

(vii) Number of code swaps;

(viii) Number of reports with duplicated Mode S address;

(ix) Number of test transponders;

(x) Number of test targets.

(b) Information about the data transferred through the SCN:

(i) Number of Track Initiations sent out;

(ii) Number of Track Initiations received;

(iii) Number of Track Data messages sent out;

(iv) Number of Track Data messages received;

(v) Number of Track Data Requests sent out;

(vi) Number of Track Data Requests received;

(vii) Number of Tracks for which SCN Track Support is being given;

(viii) Number of Tracks for which SCN Track Support is being received.

(c) Information (including the rationale) about the data exchanged with the GDLP;

(d) CPU loading on the different processing boards;

(e) measured data rate on each link (surveillance, SCN and DLF). **[I3]**

Control of every facility and function of the system shall be provided via these interfaces. **[E2]**

A disconnection of the CAM link shall not create an interruption to the operational service. **[E3]**

Under CAM link failure full control shall automatically be provided locally, either through the local CAM interface or through another terminal. **[E4]**

When under control of the remote terminal, all local control of the system shall be inhibited except for the request for local control. Transfer to local control is executed only after permission by the remote terminal. **[E5]**

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. **[E6]**

The Tenderer shall provide details in the proposal of the list of parameters subject to remote control and monitoring in their proposed system. **[I4]**

10.2.2 The CAM interface shall enable the connection or disconnection of the ground station from the Surveillance Co-ordination Network (SCN). **[E1]**

10.2.3 The Contractor shall supply, at a date to be agreed with the Agency, interface control documents defining the interfaces, protocols and message formats used for the CAM function. **[E1]**

10.3 Built in Test Equipment (BITE)

10.3.1 Comprehensive on-line and off-line BITE shall be provided in the Mode S system. **[E1]**

On-line BITE testing is defined as BITE tests performed while the system is in the operating mode or in the standby mode; such tests would normally be conducted with normal operating signals or internally injected stimuli that did not interfere with normal operation. Off line BITE tests are those conducted while the system is in the maintenance mode using internal test checks and routines. **[A1]**

Off line BITE shall be capable of being initiated locally and remotely. **[E2]**

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. **[E3]**

The BITE coverage rate (part of the system [including all units, boards and components] monitored by BITE) shall be at least 90%. **[E4]**

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). The BITE fault-finding rate is algebraically equal to the product of the fault detection rate and the fault isolation rate. **[E5]**

It is anticipated that the above requirement be met by on-line BITE. **[A2]**

The Tenderer shall state in the response the on-line and off-line fault finding rate that shall be achieved. **[I1]**

It is expected that achieved performance figures will be higher. The Tenderer shall provide in the proposal details of the performance figures which the equipment shall be able to meet and state under what conditions. **[I2]**

10.3.2 The on-line and off-line testing of the system shall work without the need for any additional external test equipment. **[E1]**

The on-line fault reporting time shall be less than 2 seconds after detecting the fault. **[E2]**

The on-line and off-line BITE shall register the faulty equipment (LRU) and report the information through the CAM interfaces. **[E3]**

The Tenderer shall provide details in the proposal of the BITE facilities available and what on-line tests the system will be able to perform. **[I1]**

10.3.3 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. **[E1]**

In the proposal, The Tenderer shall state the performance parameters and describe the method of reporting the performance data both locally and remotely for the Mode S ground station. **[E2]**

CHAPTER 11

LOCAL DISPLAY

11.1 Local Display

11.1.1 An autonomous, readily moveable and transportable raster scan radar display shall be provided with interfaces as described in Figure 14. **[E1]**

11.1.2 By using the display, maintenance and commissioning engineers shall be able to fully assess the operational performance and serviceability of the Mode S system. **[E1]**

11.1.3 The display hardware shall make use of an industry standard graphics (minimum 1000 line) work station with an industry standard operating system. **[E1]**

Where specialised external processing hardware is proposed, it shall be interfaced to the same operating system as the display. **[E2]**

The display shall be capable of handling the target loads as specified in Annex G. **[E3]**

The Tenderer shall provide details of the hardware which will be supplied. **[I1]**

11.1.4 The display system shall accept and display signals or data from the Mode S radar system (live) or from the optional data recording and playback facility, if any, consisting of at least:

(a) Turning and trigger information (for SSR Mode A/C and Mode S All Call); **[E1]**

(b) SSR/Mode S video signals; **[E2]**

(c) PSR video signals; **[E3]**

(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); **[E4]**

(e) Reply Report Data (messages output from the Mode A/C and Mode S reply processor); **[E5]**

(f) Plot Assignor data (ASTERIX Cat. 1, 48); **[E6]**

(g) Mode S enhanced surveillance information (ASTERIX Cat. 48); **[E7]**

(h) Status information (ASTERIX Cat. 2, 34); **[E8]**

(i) Track data exchanged on the Surveillance Co-ordination Network (content of ASTERIX Cat. 17 messages); **[E9]**

(j) Presentation of the currently operational local Surveillance Coverage maps, for a user-defined altitude; **[E10]**

(k) Data flagged as Anomalies and false plots in the PAF and NOT sent to ATCC; **[E11]**

(l) A list of the Mode S aircraft under surveillance (Mode S address, height & position); **[E12]**

(m) The data link capability of each aircraft; **[E13]**

(n) The last received message decoded per aircraft; **[E14]**

(o) The Broadcast Comm Bs received; **[E15]**

(p) The GICB's received; **[E16]**

(q) MSPs (for Dataflash); **[E17]**

(r) TCAS resolution advisories. **[E18]**

Data (b), (c), (d), (f), (g), (i), (j) and (k) shall be displayed in a geographical representation. **[E19]**

The Tenderer shall provide information on the subset of these signals that can be displayed simultaneously. **[I1]**

The Tenderer shall provide detailed information about the editing and display of border and coastline maps. **[I2]**

The Tenderer shall provide detailed information about the editing and display of other geographical maps (other radar positions, airways, runways…). **[I3]**

The Tenderer shall provide detailed information about the display of the coverage maps (surveillance, lockout and datalink). **[I4]**

The Tenderer shall provide detailed information about the display of Asterix Cat 17 data. **[I5]**

The system shall provide the operator with the ability to select any combination from the above list for display. **[E20]**

The Tenderer shall provide detailed information on how the above data is selected and retrieved from the station (software or hardware selection…). **[I6]**

11.1.5 The system shall be able to display the content of the ASTERIX data sent on the ATCC output specified in 4.9.2.1. **[E1]**

11.1.6 The display system shall recognise, process and interpret all message types in ASTERIX and display the data from these messages [Ref.5.]b,c and [Ref.6.]a. **[E1]**

11.1.7 The Contractor shall supply any peripherals and/or ancillary equipment that are necessary for the operation of the display **[E1]**

11.1.8 The symbology (and/or colour) shall be such as to distinguish between different plot types. **[E1]**

A background map facility shall be provided for up to 300 NM radius of the origin. **[E2]**

It shall be possible to import the map parameter co-ordinate set. **[E3]**

11.1.9 The Tenderer shall include in the response details of how all the information for selected plots could be displayed (including additional data such as GICB reply data, status information). **[I1]**

11.1.10 There shall be a facility to record the data defined in 11.1.4, (l) to (r), and to display this stored information. **[E1]**

The Tenderer shall provide details in their proposal of the method used to store the above data. **[I1]**

CHAPTER 12

FAR FIELD MONITOR

12.1 General

12.1.1 The far field site monitor shall be a self contained unit acting as a Mode S level 3 transponder (as defined in [Ref.1.] 2.1.5.1.3) located externally to the ground station site. **[E1]**

12.1.2 It shall be a dual channel system with redundant capacity in the event of a single channel failure. **[E1]**

The radar processing shall enable the definition of multiple far field monitors and provide the capability to suppress their reports from delivery to ATC. **[E2]**

12.1.3 The Mode S site monitor shall include the following features:

(a) Operation on Modes 3/A,C, intermode and Mode S (II and SI codes); **[E1]**

(b) Simulated range and flight level reporting; **[E2]**

(c) Robustness to common-mode failure (i.e. one channel shall transmit in the event of failure in the other channel); **[E3]**

(d) Comprehensive BITE facilities to enable fault diagnosis to module level; **[E4]**

(e) Modular construction with plug/socket connections on all modules; **[E5]**

(f) Fully solid state; **[E6]**

(g) BITE status and configuration status shall be reported to CAM; **[E7]**

(h) Configuration shall be controlled by CAM; **[E8]**

(i) User definable data as described in 12.2.1. **[E9]**

The far field monitor shall comply with all the requirements of [Ref.1.]. **[E10]**

The Tenderer shall advise what additional features could enhance the capability of the far field monitor (e.g. external frequency selection, battery back-up, power attenuation adjustment) **[I1]**

The Tenderer shall include in the proposal details of the Mode S site monitor configuration and how the changeover action is reported to the CAM. **[I2]**

12.2 Reply Processing

12.2.1 User definable data shall include:

(a) The Mode S technical address for each channel shall be selectable as a 6 character Hexadecimal address. **[E1]**

(b) Separate altitude and identity information for each channel shall be selectable (in terms of octal Mode A code and FL respectively). **[E2]**
Each code shall remain configured during periods of power interruption. **[E3]**

(c) Separate Flight Identity (or call-sign) information for each channel shall be selectable. During switch-over (due to equipment failure) the change of Flight ID shall be announced by the use of the standard Mode S broadcast protocol. Such a facility will provide the ground station with an indication of site monitor failure. **[E4]**

(d) Separate range offset parameters for each channel shall be selectable.

(e) It is anticipated that the data defined in a, b, c and d are all selectable via portable test equipment (e.g. lap top computer). **[A1]**

(f) The portable test equipment shall be provided with each site monitor equipment **[E5]**

12.2.2 In addition the following test functions shall be provided:

(a) Delivery of "active" II/SI code; **[E1]**

(b) Remote Setting Failure. That is the ground station shall be able to set remotely (or "trigger"):

(i) The Alert bit; **[E2]**

(ii) The Downlink Capability Report announcement; **[E3]**

(iii) Change of Flight Identity; **[E4]**

(iv) Test RA broadcast. **[E5]**

The use of MSP uplink channel 6 (ground to air service request) allows the ground station to be able to set remotely (or " trigger") such features. **[A1]**

The Tenderer shall provide in the proposal implementation details of the test functions which have been listed above. **[I1]**

12.2.3 The equipment shall function on a power supply consistent with the requirements of 4.11. **[E1]**

12.2.4 The Tenderer shall provide power budget calculations to support a ‘typical’ far field monitor installation. **[I1]**

The equipment supplied shall include all ancillary equipment including antenna, cabling power supplies and any necessary mounting hardware. **[E1]**

CHAPTER 13

OPTIONAL REQUIREMENTS

13.1 General

This chapter contains a number of optional requirements that, if exercised by the customer, will be identified as deliverable items in the List of Price & Deliverables (under 'Optional Deliverables') that accompanies any call for tender. **[A1]**

13.2 Cluster Controller

13.2.1 Surveillance Co-ordination Network

The objective of surveillance co-ordination is to allow any Mode S ground station to operate effectively within any radar siting plan as was stated in Chapter 8. **[A1]**

Figure 11 shows the overall layout of a typical Surveillance Co-ordination Network Cluster. It consists of a number of nodes which are all using the same limited set of II codes. A Cluster Controller (CC) is connected via a network to a number of ground station SCFs in order to provide centrally controlled mode of operation. The ground station SCFs are also connected via the network so as to provide a distributed mode in the event of the CC not being available. **[A2]**

The central controlled mode has been designed to take advantage of the central and therefore global view of the cluster. This view can be established in one of two ways:

(a) by passing track information from the connected cluster radars to the CC using track data messages in ASTERIX Category 17. This information is then processed by the CC to construct a CC global roll-call.

(b) by using system track data already available and processed in Radar Data Processing (RDP) systems. This option allows the CC and RDP systems flexibility in configuring the cluster to optimise the overall surveillance performance. The CC can take advantage of this pre-processing if a suitable interface is provided between the CC and the RDP system. **[A3]**

13.2.2 Functionality

The Cluster Controller is an optional item and as such the act of exercising this option shall not require a modification to the basic functionality of the ground station equipment. **[E1]**

The functions of the CC SCF are designed to optimise the Surveillance Co-ordination Network. They are illustrated in Figure 10, referred to in [Ref.1.] and described below. **[A1]**

13.2.2.1 Global Roll-Call

The CC SCF's function is to maintain the global roll-call by using knowledge of all the solution lists for each connected ground station. Three types of target lists shall exist:

(a) The Global Tracked Target list which contains information on every aircraft currently tracked by the connected ground stations. **[E1]**

(b) For each connected station, a Station Tracked Target List containing only those targets that are fully tracked (ie successfully added to the roll call list) by the station. **[E2]**

(c) For each connected station, a Station Potential Track List containing targets that the station is capable of tracking. **[E3]**

13.2.2.2 Track Data and Surveillance Processing.

Track information to maintain the Global Roll-Call lists can be received from:

(a) The SCF via the SCN, or **[E1]**

(b) The Radar Data Processing system (in the future). **[E2]**

The surveillance processing function maintains the Global Tracked Target List. Track data received from connected stations shall also be inserted into the respective Station Tracked List to which they are associated. **[E3]**

The Surveillance Processing Function shall be responsible for the deletion of Roll-call entries when no further track data is received. **[E4]**

The Surveillance Processing Function shall provide a Co-ordinate Transformation to the local co-ordinate set for the track data received from the connected stations. **[E5]**

The particular algorithms required for the Co-ordinate Transformation will be provided to the Contractor by the Agency. **[A1]**

13.2.2.3 CC Surveillance Co-ordination function.

13.2.2.3.1 The CC SCF shall contain the following functions:

(a) A pre-defined cluster coverage map indicating all ground station responsibilities for providing lockout and handover on targets located in different regions of the cluster. The map structure shall be defined as in [Ref.1.] and shall be at least capable of mapping a cluster covering an area of 600 NM by 600 NM; **[E1]**

(b) A network system status list containing the cluster topology determined by the Network Monitoring Protocol (NMP) running in the `Network Failure and Control' function of the CC. It shall consist of a table containing the status of all connections between the network nodes; **[E2]**

(c) A periodic monitoring process shall be responsible for the routine monitoring of the global roll-call, the coverage map and the network system status list. The process shall ensure that status changes result in the appropriate cluster handover activity; **[E3]**

(d) A network and failure control process which runs the protocols required to maintain the central mode of operation within the cluster. The acquisition and lockout responsibilities shall also be noted in the Station Potential Track list for subsequent processing and monitoring of cluster, station and target status. **[E4]**

13.2.2.3.2 The Periodic Monitoring Process (PMP) shall:

(a) Monitor the network system status list; **[E1]**

(b) Monitor the CC global roll-call; **[E2]**

(c) Based on the cluster topology, select the coverage map and maintain the global roll-call based on that map. **[E3]**

When the PMP detects a change of target status in global roll-call, or of cluster topology in the network system status list, it shall update the global roll-call target lists and ensure that the Network and Failure control process is made aware of the targets to which this change applies. **[E4]**

The PMP shall check the consistency between the Station Potential and Station Tracked target lists and ensure that inconsistencies which could indicate a cluster fault (e.g. Targets which should be being tracked but which are not and which are not subject to a lost track request) are resolved consistent with the cluster system configuration. **[E5]**

The Tenderer shall provide information in the Tender Response on the inconsistencies that shall be checked. **[I1]**

The simplest solution to be adopted in these cases is for a CC failure to be declared and actioned as in 13.2.2.3.3 below. **[A1]**

The PMP shall handle at least the following changes of status:

(a) Newly acquired targets - those targets which have flown into the cover of the CC cluster coverage area; **[E6]**

(b) Targets flying into the surveillance coverage of cluster radars; **[E7]**

(c) The network system status list indicates a change of cluster topology. In this case the PMP shall select the appropriate coverage map and amend target details on the global roll-call to reflect the new target status. **[E8]**

The Tenderer shall propose in the Tender Response a method used to select the appropriate coverage map. **[I2]**

The method to be used shall be agreed between the Contractor and the Agency. **[E9]**

13.2.2.3.3 The Network and Failure Controller shall perform: **[E1]**

(a) Handover management - which shall include running the following protocols defined in [Ref 10]:

(i) Track acquisition protocol to ensure that any interrogator is aware of any new track entering its coverage; **[E2]**

(ii) Track support protocol used when a radar requests track information from the CC on targets where a track miss has occurred. **[E3]**

(b) Cluster topology and state determination: **[E4]**

(i) This shall be achieved using the network monitoring protocol (NMP). **[E5]**

(ii) The NMP derived cluster topology shall then be communicated to the cluster stations as defined in [Ref 10]; **[E6]**

(c) Failure management, where: **[E7]**

(i) The SCF shall be able to safely reconfigure the cluster in the event of failures. **[E8]**

(ii) The reconfiguration shall ensure the fault is isolated and that the remaining cluster can continue to provide for correct Mode S operation. **[E9]**

(iii) The SCF shall reconfigure the cluster in the case of CC failure and network failures as described in [Ref 10]. **[E10]**

The Network and Failure Control process shall determine the cluster response to the changes in target status. **[E11]**

The Tenderer shall provide in the proposal details of all the functions defined below:

(a) The coverage map, and adaptations of it **[I1]**

(b) The network system status list. **[I2]**

(c) The periodic monitoring process. **[I3]**

(d) The network and failure controller. **[I4]**

13.2.2.4 Cluster Size

The cluster is normally considered to consist of up to six ground stations. **[A1]**

The Cluster Controller shall be able to handle at least 4000 targets. **[E1]**

The Tenderer shall provide information on the upgradeability of the CC functionality to support a larger cluster size. **[I1]**

13.2.2.5 Network Link

The link shall be able to provide a communication interface with the SCN and the CAM and optionally a local RDP system. **[E1]**

The SCN interface shall support X.25 at a minimum data rate of 19.2 Kbps for out going and incoming data. **[E2]**

The SCN interface shall support TCP/IP connections (client and server over IPv4 or IPv6). **[E3]**

The interface shall support the ASTERIX formats for surveillance co-ordination data defined in [Ref.6.]a. **[E4]**

Note that if an optional RDP connection is not provided additional bandwidth will be required. **[A1]**

The Tenderer shall propose information on the data rate to be used, and how it has been calculated. **[I1]**

13.2.2.6 Control and Monitoring (CAM)

The Cluster Controller shall be provide with local and remote control and monitoring. **[E1]**

The Tenderer shall provide details of the CAM capabilities provided with the CC. **[I1]**

13.3 LVA Antenna Requirements

13.3.1 The Tenderer shall propose a Large Vertical Aperture (LVA) 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 (Chapters 4 and 6) to be met in all respects. **[E1]**

13.3.2 The Tenderer shall detail in their proposal where they consider their antenna will not enable the requirements of this specification (Chapters 4 and 6) to be met in all respects. **[I1]**

13.3.3 The Tenderer shall provide details in their response of the antenna characteristics, with guaranteed parameter limits, and supported with measured antenna polar diagram. **[I1]**

13.3.4 As a minimum the following information shall be supplied by the Tenderer in their response:

(a) Vertical sum polar diagrams (field strengths, -3dB beamwidth, sidelobes, underside rolloff rate, etc.); **[I1]**

(b) Sum horizontal polar diagrams (peak forward gain, beamwidth at -3dB, -10dB, -20dB, symmetry/alignment of sum peak and beamwidths over elevation, sidelobes, etc.); **[I2]**

(c) Control pattern (coverage of sum sidelobes, crossover points, notch/minimum, symmetry/alignment over elevation, etc.); **[I3]**

(d) Difference pattern (crossover points, peak gain, difference null, symmetry/alignment over elevation, etc.); **[I4]**

(e) Fully dimensioned drawings; **[I5]**

(f) Safety (maintenance personnel, lightning strike protection); **[I6]**

(g) Mechanical requirements (dismantling/reassembly of columns, transportation, lifting); **[I7]**

(h) Environmental protection; **[I8]**

(i) Maximum operational wind speeds and ice depth such that the antenna can function within the conditions of 4.2; **[I9]**

(j) Maintenance requirements and lifetime of the array. **[I10]**

13.3.5 Prior to acceptance and delivery of each antenna the Contractor shall provide measured azimuth and elevation patterns for the antenna supplied, according to an agreed test procedure. **[E1]**

13.4 The LVA Turning Gear Requirements

13.4.1 The Tenderer shall propose in their response turning gear and azimuth take off equipment for the ground station that enables the requirements of this specification to be met in all respects. **[E1]**

The radar gear and associated components, i.e. rotating joint, slip ring assemblies, etc. shall be based on proven equipment of established mechanical accuracy and reliability. **[E2]**

The turning gear shall have dual azimuth take off to a resolution of 360/16384°. **[E3]**

The Tenderer shall provide in the tender response information on the format of the azimuth data. **[I1]**

The Tenderer shall provide detailed information on the turning gear and the associated pedestal mounted electronics on the following configurations:

(a) 1 Motor Drive **[I2]**

(b) 2 Motor Drives **[I3]**

The Tenderer shall describe in detail the behaviour of the system when the turning gear speed fluctuates too much due to excessive loading (due to the wind for example). In particular the Tenderer shall indicate the consequences of such conditions on the output of the data to the ATCC users. **[I4]**

The Tenderer shall detail in their response where their proposed turning gear will not enable the requirements of this specification to be met in all respects. **[I5]**

13.4.2 As a minimum the following information shall be supplied by the Tenderer in their response:

(a) LVA weight and details of the on mounting interfaces **[I1]**

(b) Details of the tilt and horizontal mechanisms **[I2]**

(c) Rotation speeds and speed variations under the worst conditions of 4.7.2 (include effects on system performance, tracking, etc.) **[I3]**

(d) Details of braking and locking the antenna **[I4]**

(e) Details of safety interlocks to immobilise the antenna during maintenance **[I5]**

(f) Horizontal stability of the antenna/tower interface and the main antenna drive Dearing over the full turning rate and tilt range of the antenna **[I6]**

(g) Details of the azimuth take off systems **[I7]**

(h) Details of alignment and maintenance of the azimuth data and north marker **[I8]**

(i) Details of how the turning information is to be validated **[I9]**

(j) Details of the rotating joint including power handling capabilities **[I10]**

(k) Details of the drive assembly and couplings **[I11]**

(l) Details of the lifting points for each major component **[I12]**

(m) Details of the turning gear lubricating system **[I13]**

(n) Details of the maintenance of the turning gear system **[I14]**

(o) Detailed list of the tools being delivered in order to perform the preventive and corrective maintenance operations for the LVA and the turning gear (including lifting devices) **[I15]**

13.5 Shelter

13.5.1 This section details the requirements which a shelter holding the Mode S ground station shall meet if this option is accepted. **[A1]**

13.5.2 The structure of the shelter shall be of metal construction designed in accordance with the accepted practices. The structure shall meet the building codes and other relevant regulations of the country in which it is situated. **[E1]**

The Tenderer shall state any specific exceptions. **[E2]**

The Tenderer shall provide in the proposal details of the shelter's structure. **[I1]**

The shelter shall have a design life of 25 years with a time to first maintenance of 10 years **[E3]**

The shelter shall have two access doors, separated for fire safety purposes. One of the doors shall be of sufficient size to permit all equipment to be loaded or removed from the shelter. **[E4]**

It is anticipated that the main personnel door has a lobby area (foyer) and internal door. **[A1]**

The shelter shall be provided with suitable fixings at each corner to allow the shelter to be secured to the concrete foundations so as to prevent movement (or structural damage)in wind speeds up to the specified wind load environment. **[E5]**

13.5.3 The shelter, building services and equipment shall be designed to meet all current planning requirements and provide an environment that enables staff to carry out their work in a manner that it acceptable to the Agency and permits the delivered equipment to be installed and operated without modification to the shelter or equipment. **[E1]**

The shelter shall be capable of housing all technical equipment required for the system and the following items of furniture, desk, chair, filing cabinet (4 drawer) and stationery cupboard. **[E2]**

The Tenderer shall provide in the proposal details of the layout of the shelter. **[I1]**

13.5.4 The shelter shall be approved by the Agency for fire protection and security. **[E1]**

13.5.5 The shelter shall have suitable lifting points at each corner to allow for cranage on and off a lorry and be capable of transportation in the EC area without police escort. **[E1]**

The shelter shall be capable of being transported with the full technical load installed. **[E2]**

The above is not a requirement for the equipment to be ruggedised for transportation; delicate equipment may be removed for subsequent transportation. **[A1]**

The shelter roof shall be capable of supporting the necessary snow and maintenance loads **[E3]**

13.5.6 The 3 phase 400V 50Hz distribution system shall comprise of at least the following:

(a) Main incoming fuse switch for isolation and protecting the full installation; **[E1]**

(b) Domestic distribution board with circuit breaker protection for:

  (i) Lighting;

  (ii) Domestic ring main;

  (iii) Heating/cooling plant;

  (iv) Obstruction light and tower power;

  (v) Fire alarm system;

  (vi) Intruder alarm system; **[E2]**

(c) Technical distribution board with circuit breaker protection for the technical equipment; **[E3]**

(d) Connection for mobile 3 phase 400V 50Hz generator, with change-over switch for selection between mains and generator for supplying the full load requirements of (b) and (c) above. **[E4]**

The Tenderer shall provide details in the proposal of the electrical components of the shelter. **[I1]**

13.5.7 The shelter should be considered in two modes of operation occupied and unoccupied. **[A1]**

In either mode the shelter shall be maintained at a temperature of 21° +/- 5° of the selected temperature for the period at the limit of the hot (with sun loading) and cold soak specified extremes. **[E1]**

A spare (redundant) heating and cooling system shall be provided. **[E2]**

The Tenderer shall detail in the proposal how the air temperature shall be maintained within the shelter. **[I1]**

13.6 Tower

13.6.1 This section details the tower requirements which shall be met if this option is accepted. **[A1]**

The tower is not considered as a mobile facility. **[A2]**

13.6.2 The aerial support shall be designed to meet the operational needs of the system proposed including structural requirements at the environmental extremes and access for maintenance of all antenna elements. The tower shall be capable of providing a mount for the standalone designated LVA antenna type (i.e. no co-located primary antenna) **[E1]**

The torsional deflection shall not exceed 1.5 minutes of Arc. **[E2]**

Deflection in the vertical plane shall not exceed 2.0 minutes of Arc. **[E3]**

Both of these are measured with the antenna installed and at the aerial/tower interface level over the specified operational wind speeds. **[A1]**

The required tolerance of horizontal level shall not to exceed +/-2 minutes of Arc through the azimuth of 360°. **[E4]**

The design of the structure shall be such that this tolerance shall not be subject to deterioration with age. Alternatively the design shall allow for easy adjustment of the level. **[E5]**

13.6.3 The steelwork of the tower shall be to BS4360 (or equivalent). **[E1]**

All steelwork of the tower shall be galvanised in accordance with BS 729 (or equivalent) after fabrication. **[E2]**

The tower shall comply with the requirements of BS CP3 Chap V:Part 2: 1972 including amendments AMD 4952, 5152, 5343(or equivalent). **[E3]**

13.6.4 The tower shall have a design life of 25 years, allowing for preventative visits every year, and a time to first maintenance of 10 years. **[E1]**

13.6.5 The tower shall have staircase access to the top inspection/working platform. **[E1]**

The staircase shall have suitable lighting. **[E2]**

The top inspection/working platform shall have all necessary handrails and toeboards. **[E3]**

The top platform shall have an access hatch with lifting beam over capable of lowering the elements of the array necessary for maintenance to the ground. **[E4]**

The top of the staircase on to the platform shall have a lockable door to prevent unauthorised access to the top platform. **[E5]**

The tower shall be fitted with obstruction lights of 2000 candela (steady red light) in such a way that they are visible for 360° of the azimuth. **[E6]**

The Tenderer shall include in the proposal details of the design of the tower. **[I1]**

13.6.6 The Contractor shall design, supply and install a lightning protection system to cover the tower and antenna system in accordance with BS6651(or equivalent). **[E1]**

13.7 Data Recording and Playback

13.7.1 The Tenderer shall provide in the proposal details of the record/replay facilities which shall be used to evaluate radar data and details of how these facilities shall be connected with the Mode S ground system, as indicated in [Ref.12.]. **[I1]**

13.7.2 The system shall be capable of selective and full data recording and replaying of the following time-stamped data:

(a) Plot Assignor Data (inc. SSR/PSR/combined RDIF/ASTERIX Cat. 001, 2, 34, 48 data); **[E1]**

(b) Mode S enhanced surveillance information (ASTERIX Cat. 48 data); **[E2]**

(c) Status information (time, date, scan no.); **[E3]**

(d) Data flagged as Anomalies and false in the PAF and NOT sent to ATC; **[E4]**

(e) Interrogation instructions; **[E5]**

(f) Mode A/C and Mode S reply report data; **[E6]**

(g) Data from the Surveillance Co-ordination Network. **[E7]**

The bulk data recording capability shall be capable of recording up to four of the above simultaneously. **[E8]**

In addition it shall be capable for up to four of the above to be selectively recorded with time-stamp for up to eight hours without interrogation instructions (2 hours with interrogation instructions) with all radar systems operating at full capacity. **[E9]**

The selection of inputs shall be independent of the data being displayed. **[E10]**

The Tenderer shall provide in the response the proposed method for data recording and playback, stating the expected duration for the above signals. **[I1]**

13.7.3 It shall be capable to record full data of a given type and selectively record in order to replay, the following information together with azimuth information where appropriate:

(a) SSR quantised processed sum video signals; **[O1]**

(b) Mode S All-Call quantised processed sum video signals. **[O2]**

The Tenderer shall provide information in the response of the preferred approach. **[I1]**

13.7.4 Control of full and selective data recording shall be via the operator interface. **[E1]**

13.7.5 The medium to be used for bulk and selective digital recording shall allow recordings to be replayed for analysis on another computer. **[E1]**

13.7.6 Selection of digital recording shall be by any logical and/or combination of the following criteria:

(a) All aircraft within a static volume bounded by any azimuth and altitude interval. **[E1]**

(b) Aircraft with selected Mode 3/A codes (from a definable list of up to 20 Mode 3/A codes) **[E2]**

(c) All aircraft Mode S addresses selected (from a definable list of up to 20 Mode S addresses). **[E3]**

(d) All plot data which falls within a dynamic log box (size defined by the user). The centre of the box to be given by an aircraft defined as in (b) or (c) above. **[E4]**

(e) All data described as ‘anomaly’ or ‘false’. **[E5]**

13.8 RDIF Requirements

13.8.1 As an option, Data Rate Control and Real Time Quality Control shall be implemented in the RDIF format as described in CAA Paper 87002 § 5.1.2 and 5.1.4. **[O1]**

13.8.2 Each input port shall receive filtered primary plot data in RDIF/ASTERIX format, HDLC protocol, synchronous and simplex; at a rate in the range 7.2 to 38.4 Kbps in increments of 2.4 Kbps. **[E2]**

13.8.3 For Surveillance data, there shall be 3 interfaces per SMF and each interface shall be dual channel. Thus, each interface should be software configurable to be either both ASTERIX (or optionally both RDIF) **[A1]**

13.8.4 As an option, output of RDIF messages on three simultaneous, independently configurable, channels at an average rate of 250 messages/second **[O1]**

13.8.5 As an option, the SMF shall have an RDIF interface. **[O1]**

13.8.6 As an option the PAF shall include RDIF plot formatting. **[O1]**

13.8.7 As an option the data shall be provided at the same rate to the local display in RDIF. **[O1]**

13.8.8 As an option, the display system shall recognise, process and interpret all messages types in RDIF including the extensions as defined in (CAA Paper 87002) and display the data from these messages. **[O1]**

13.8.9 The system shall be capable of selective and full data recording and replaying of time-stamped data Plot Assignor Data (inc. SSR/PSR/combined RDIF/ASTERIX Cat. 001, 2, 34, 48 data) **[E1]**

13.9 FFM Optional Requirements

13.9.1 The Tenderer shall provide a detailed proposal for the following FFM optional items:

(a) Power Attenuator **[O1]**

(b) Battery back-up **[O2]**

(c) Outdoor packaging **[O3]**

13.9.2 The test functions described in 12.2.2 [E2] to [E5] shall independently be selectable through dedicated SDPs. **[E1]**

13.10 Test and Development System

A Test and Development System may not be appropriate for this project but the Agency may wish to support a tool for the operational implementation of Mode S. **[A1]**

To ensure that the Agency always has access to hardware to enable testing of new versions of software to be performed, the Tenderer shall provide as an option a proposal for the following: A test system comprising a representative sub-set of all the hardware in the system that can be used to perform system tests of the software. Sufficient hardware shall be provided to ensure that all fall-back, fail-safe and automatic switchover mechanisms can be tested. **[O1]**

The Tenderer shall state in his proposal what constitutes a representative sub-set and give reasons why this is sufficient. **[I1]**

13.11 Software Development System

A Software Development System may not be appropriate for this project but the Agency may wish to support a tool for the operational implementation of Mode S. **[A1]**

This Software Development System shall be separate from the Test and Development system specified above. **[E1]**

The Tenderer shall provide as an option a Software Development system to hold all of the source code under control of CM software, and on which compilation, linking etc. is carried out. **[O1]**

The Tenderer shall state the processing power and disc capacity for this bureau and provide performance figures for the following:

(a) An estimate of the time to complete a single complete rebuild of the system software. (assuming that no other build/compilation processes are running). **[I1]**

(b) Development System Storage capacity. **[I2]**

(c) Storage capacity required for one build. **[I3]**

The Build software shall allow for a minimum of 5 software engineers to generate different versions of a complete set of system software simultaneously. **[O2]**

The first item in an acceptance test of a Software Development System would commence with an 'empty' machine and load all operating systems, applications programs and source code onto it, to arrive at a working system. **[A2]**

13.12 Control and Monitoring Terminals

13.12.1 General

13.12.1.1 The Tenderer shall state how the following data is displayed on the local and remote terminal:

(a) Radar sensor, including antenna, turning gear, RF change-over and azimuth data; **[E1]**

(b) Interrogator; **[E2]**

(c) System Management Function (SMF); **[E3]**

(d) Surveillance Co-ordination Function (SCF); **[E4]**

(e) Data Link Function (DLF); **[E5]**

(f) Data transmission facilities (modem, multiplexer and network terminating units); **[E6]**

(g) Far Field site monitor; **[E7]**

(h) General site utilities (fire and intruder alarm, air conditioning equipment); **[E8]**

The Tenderer shall indicate whether the following statistical information (on a Scan or timely basis) are provided for display at the CAM terminals (locally or remotely):

(a) Information about the data supplied to the ATCC users:

(i) Number of solo Mode S reports;

(ii) Number of solo SSR reports;

(iii) Number of solo PSR reports;

(iv) Number of combined SSR/PSR reports;

(v) Number of combined Mode S /PSR reports;

(vi) Number of Splits plots;

(vii) Number of code swaps;

(viii) Number of plots with duplicated Mode S address;

(ix) Number of test transponders;

(x) Number of test targets.

(b) Information about the data transferred through the SCN:

(i) Number of Track Initiations sent out;

(ii) Number of Track Initiations received;

(iii) Number of Track Data messages sent out;

(iv) Number of Track Data messages received;

(v) Number of Track Data Requests sent out;

(vi) Number of Track Data Requests received;

(vii) Number of Tracks for which SCN Track Support is being given;

(viii) Number of Tracks for which SCN Track Support is being received.

(c) Information (including the rationale) about the data exchanged with the GDLP;

(d) CPU loading on the different processing boards;

(e) measured data rate on each link (surveillance, SCN and DLF). **[I1]**

13.12.1.2 The CAM terminals shall enable the connection or disconnection of the ground station from the Surveillance Co-ordination Network (SCN). **[E1]**

13.12.1.3 The Tenderer shall provide detailed information about the BITE of the CAM terminal (local or remote). **[I1]**

Each CAM terminal shall be delivered with a printer capable of printing all controlled and monitored data. **[E1]**

13.12.2 Local Terminal

13.12.2.1 Control and monitoring of the system and all subsystem shall be provided through a local (i.e. local to the equipment) terminal. **[E1]**

The Tenderer shall provide details on the HMI, including screen layout, used in the local terminal. **[I1]**

The Tenderer shall provide details on the platform used in the local terminal. **[I2]**

The Tenderer shall state the number of days over which the local terminal can store the control and monitoring messages received and sent. **[I3]**

13.12.3 Remote Terminal

13.12.3.1 Control and monitoring of the system and all subsystem shall be provided through a remote terminal. **[E1]**

The Tenderer shall provide details on the HMI, including screen layout, used in the remote terminal. **[I1]**

The Tenderer shall provide details on the platform used in the remote terminal. **[I2]**

The Tenderer shall state the number of days over which the remote terminal can store the control and monitoring messages received and sent. **[I3]**

13.13 GPS Receiver

As an option, the system shall be fitted with two GPS receivers acting as the external source. **[E1]**

13.14 Mode S interrogator with primary radar collocation

13.14.1 Some states might choose to collocate primary L-band or S-band radar with Mode S interrogators as defined below. **[A1]**

The Tenderer shall provide interfaces for the L-band 23cm HSA primary radar and co-locating with the L-band SRE-M5 AEG or Alenia/Thomson S-band: **[A2]**

Each channel of the Mode S ground station shall have a configurable primary interface to each primary channel, which may be selectable locally and remotely. **[E1]**

Each input port shall receive filtered primary plot data in RDIF/ASTERIX format, HDLC protocol, synchronous and simplex; at a rate in the range 7.2 to 38.4 Kbps in increments of 2.4 Kbps. **[E2]**

Each input port data rate shall be independently set to any output data rate in the range 7.2 to 38.4 Kbps in increments of 2.4 Kbps. **[E3]**

Each input port shall be able to be independently synchronised with either an external or internal clock, where the internal clock accuracy shall be better than one part in one million. **[E4]**

The clock and data levels shall conform to RS232-C or RS422. **[E5]**

The Mode S ground station shall perform plot combination with the primary radar data that is found to be associated with an SSR/Mode S target. **[E6]**

The Tenderer shall provide all necessary information of how it is intended to solve the problem of mutual interference. **[I1]**

The Mode S system shall be capable of operating asynchronously with the co-located radars. **[E7]**

The Tenderer shall provide details in the response of the proposed PSR interface. **[I2]**

13.15 Additional equipment and performance requirements

The system shall support PVCs for all connections except the SCN ones **[E1]**

In the case of repeated absence of a reply to a UF 4 or UF 5 interrogation containing a RR field higher or equal to 17, the system shall re-interrogate the

aircraft with a UF 4 or UF 5 interrogation containing a RR field lower or equal to 16, and shall attempt to schedule this new interrogation in the same scan. **[E2]**

The Tenderer shall provide details on how the above function will be implemented. **[I1]**

13.16 Additional System Management Function requirements

An operational parameter shall be available to override the check of bit 33 of BDS 1,0 for the extraction of BDS 2,0 during the acquisition process. **[E1]**

An operational parameter shall be available to override the check of bit 25 of BDS 1,0 for the extraction of BDS 1,7 and BDS 1,D during the acquisition process. **[E2]**

An operational parameter shall be available to override the check of BDS 1,7 for the extraction of BDS registers. **[E3]**

13.16.1 II/SI code operation

An SI code, defined in [Ref.1.], is composed of the IC field and the CL field. Only transponders complying with Amendment 73 of Annex 10 will decode the CL field in order to determine if the content of the IC field is an II code or an SI code. Transponders which have not been upgraded to handle SI code will, by default, consider the content of the IC field as being an II code value. Therefore, if CL is not equal to zero (meaning that the IC field contains a SI code), the non-upgraded transponders will encode the parity sequence of the reply using the "matching" II code rather than the SI code contained in the interrogation. **[A1]**

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. **[E1]**

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. **[E2]**

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. **[E3]**

The system, if operating with an SI code and if enabled by an operational parameter, shall be configurable by the user to either:

(a) not lockout non SI transponders on the "matching" II code ; **[E4]**

(b) use intermittent lockout for this "matching" II code. **[E5]**

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 ; **[E6]**

(b) use intermittent lockout for Mode S transponders which do not report the SI capability in BDS 1,0. **[E7]**

The above requirements are to allow neighbouring stations operating with an SI code and the “matching” II code to acquire the non SI targets. **[A2]**

When this additional system management function is activated, the lockout maps are not taken into account for non SI equipped transponders. **[E8]**

This additional system management function will only be activated when the aircraft population consists of a significant proportion of SI equipped transponders. **[A3]**

13.17 Additional DLF requirements

When the station extracts a downlink Dataflash message following the announcement of the event, the station shall check if the message is associated to a contract that has been set-up by the station's IAL and if so, shall identify the register which is subject to monitoring. **[E1]**

If the Dataflash contract was set-up by the Internal Application List, the station shall program a GICB extraction for the monitored register during the same scan as the reception of the downlink Dataflash message. **[E2]**

This function shall be selectable by an SDP, for each contract independently. **[E3]**

The above option does not modify the normal operation of the station Dataflash application. Consequently, the operator should normally not select this function for a two-segments contract. **[A1]**

13.18 Processing of Position Reports

Mode S ground stations, when not clustered, exclusively rely on All Call interrogations and replies for Mode S targets acquisition. The processing of additional, indepedent target reports could support Mode S targets acquisition, anti-reflection processing as well as identifying Mode S detection failures. Such independent target position reports could come from Extended Squitters decoded on the omni antenna, or from target reports decoded on an external interface (e.g. ADS-B ASTERIX target reports). **[A1]**

The Tenderer shall provide details on the extensibility of their design to accommodate such enhancements, and the expected benefits. **[I1]**

CHAPTER 14

GENERAL EQUIPMENT CONDITIONS

14.1 Logistic Support

14.1.1 General

All parts of the ground station to be provided under this contract shall be designed and constructed in order to withstand possible operations of 24 hours per day, 7 days per week, 52 weeks per year for a minimum 10 year life cycle. **[E1]**

A modular approach, with easy access to each LRU and test point, shall be employed. The approach shall facilitate rapid replacement of faulty units, in order to satisfy the availability and maintainability requirements, whilst minimising impact on personnel and equipment safety. **[E2]**

It is preferred that duplicated items in the antenna turning gear can be replaced without the need to stop the antenna rotating. **[A1]**

The Tenderer shall state in his response the antenna turning gear items that require the antenna to be stopped when replaced. **[I1]**

It is preferred that no rear access is required for maintenance purposes. **[A2]**

It is required that related equipment maintenance actions shall be carried out from the same side of the equipment. **[E3]**

Maintenance philosophy for the ground station shall be consistent with unattended operation and shall be as follows:

(a) Restoration of service by Line Replaceable Unit (LRU) exchange at Organisational level. This may be carried out by appropriately trained Contractor, Agency or National personnel. **[A3]**

(b) Further diagnosis and exchange of Field Replaceable Units (FRU) to be carried out by engineering staff, either Contractor, Agency or National, utilising Intermediate or Depot level facilities. **[A4]**

(c) Defective LRU/FRU shall be returned for appropriate action (e.g. repair, recalibration, replacement) to the Contractor or a designated National Repair Centre. **[A5]**

A Logistic Support Plan shall be provided by the Tenderer with his Proposal regarding cost efficient approaches to Engineering, Logistic Support and Maintenance of the system(s), equipment(s) and software. This shall cover the entire planned life cycle of the system(s). **[I2]**

The Plan shall detail the methods & standards to be employed to achieve the Availability, Reliability and Maintainability objectives (including safety aspects) contained in this Specification. **[E4]**

The Plan shall also provide outline details of types of personnel, training, Support & Test Equipment requirements, Spares availability and Corrective & Preventative maintenance tasks (particularly those expected to exceed 30 minutes in length). **[E5]**

The Tenderer shall indicate in his Tender response the level of support available from their own resources to provide backing for the Agency or the National organisation's support facilities. **[E6]**

The Commercial Response shall include appropriate cost scales for:

(a) Maintenance Support Contract set-up and renewal **[E7]**

(b) Manufacturer's repair of LRUs and FRUs **[E8]**

(c) Post Design Services contract to provide technical information and assistance to component level and to allow any changes or improvements resulting from the test and validation period to be accommodated **[E9]**

Examples of the above, where available, shall be included in the Tender Response. **[E10]**

The Agency, or the National organisations may be required to perform Logistic Support Analysis to MIL STD 1388-1A. **[A6]**

The Tenderer shall indicate in the Tender Response his ability to comply with the objectives of this Standard (or equivalent) by citing previous examples of deliveries using Logistic Support Analysis. **[I3]**

The Tenderer shall guarantee the availability of all items required to support the system(s) supplied for at least 10 years after final acceptance of the last station to be installed. **[E11]**

Advance warning of at least 12 months shall be required for inability to meet this commitment to allow the Agency the option of a Lifetime spares procurement. **[E12]**

All components used in the Mode S system shall be available from more than one source, except with the prior written agreement of the Agency. **[E13]**

The Agency retains the right to purchase items required to support the system(s) supplied directly from the original equipment or component manufacturers. **[A7]**

Software maintenance, including PROM/EPROM programming shall be addressed specifically by the Tenderer who shall include details of his intended software Maintenance Policy in his Tender Response **[E14]**

14.2 Reliability, Availability, and Maintainability (RAM)

14.2.1 General

Availability, Reliability and Maintainability are characteristics of the overall system which shall be specified, designed, implemented, tested, validated and documented. **[E1]**

The methodology, techniques, processes and tools The Tenderer intend to use to achieve the specified RAM objectives shall be described or referenced in specific plans addressing architecture, hardware and software aspects. **[I1]**

The Military Standards Referenced in Annex C provide the preferred methodology. **[A1]**

14.2.2 Availability

For the purposes of this specification, Availability is defined as a ratio of the total time the system is capable of performing it's mission, against the time for which it is required to perform that mission, expressed as a percentage. **[A1]**

The availability calculation excludes all planned downtimes. **[A2]**

The figures for Availability quoted in this Specification are for Operational Availability (Ao) and shall be calculated using the following equation:

$$A(o) = \frac{MTBF}{MTBF + MTTR + MRT}$$

MTBF = Mean Time Between Failures in hours.

MTTR = Mean Time To Repair in hours.

MRT = Mean Response Time in hours (i.e. the average time from notification of failure for a technician to be ready to commence repair action). **[A3]**

14.2.2.1 Failure Definition

The Mode S System is to be considered as failed when coherent and full radar data is no longer provided by that system to Air Traffic Control. **[A1]**

The Mode S System is defined in Chapter 2 of this specification. **[A2]**

14.2.2.2 System Availability

The operational availability of coherent and full radar data from the Mode S ground station site shall be greater than 99.98%. **[E1]**

The Tenderer shall use availability figures for the customer-supplied components in order to predict the overall system availability. **[E6]**

The system reliability requirement for each Mode S ground station as described in Figure 3 (excluding Local Display and Recording/Playback facility) shall be greater than 20,000 hrs MTBF. **[E2]**

MTTR at Organisational Level shall be 30 (thirty) minutes. **[E3]**

The following figures are given for Tender Evaluation purposes:

(a) The MRT shall be 3.5 hours;

(b) The maximum time to repair shall not exceed 8 (eight) hours for 95% of all repairs;

(c) The maximum response time shall not exceed 8 (eight) hours. **[A2]**

When procuring equipment during the operational implementation phase of Mode S the Agency will provide the MRT based on their individual maintenance philosophy. **[A3]**

If the option is taken, the operational availability of the cluster controller shall be greater than 99.99% using the MTTR and MRT above. **[O1]**

The operational availability of the site monitor shall be greater than 99.995% using the MTTR and MRT above. **[E5]**

14.2.3 Reliability

Reliability is the probability that an item will perform it's intended function without error, under stated conditions, for a specified period of time. **[A1]**

14.2.3.1 Reliability Model

The Tenderer shall substantiate his ability to meet the specified RAM by providing in his response a reliability model consisting of reliability block diagrams covering all functions of the system. **[E1]**

The MTBF and MTTR in hours and the Availability shall be clearly shown in either the block diagram or in a list showing the equipment breakdown to functional unit level, with identification of specific common failure mode (e.g. switch over equipment). **[E2]**

14.2.3.2 Reliability Goals

Where appropriate hardware and software shall be separately identified and included in the Reliability predictions. **[E1]**

The Tenderer shall state the individual MTBF's of the equipment listed below and identify which items are duplicated to achieve the required availabilities of 14.2.2.2:

(a) SSR Antenna and cabling; **[I1]**

(b) Main bearing and drive ring; **[I2]**

(c) Rotary Joint and slip rings; **[I3]**

(d) Drive Motors and clutch; **[I4]**

(e) Antenna controllers; **[I5]**

(f) Azimuth Encoders; **[I6]**

(g) Control and Monitoring (Single Channel); **[I7]**

(h) Mode S Electronics (Single Channel); **[I8]**

(i) Monitor Display; **[I9]**

(j) Site Monitor; **[I10]**

(k) Cluster Controller. **[I11]**

The above info is required only if the corresponding equipments are being procured. **[A2]**

The Tenderer shall ensure the design minimises system outage due to preventative maintenance. **[E2]**

The Tenderer shall state in the Tender Response all expected outages. **[I12]**

14.2.3.3 Reliability Prediction

The Tenderer shall provide in his Response reliability predictions and analysis for each site as per MIL-HDBK-217 using exclusively a generic parts count method. **[I1]**

A Ground Fixed environment shall be used for all calculations. **[E1]**

Predictions for single channel MTBF and System MTBF shall be provided for the following:

(a) Line replaceable units; **[I2]**

(b) Each major equipment group; **[I3]**

(c) Each single channel of the system. **[I4]**

Where existing equipments are being offered to fulfil the contractual requirements then field failure rates and MTBF data shall be provided to substantiate the predicted data. **[E2]**

The Tenderer shall indicate the condemnation rate for the following:

(a) Line replaceable unit; **[I5]**

(b) Each major equipment group; **[I6]**

(c) Each single channel of the system. **[I7]**

14.2.3.4 Reliability Predictions Update

Reliability Predictions shall be provided within ninety (90) days of contract award and at agreed intervals thereafter for approval by the Agency. **[E1]**

14.2.3.5 Reliability Demonstration

The Contractor shall conduct a Reliability Demonstration. **[E1]**

The preferred methodology is described in MIL STD 785. **[A1]**

The Tenderer may propose an alternative methodology, to be described in the SAT Test Strategy, subject to Agency approval. **[I1]**

14.2.4 Maintainability

Maintainability is the measure of the ability of an item to be retained in or restored to a specified condition when maintenance is performed by personnel having specified skill levels, using prescribed procedures and resources, at each prescribed level of maintenance and repair.. **[A1]**

MTTR is the sum of corrective maintenance times at any specified level of repair, divided by the total number of failures within an item repaired at that level, during a particular interval under stated conditions. **[A2]**

14.2.4.1 Maintainability Goals

The Contractor shall meet or improve on the MTTR targets for the following functional areas:

(a) Mode S Antenna - 4 hrs; **[E1]**

(b) Main Bearing - 8 hrs; **[E2]**

(c) Motors & Encoders - 4 hrs; **[E3]**

(d) Mode S Electronics - 0.5 hrs; **[E4]**

(e) CAM - 0.5 hrs; **[E5]**

(f) Monitor Display - 1 hr; **[E6]**

(g) Site Monitor - 0.5 hrs; **[E7]**

(h) Cluster Controller - 0.5 hrs. **[E8]**

The above info is required only if the corresponding equipments are being procured. **[A1]**

The Tenderer shall provide in Tender response the MTTR estimates for each of the following:

(a) Line Replacement Unit; **[I1]**

(b) Each major equipment group; **[I2]**

(c) Each single channel of the system; **[I3]**

14.2.4.2 Maintainability Predictions

The Tenderer shall provide in the Tender response Maintainability Predictions for the following equipments:

(a) Line Replaceable Unit; **[I1]**

(b) Each major equipment group; **[I2]**

(c) Each single channel of the system. **[I3]**

MTTR predictions shall be in accordance with MIL HDBK 472. **[E1]**

The Tenderer shall conduct a Maintenance Task Analysis in accordance with MIL STD 470. **[E2]**

14.2.4.3 Maintainability Prediction Updates

Maintainability Predictions shall be provided within ninety (90) days of contract award and at agreed intervals thereafter for approval by the Agency. **[E1]**

14.2.4.4 Maintainability Costs

The Tenderer shall provide in the Tender response the average material cost of repair, the average cost per repair and the depot response time for the following:

(a) Line Replaceable Unit; **[I1]**

(b) Each major equipment group; **[I2]**

(c) Each single channel. **[I3]**

14.2.4.5 Maintainability Demonstration

The Contractor shall conduct a Maintainability demonstration in accordance with MIL STD 471. **[E1]**

14.3 Life Cycle Aspects

The ground station equipment shall be designed to have an in-service life of at least 10 years and shall be designed in such a manner that it may be progressively upgraded in functionality and performance. **[E1]**

The Tenderer shall indicate in the Tender Response the expansion capability of his proposed equipment (processor power, memory capacity, etc.). **[I1]**

The Tenderer shall be prepared to provide data for life cycle costing (Refer to Annex F for Data Requirements List). **[A1]**

To enable the Agency to fully calculate Life Cycle Cost implications, the Tenderer shall include as part of his proposal a provisional Build List of all repairable items. **[I2]**

The following information shall be provided for each item listed:

(a) Mean Time Between Failure, **[E2]**

(b) Mean Time To Repair, **[E3]**

(c) Original Manufacturer (Name, Address & Telephone Number) (include Alternative Manufacturer if available) **[E4]**

(d) Manufacturer's Part Number and Designation, **[E5]**

(e) Supply Price (including volume discount if any) and initial escalation rate. **[E6]**

The sources for all data shall be quoted. **[E7]**

Where any item of data is not supplied, the reason for non inclusion is to be stated. **[E8]**

All data shall be supplied by the Contractor within 12 months of Contract Let. **[E9]**

The Tenderer shall provide as part of the Commercial Response a Life Cycle Cost analysis. **[E10]**

14.4 Documentation

14.4.1 General Requirements

The Tenderer shall provide a detailed list of technical documents to be delivered, which include, but is not limited to, the following documents:

(a) System Overview; **[E1]**

(b) List of Deliverable Items; **[E2]**

(c) Statement of Compliance; **[E3]**

(d) Project Management Documentation:

  (i) Project Management Plan (PMP); **[E4]**

  (ii) Configuration Management Plan (CMP); **[E5]**

  (iii) Quality Plan (QP); **[E6]**

  (iv) Software Development Plan (SDP); **[E7]**

  (v) Verification and Validation Plan (VVP); **[E8]**

(vi) Installation and Commissioning Plan. **[E9]**

(e) Reliability, Maintainability and Availability Predictions (RMA). **[E10]**

(f) Lifecycle Documentation:

(i) System Requirement Specification (SRS or DOD-2167 SSS). **[E11]**

(ii) System Architecture Design Document (SAD or DOD-2167 SSDD). **[E12]**

(iii) Software Requirement Documents (SRD or DOD-2167 SRS), for each CSCI. **[E13]**

(iv) Software Architectural Design Documents (ADD or DOD-2167 SDD), for each CSCI. **[E14]**

(v) Interface Control Documents (ICD) for internal and external interfaces. **[E15]**

(vi) Hardware Development Specifications, for each HWCI. **[E16]**

(vii) Hardware Architectural Design Documents, for each HWCI. **[E17]**

(viii) COTS customisation documents. **[E18]**

(ix) Operator Handbooks. **[E20]**

(x) Verification and Validation Documents (for the system, the hardware and software components). **[E21]**

(g) COTS standard documentation. **[E22]**

(h) Training and Maintenance documentation. **[E23]**

(i) System Documentation **[E24]**

The Tenderer shall state when these documents will be delivered. **[I1]**

The exact delivery schedule shall be subject to agreement with the Agency. **[E25]**

The Tenderer shall deliver preliminary versions of the documents listed in (a), (b), (c), (d) and (e). **[E32]**

The Contractor shall deliver the documents identified in the Tenderer's list. **[E26]**

All deliverable documentation shall be written in English, using standardised presentation and notation. **[E27]**

All deliverable documentation shall be provided as paper and computer readable in a format to be agreed with the Agency prior to contract let. **[E28]**

The Contractor shall ensure that the Agency has the right to a free licence to copy the deliverable documentation called for under the contract, and to circulate or use the copies within the establishments of the Agency. The Agency will not disclose such documents outside its establishments without the prior written consent of the Contractor which shall not be unreasonably withheld. **[E29]**

The Tenderer shall identify in their Tender Response any deliverable documentation which will not be subject to the licence above. **[I2]**

Delivered documentation shall always be identified on the cover page with the assigned code referred to in the List of Deliverables. **[E30]**

In addition to the requirements above; flow charts, block diagrams and preventative/ corrective procedures (including diagnostics) shall be required. **[E31]**

These may be provided as a separate document or included in the main document. **[A1]**

14.4.2 Requirements Traceability

Traceability through cross references of the functional requirements shall exist throughout all levels of the documentation produced, including maintenance phases documentation. **[E1]**

14.4.3 Operator Handbooks and Maintenance Documents

The purpose of the Operator Handbooks and Maintenance Documents is to enable operation, maintenance, fault diagnosis and repair of the equipment by trained personnel in the Agency . **[A1]**

Although service restoration will be effected by replacing faulty LRUs with serviceable items, all the data needed to enable staff to locate faults to LRU level is required. **[A2]**

14.4.4 Cable Schedules

The System Cabling Schedule shall form part of the System Documentation. **[E1]**

The system cabling comprises all the cables used to interconnect the complete system. **[A1]**

14.4.5 Lifecycle Documentation

Either a component needs to be newly developed, or it exists already as a product or as part of a product. Those existing products are Off The Shelf products. They can be classified into Commercial Off the Shelf products (COTS) and Non Commercial Off The Shelf products (OTS). **[A1]**

A component shall only be categorised as COTS if it satisfies the following conditions:

(a) It has been developed ready for sale (in stock) by a third party, prior to receiving the contract (e.g. standard PC…);

(b) It is available to the market;

(c) It has an established history of use by different customers;

(d) It is a product of a reputable, well-established company;

(e) It is maintained by the vendor;

(f) The vendor possesses the source (in case of a software component);

(g) It is not modified for the contract (customisation in the form of setting/tuning parameters is not considered a modification). **[E1]**

A component shall only be categorised as OTS reused component if it satisfies the following conditions:

(a) It has been developed by the Tenderer and used outside the current contract;

(b) The product is developed according to an acceptable QA system, the complete lifecycle documents belonging to the product are available;

(c) It needs minor modifications (no more then 30 % of the original source code is to be modified/extended for the contract, in case of software) **[E2]**

Full lifecycle documentation shall be produced and delivered for newly developed components. **[E3]**

The existing lifecycle documents belonging to the OTS products shall be provided, updated if they were modified to fit in the procured system. **[E4]**

The COTS standard documentation (User Manual, Reference Manual…) shall be provided, together with documents describing how they were customised to fit in the procured system. **[E5]**

The Tenderer shall state, for each Configuration Item, whether it classifies as COTS, OTS or needs to be developed. **[E6]**

In addition to the above requirements, all source code listings of new and OTS reused software modules shall be provided in hardcopy and an appropriate computer readable format and provide the full definition and identification of the software development environment used (compilers, testing tools, simulator). **[E7]**

14.4.6 Amendments

The Tenderer shall advise the Agency in the Tender response on the exact procedures that will be employed to amend the documentation to include subsequent updates. **[I1]**

Specific Procedures shall be defined to control the various status of documentation, its approval and to ensure that the pertinent issues of appropriate documents are available at the appropriate locations, particularly when computerised documentation is used distributed and archived. **[E1]**

14.5 Training

Training for the delivered equipment shall be sufficient to enable Agency engineers to efficiently undertake the necessary trials to evaluate the ground station. **[E1]**

The following 'minimum training requirements' are identified for the ground station system:

(a) System description, including data flows;

(b) Interpreting system status;

(c) Initiate changes to system configuration;

(d) Reinstating equipment after failure/maintenance;

(e) Routine maintenance;

(f) Fault location;

(g) Restoration of service by module changing;

(h) Running and interpreting diagnostic software. **[A1]**

The Tenderer shall provide in the Tender responses a Training Plan for the ground station equipment as part of the Tender response. **[I1]**

The Training Plan shall describe the objectives, pre-requisites, duration and approach for training personnel involved with the delivered equipment (both hardware and software). **[E2]**

The Tenderer shall provide as part of the Commercial Response a separately cost proposal for the training of staff, stating how they intend to comply with the Training Plan objectives. **[I2]**

It is anticipated that all Training Courses shall be held at the Contractors premises. **[A3]**

The Contractor's training personnel shall utilise a complete and fully functioning system for all practical training. **[E3]**

To ensure a good standard of training, the Contractor shall employ Instructors who are fully trained in Instructional Techniques. **[E4]**

14.6 Safety Requirements for Personnel and Environment

14.6.1 Safety Regulations and Standards

The Contractor shall meet all International, European and National Health and Safety standards, rules and practices and the legislation that has relevance to the equipment being supplied. **[E1]**

'National' Health and Safety standards, rules and practices in this context is considered to be the standards of the country in which the equipment is to be installed, as specified in the local language. **[A1]**

The Tenderer shall state the National Health and Safety at Work requirements which will be adhered to. **[I1]**

The Tenderer shall state the standards relevant to the equipment being supplied. **[I2]**

The Contractor shall at all times observe the local rules regarding health and safety at work, relative to the personnel in his service The expenses which arise from this obligation (including any necessary translation of documentation) shall be borne by the Contractor. **[E2]**

The Tenderer shall show his understanding of the rules in force for the sites selected for the implementation of the Mode S ground system. **[E3]**

The Tenderer shall provide in Tender response details of their management system for Health and Safety and demonstrate the processes used to ensure compliance. **[I3]**

The Tenderer shall provide in Tender response details of the acoustic noise level of the proposed equipment. **[I4]**

14.6.1.1 Pre-Contract Audit

The Agency shall have the right to carry out a Pre-Contract Audit to confirm that the standards and the management system detailed by the Tenderer fully meet the Agency's requirements. **[E1]**

The audit will confirm that the Tenderer is operating to the standards defined in the Tender Response. **[A1]**

14.6.1.2 Climbing Devices

All ladders that may be required to gain access to areas that are out of reach from ground level in areas where particular hazard may exist shall be fitted with "Railok" to prevent personnel falling. **[E1]**

All installations shall require the approval of the Agency’s delegated Safety Officer. **[E2]**

14.7 Air Traffic Service Safety

14.7.1 Introduction

14.7.1.1 The Agency's safety policy is to secure high standards of safety within the air traffic services and systems it plans, provides and operates by minimising

those risks which contribute to aircraft accidents as far as reasonably practicable. Safety is afforded the highest priority and it is an integral part of the Management function. **[A1]**

14.7.1.2 The Contractor shall demonstrate his understanding of the safety requirements and that their design and implementation plans will meet all of the safety criteria. The necessary demonstrations shall be through analysis of the design, components and maintenance procedures. **[E1]**

14.7.1.3 The safety activities and analysis present the evidence, arguments and assumptions, at significant points in the system life cycle, to provide assurance that:

(a) The Safety Requirements of the system are either met or that any shortcomings, limitations or unresolved hazards are understood and accepted. **[A1]**

(b) When introduced into operational service the new system does not, of itself, exhibit any hazards due to installation, commissioning and integration activities. **[A2]**

(c) The introduction of the new system does not adversely affect the safety of the existing ATS. **[A3]**

14.7.1.4 The safety assurance activities provide the necessary confidence that the following objectives have been met:

(a) The Safety Requirements of the system have been correctly identified. **[A1]**

(b) The procedures and standards used to design, develop and analyse the system are adequate and have been implemented correctly. **[A2]**

(c) There is sufficient evidence available to show compliance with the Safety Requirements, and to allow the system to proceed to the next life cycle phase or continue in operation, as appropriate. **[A3]**

14.7.2 Safety Plan

14.7.2.1 The Safety Plan shall define the safety management, safety analysis and assurance activities to be performed by the Contractor. **[E1]**

14.7.2.2 The Tenderer shall provide a preliminary Safety Plan. **[E1]**

The Tenderer's Safety Plan shall, as a minimum, address the items detailed at Annex D and shall confirm that they are commensurate with ensuring the Safety Plan deliverables are met. **[E2]**

14.7.2.3 The Contractor shall provide a Safety Plan. **[E1]**

14.7.3 Safety Plan Deliverables

14.7.3.1 The Contractor shall deliver the following documented deliverables resulting from the activities defined in their Safety Plan:

(a) Design Process and Assurance Deliverable; **[E1]**

(b) Installation, Commissioning, Integration and Test and Evaluation Deliverable. **[E2]**

14.7.3.2 The Design Process and Assurance deliverable shall:

(a) Provide a summary description of the Mode S functions, supported with diagrams, showing their physical location(s) and role. The boundaries of the Mode S System and its interface with other systems or facilities should be clearly identified. **[E1]**

(b) Identify or reference the Safety Requirements of the Mode S System. **[E2]**

(c) Describe the physical configuration of Mode S, including permitted variations of the configuration during operation. **[E3]**

(d) Identify the documentation and its status, which records the system build state for Mode S. **[E4]**

(e) Provide a description of the design process used for the development of the hardware and software aspects of Mode S. **[E5]**

(i) This description shall show the design, coding, verification and validation methods to be employed that will allow the software to meet the Safety Requirements. **[E6]**

(ii) This description shall provide evidence, arguments and assumptions for claiming that the hardware design has been implemented to a level consistent with the Safety Requirements. **[E7]**

(f) Identify any dependencies on other systems or facilities that affect the ability of Mode S to meet its Safety Requirements. **[E8]**

(g) Address each Safety Requirement: **[E9]**

(i) Providing arguments to support the claim that the Mode S design will meet the Safety Requirement; **[E10]**

(ii) Summarising, and referencing, any evidence available that supports the arguments that the design will meet the Safety Requirement; **[E11]**

(iii) Identifying the current compliant status of the Safety Requirement (met, not met, not proven); **[E12]**

(iv) Identifying any further verification and subsequent validation that is to be performed during the Installation, Commissioning and Integration activities; **[E13]**

(v) Identifying any features in the design that specifically address the Safety Requirement. **[E14]**

(h) State any limitations on the use, or maintenance, of Mode S or other shortcomings identified in the design. **[E15]**

(i) Specify any aspects of the Mode S performance that should be monitored in service to provide assurance that the Safety Requirements continue to be met in operation. **[E16]**

(j) Detail the confidence that has been gained that the Installation, Commissioning and Integration activities will not have an adverse effect on the safety of the existing ATS. **[E17]**

14.7.3.3 The Installation, Commissioning, Integration and Test and Evaluation Deliverable shall:

(a) Describe the installation, commissioning, integration and test and evaluation process and provide evidence, arguments and assumptions for claiming that this process was effective in maintaining the safety of Mode S and the existing ATS. **[E1]**

(b) Identify any dependencies on other systems or facilities that affect the ability of the Mode S System to meet the Safety Requirements. **[E2]**

(c) State any limitations on the use, or maintenance, of Mode S or other shortcomings identified in the design. **[E3]**

(d) Address each Safety Requirement: **[E4]**

(i) Identifying the compliant status of the Safety Requirement. **[E5]**

(ii) Identifying and reference the results of any other evidence that confirms or otherwise that the Safety Requirement will be met, and revise the status of the Safety Requirement accordingly. **[E6]**

(iii) Where it has not been concluded that a Safety Requirement will be met provide information about the possible impact to ATS. **[E7]**

(e) Declare and identify any other deficiencies in Mode S that may affect the safety of the ATS. **[E8]**

(f) Identify any aspects of the Mode S performance that should be monitored in service to provide assurance that the Safety Requirement continue to be met in operation. **[E9]**

(g) Identify any Mode S operation and maintenance requirements necessary to preserve the safety, including the identification and provision of relevant training. **[E10]**

(h) Detail the confidence that has been gained that the transition to operational use will not have an adverse effect on the safety of the existing ATS. **[E11]**

(i) Identify the documentation and its status, which records the Mode S build state. **[E12]**

(j) Identify or reference the process and responsibilities for initiating, performing and approving changes to Mode S. **[E13]**

14.7.4 Mode S Safety Requirements

14.7.4.1 A provisional analysis has been undertaken for the Mode S Safety Requirements and was derived by consideration of the failure modes on Air Traffic Operations. Annex E provides the target figures for the Mode S system in the operational phase, for a limited list of failure modes. The contribution of Radar Data Processing Systems, communication links and ATC workstations to the Mode S system are not included in Annex E. **[A1]**

The list of failure modes for the ground station shall be developed and refined by the Contractor, in consultation with the Agency. **[E1]**

Note that the strategy for the initial implementation of Mode S across the core area of Europe is defined as dual coverage (derived from two independent sources working simultaneously), wherever possible. **[A2]**

The Contractor shall demonstrate that ground stations based on their design can meet the refined Mode S System Safety Requirements. **[E2]**

Loss of radar data is defined as radar information that is not available from the ground station. **[A3]**

The loss of radar data for less than 10 seconds is considered to have no safety effect. **[A4]**

Corruption is defined as radar information that is available from the ground station(s) that is incorrect. **[A5]**

Detected corruption is defined as corrupt radar information available from the ground station(s) that has been identified as corrupt. **[A6]**

Undetected corruption is defined as corrupt radar information available from the ground station(s) that has not been identified as corrupt. **[A7]**

The corruption of any sequence of reports from the same aircraft for less than 10 seconds is considered to have no safety effect. **[A8]**

Height and Identity data is used to define the surveillance information of both Modes A/C and S. **[A9]**

14.7.5 Mode S Safety Analysis

14.7.5.1 General

In support of the Safety Plan deliverables the following specific safety activities shall be conducted by the Contractor. The product of these analyses, where appropriate, are deliverables to the Agency. **[E1]**

14.7.5.2 Standards

Relevant standards for the conduct of Mode S safety activities are indicated at Annex C. **[A1]**

The Tenderer shall state in his response the standards they will be using for each safety activity. **[I1]**

14.7.5.3 Hazard Log

14.7.5.3.1 The Contractor shall:

(a) Produce and maintain a Hazard Log; **[E1]**

(b) Ensure that all changes initiate a review of existing and new hazards that may arise as a result of such changes; **[E2]**

(c) Use a common tool (Word, Excel etc.) to maintain the Hazard Log (Refer to Section 14.13.3). **[E3]**

14.7.5.3.2 The Contractor's Hazard Log shall be provided as soon as it is updated throughout the life cycle of the product, including updates resulting from third contracts. **[E1]**

14.7.5.4 Hazard Identification and Analyses

14.7.5.4.1 The Contractor shall conduct a programme of Hazard Identification and Analyses, building on that of Annex E, and stating any assumptions about other systems; to ensure that the identification of hazards within Mode S are both refined and extended. **[E1]**

14.7.5.4.2 The ground station Safety Requirements shall form the initial assessment of the safety criticality of Mode S. The Contractor shall use this assessment as the basis for the subsequent hazard analysis as the design progresses. **[E1]**

14.7.5.4.3 The Contractor shall incorporate the results of the Hazard Identification and Analyses into the Hazard Log. **[E1]**

14.7.5.4.4 The Hazard Identification and Analyses shall include, but not be limited to:

(a) A system FMECA (Failure Modes Effect and Criticality Analysis) for Mode S hardware and software updating it regularly during system development. In the case of hardware, the FMECA shall decompose Mode S to Line Replacement Unit level. Where the FMECA has identified a safety significant failure, the Contractor shall take steps to eliminate, mitigate, circumvent, or otherwise reduce the safety significance of the failure. **[E1]**

(b) A Fault Tree Analysis (FTA) to complement the FMECA and to derive quantitative probabilities of occurrences of all hazards and to demonstrate that the Safety Requirements have been met. The FTA

shall explicitly state the source and justification of all failure probabilities used in the derivation of quantitative probabilities for each hazard. **[E2]**

The Tenderer shall provide in the Tender Response his approach to the above with respect to software. **[I1]**

14.7.5.5 Spare.

14.7.5.6 Independent Safety Assessment

14.7.5.6.1 The Contractor shall carry out an Independent Verification and Validation (IV&V) of the implementation of the Contractor Safety Plan and its products. Suitably qualified personnel independent of the development team shall be used. **[E1]**

14.7.5.7 Safety Assurance Traceability

14.7.5.7.1 The Contractor shall document, implement and maintain traceability procedures to allow for full forward and backward traceability of all documents, components, materials, designs, reviews, records pertaining to the safety assurance activities. **[E1]**

14.8 Hardware Requirements

14.8.1 General Hardware Requirements

The construction of the system and all its components shall be in accordance with the best current practices and standards in force at the International and European levels. **[E1]**

As part of the Tender Review Process the Agency will carry out an on-site audit of the Tenderers Hardware Design and Management processes. **[A1]**

The audit will involve an assessment of the controls used in the hardware design and management process and an evaluation of their effectiveness. **[A2]**

14.8.2 Hardware Standards and Codes of Practice

The Tenderer shall state in the Tender Response the Hardware Standards and Codes of Practice which will be applied to the system. **[I1]**

Copies of these standards and codes of practice shall be made available on request. **[E1]**

The Tenderer shall identify where each of the following hardware aspects are defined in the standards quoted:

(a) Component Selection, including, but not limited to, semiconductor devices, fuses, fans etc; **[I2]**

(b) Circuit Design; **[I3]**

(c) Electrical Wiring; **[I4]**

(d) Connections; **[I5]**

(e) Printed Circuits and Wiring; **[I6]**

(f) Circuit and Equipment Layout; **[I7]**

(g) Circuit and Equipment Assembly; **[I8]**

(h) Protective Devices; **[I9]**

(i) Interchangeability of equipments, sub-assemblies and components; **[I10]**

(j) Full accessibility of components for maintenance, with easily accessible connection, testing and fixing points; **[I11]**

(k) Replaceable parts located and secured so as to permit inspection, servicing and replacement without damage to, or interference with adjacent part of wiring; **[I12]**

(l) Fail safe characteristics for each component, circuit and equipment; **[I13]**

(m) Use of autotest and automatic detection and indication of failed components; **[I14]**

(n) Protection of cables, wiring, and board against damage from liquids, heat, shock and vibration; **[I15]**

(o) Marking and labelling of the various components, boards, equipment, cables and wiring; **[I16]**

(p) Use of warning and instruction labels for any risk of danger. **[I17]**

14.8.3 Spares Availability

The Tenderer shall undertake to ensure that spares will be available for at least 10 years after acceptance of the equipment. **[E1]**

14.8.4 Modification After Delivery

Modification to the type of equipment supplied under the Contract made by the Contractor subsequent to delivery shall be notified to the Agency in order that consideration may be given to the embodiment of such modifications in ancillary equipments. **[E1]**

Post Contract Support shall be available for a minimum of five years after acceptance of the equipment. **[E2]**

14.8.5 Handling Requirements

Panels, units and chassis which require removal for maintenance should not normally exceed 10 kg in weight (including the weight of the transit case). **[E1]**

Units exceeding 10 kg in weight shall be provided with suitable lifting facilities. **[E2]**

Such equipment shall be clearly labelled as being heavier than 10 kg with a warning label. **[E3]**

The Tenderer shall identify in the proposal any special handling requirements. **[I1]**

The design of panels, units, chassis etc. shall be such that they can be safely set down without damage. **[E4]**

Fragile components shall not be positioned in exposed places, but should be protected in the best way possible (e.g. guard rails). **[E5]**

The Contractor shall bring to the Agency's notice components or devices supplied under the Contract that could be in any way affected by electrostatic discharge and which might as a consequence be damaged by incorrect handling or storage. **[E6]**

14.8.6 Air Conditioning

Air Conditioning shall be provided as required by National Administration regulations. **[E1]**

14.9 Software Requirements

14.9.1 General

For the purpose of this specification, firmware is defined as software burned in hardware devices. **[A1]**

The following software requirements shall apply for firmware and software. **[E1]**

The software shall be designed to preclude abnormal behaviour and to limit the consequences of system failure conditions through appropriate fault avoidance techniques, fault tolerant design architecture, verification and validation methodologies. **[E2]**

Software design, development, verification, validation and maintenance shall be carried out according to methodical and rigorous procedures to ensure that the system fully complies with the specification, and to ensure that performance, safety and quality objectives allocated to the software are met. **[E3]**

The Tenderer shall list the software deliverables in a preliminary Configuration Management Plan, to be provided as part of the Tender Response. **[I1]**

As part of the Tender Review Process the Agency will carry out an on-site audit of the Tenderers Software Development and Management processes. **[A2]**

This audit will involve an assessment of the controls used in the software development and management process and an evaluation of their effectiveness. **[A3]**

14.9.2 Software Standards

The software deliverables shall be produced in accordance with the best current practices and standards in force at the International and European levels. **[E1]**

High order languages conforming to a recognised ISO or ANSI standard shall be used. **[E2]**

The Tenderer shall state in his response the software language to be used. **[I1]**

The Tenderer shall identify in the Tender Response the Software Standards and Codes of Practice which will be applied to the Project. **[I2]**

The Contractor shall review with the Agency the appropriate software standards for this Project. **[E3]**

14.9.3 Design Methods

An important factor in an orderly software development program is an early establishment of a design discipline which makes the software traceable, testable, maintainable and understandable to persons other than the developers. **[A1]**

An industry standard method of software design shall be employed. **[E1]**

If new software developments are needed, the Tenderer shall state in a preliminary Software Development Plan the software development environment in terms of hardware and software including as a minimum:

(a) Software development objectives (criticalities of the software functions, quality, safety, etc.); **[E2]**

(b) Team organisation; **[E3]**

(c) Interfaces; **[E4]**

(d) Design methodology and all tools which will be employed; **[E5]**

(e) Standards and activities with regards the software life cycle; **[E6]**

(f) Technical milestones; **[E7]**

(g) Support environment to be used or implemented (tools, simulator, etc.); **[E8]**

(h) Hardware platform(s) for the tools to be used. **[E9]**

The standard for airborne software embedded system RTCA DO 178B/EUROCAE 12B may be used as guidelines for coping with the software

requirements and tailoring the effort of development, verification and validation versus the criticality of the software functions. **[A3]**

14.9.4 Software Safety

The required Safety Requirements are defined in 14.7. In order to meet these requirements it is essential that the software processes shall be examined as part of the FMECA. The criticality of each software module/process shall be identified according to the role carried out by the process within the system. **[E1]**

The Tenderer shall identify in the Software Development Plan the various criticalities of the tasks carried out by the software functions and the measures (in terms of developments, verification, validation and assurance activities and techniques) to ensure that the characteristics of the software, in particular its failure modes, do not impact on the overall system safety level as defined in 14.7. **[E2]**

The Tenderer shall state the levels according to which they have developed, or intend to develop the software components in terms of the Mode S ground station (see RTCA DO 178). **[I1]**

14.9.5 Operating System Standards

The Tenderer shall provide in the Tender response details of the Operating System to be used. **[I1]**

The Contractor shall ensure that the Operating System design shall allow for future hardware, software and communication enhancements. **[E1]**

The Tenderer shall state the level to which the Operating System can analyse the type and cause of detected system errors. The level of ability to record data concerning the error and its cause for error notification and subsequent investigation from a maintenance position shall be stated. **[I2]**

Where an Operating System has been written by, or is owned by the Tenderer, the source code for the operating system shall be defined as a deliverable item in the Contract. **[E2]**

The Tenderer shall state the system reload time. **[I3]**

14.9.6 System Compatibility

Where any form of distributed processing architecture is used, the Contractor shall provide details of procedures and specific techniques to ensure that the software that runs in each processor is compatible with the software running in all the other processors that make up one channel of the overall system. **[E1]**

Suitable recovery mechanisms shall be coded for the case where incompatible versions are found to be running in different processors. **[E2]**

14.9.7 Upgrades and Reversion

Unless a version of software for a processor is to be kept on removable media, where changing the version of software that is running is performed by changing the media and reloading the system, the storage medium built into the system is to be capable of holding two versions of the system software. **[E1]**

The time taken to switch between software versions shall be no more than 3 minutes plus the system reload time as given in 14.9.5. **[E2]**

14.9.8 Adaptation

For flexibility of operation and ease of maintenance it is essential that all variables within the software that control site configurable parameters can be modified without the need for software recompilation/rebuild. **[E1]**

All such operational parameters shall be referred to as adaptation parameters, which are a software adjustable, agreed subset of the SDPs. **[A1]**

All adaptation parameters within the system shall be stored in a manner that allows for any parameter to be easily changed without any impact on the operational software and system safety. **[E2]**

A method shall be provided for changing the content of adaptation file(s). The method provided shall be capable of range checking the variable(s) to be changed and of providing a plain language description of each parameter that can be changed. This method shall be separate from any commands used to change the values of these parameters while the system is running. **[E3]**

The site configuration parameters shall be defined in a logical manner in units which relate to the parameter concerned. (e.g. Range in NM; azimuth in degrees or Azimuth units etc.). **[E4]**

All parameters shall be accessible and/or modified through the CAM interfaces or a dedicated terminal. **[E5]**

In case a dedicated terminal is necessary to fulfil these requirements the Tenderer shall include this terminal within the bid. **[E7]**

The Tenderer shall provide detailed information on this dedicated terminal **[I1]**

The Contractor shall deliver a special document:

(a) Listing all the software parameters that could be accessed and/or modified via the CAM or any dedicated terminal;

(b) Indicating for each parameter the default value, increment, minimum & maximum values, units, etc;

(c) Listing all the hardware parameters (switches, jumpers, DIP,.....) that are accessible and/or configurable;

(d) Indicating for each hardware parameter the default configuration, the possible ones and the physical location on concerned PCB by means of a lay-out diagram;

(e) Describing for each parameter the impact of a change at the component, LRU, sub-system and system levels, especially from the point of view of the functionality being modified, and the effects on the output and input data. **[E8]**

14.9.9 Verification

The Contractor shall define in a Verification and Validation Plan the verification process being used to ensure that the results of a particular phase/activity in the software development has met the requirements of the previous phase. **[E1]**

Verification shall be carried out according to methodical and rigorous procedures to ensure that performance, safety and quality objectives allocated to the software are met. **[E2]**

14.9.10 Validation

The Contractor shall define in the Verification and Validation Plan the validation process being used to ensure that the results of the software development has met the requirements of the project. **[E1]**

Validation shall be carried out according to methodical and rigorous procedures to ensure that performance, safety and quality requirements are met. **[E2]**

There the Contractor identifies the use of simulation as appropriate to the validation process the level of simulation shall be identified. **[E3]**

Any testbeds etc. used for module/sub-system testing shall be retained under configuration control for the duration of the Contract (including maintenance period). All such software and associated test specifications shall be maintained so that any test performed at any time during system development may be re-performed on the versions of software modules that form the final delivery of software. **[E4]**

The Contractor shall state what special arrangements will be undertaken to test and validate critical software. **[E6]**

The above information is essential from the safety aspect. **[A1]**

The Test Specification shall detail and identify the test harnesses used. **[E7]**

The Contractor shall identify in the Software Development Plan the verification and validation processes used to integrate the operating system and software with the hardware. **[E8]**

Results of all tests shall be recorded for subsequent audit. **[E9]**

14.9.11 Software Development Environment

The Software Development and Verification Environment is a significant factor in the production of high quality software. **[A1]**

Qualified or intensively validated tools shall be used to achieve the necessary level of confidence for minimising potential environment related errors. **[E1]**

The development and verification environment shall be subject to Configuration Management. **[E2]**

If the Software Development and Verification environment is changed during the software life cycle, the validity of previous tests and coverage analyses shall be reconsidered by the Agency. **[A2]**

The Agency reserves the right to request the re-verification of modules in the event of changes to the Software Development and Verification Environment. **[E3]**

14.10 Design

14.10.1 General

Fault tolerant design shall be applied wherever the potential for critical consequences results from the design or operation of the Mode S ground station and associated equipment. **[E1]**

The following deterministic safety design principles shall be implemented as a minimum:

(a) No single failure condition shall have a critical consequence for ATC Services; **[E2]**

(b) No single operator error shall have a critical consequence for ATC services and the operator; [E3;

(c) Hardware or software failures shall not cause additional failures with hazardous effects; **[E4]**

(d) Safety-critical functional paths (both hardware and software) shall be isolated or partitioned from non safety-critical functions, in order to prevent propagation of errors and failures; **[E5]**

(e) Alternate or redundant safety critical functional paths shall be separated or protected in such a way that any event that causes the loss of one functional path will not result in the loss of alternate back-up, or redundant paths; **[E6]**

(f) Parametric operating ranges and performance limits for safe operation shall be established for the design and shall be specified by the Contractor; **[E7]**

(g) The design shall provide protection to avoid the erroneous acceptance of commands that may affect personnel safety or cause hardware or software damage. **[E8]**

Multiple failures that result from common cause or common mode failure mechanisms shall be considered as single failures for the purpose of determining and designing the fault tolerant system. **[E9]**

Failures modes shall be considered to originate from:

(a) Hardware; **[E10]**

(b) Software; **[E11]**

(c) Firmware; **[E12]**

(d) Procedures as the result of design error; **[E13]**

(e) Random failure due to environmental effects. **[E14]**

The Design shall allow expansion to accommodate future growth (in functional and performance requirements to achieve full Mode S) through scalable, modular design, built on structured techniques that ensure traceability and consistency between the functional requirements and the ultimate design specifications. **[E15]**

The Tenderer shall define the methodology, techniques and tools employed to achieve the system design objectives. **[I1]**

The Tenderer shall demonstrate that they are compliant with the requirements in chapters 14.2, 14.4, 14.6 and 14.7 of this specification, by delivery of sample design specification documentation described in MIL-STD-1521. **[I2]**

Traceability, consistency and completeness shall be ensured between design specification and the system requirements. **[E16]**

The system design shall take into account the necessary features for verification and validation testing, and for maintenance. **[E17]**

The Agency believes that it will be in the Projects' best interest for there to be a continuous free exchange of technical information between the Contractor and the Agency's' technical staff, especially in the early stages of the project. **[A1]**

The Tenderer shall state how such relationships will be fostered. **[I5]**

14.10.2 Ongoing technical dialogue

The Agency considers it essential that there is an ongoing dialogue with the Contractor on all technical issues. **[A1]**

If necessary the Agency shall convene additional meetings at short notice to discuss specific problems or technical issues. **[E1]**

14.11 Delivery

The Contractor shall deliver the items as described in the 'List of Deliverables' at the dates agreed and to the locations specified by the Agency. **[E1]**

The Contractor shall deliver the Mode S ground station to site for Site Acceptance Testing as specified in this document, following successful completion of all Formal Acceptance Tests on his factory test bench, in addition to any internal verification and validation testing normally described in the project quality assurance and development plans. **[E2]**

The Contractor shall provide for software, the description and the identification of each delivered version, and the associated source and executable code, the identification of the development and testing tools, the updated corresponding documentation (specifications, design, test plan, test results, listing). Compatibility with the various hardware version shall be indicated. **[E3]**

14.12 Installation and Commissioning

The Contractor shall prepare, deliver and apply an Installation and Commissioning Plan, describing the objectives, the strategy, the milestones, the installation and site testing procedures, acceptance criteria, the respective responsibilities between the Agency, the user and the Contractor. **[E1]**

This shall be subject to a specific planned review, not later than 120 working days before delivery of the Mode S ground station. **[E2]**

The Agency and the user will provide, according to an agreed plan, details of the sites where the Contractor shall install the Mode S ground station. **[A1]**

The Contractor shall provide all necessary studies and equipment to complete installation at the chosen user site, and shall provide all welfare and temporary services in support of their installation team **[E3]**

The installation and commissioning Plan shall be approved by the Agency and shall include, but not be limited to, the following aspects:

(a) Physical dimensions and weight of all equipment; **[E4]**

(b) Power consumption of all equipment; **[E5]**

(c) Heat dissipation of all equipment; **[E6]**

(d) Full wiring schedules, interconnection diagram and routing for power, signal, earthing cables; **[E7]**

(e) Full details of waveguide and RF co-ax connections and fixing including full dimensions and routing; **[E8]**

(f) All details for lifting, assembling and fixing the Antennas; **[E9]**

(g) Alignment Procedures for the PSR and SSR Antennas; **[E10]**

(h) Details of site accommodation requirements; **[E11]**

(i) Details of site plant requirements. **[E12]**

The documentation shall be updated periodically in order to reflect accurately the complete installation. **[E13]**

In order to provide a consistent response for the cost of Installation the following site facilities will be provided by states:

(a) Tower foundation (Contractor shall state size and bearing load);

(b) Equipment cabin foundation (Contractor shall state size and bearing load);

(c) Electricity supply (Contractor shall state requirements);

(d) Data lines and telephone lines (Contractor shall state requirements);

(e) Access to site;

(f) Hardstanding for 2 Agency vehicles. **[A2]**

The Tenderer shall state in the proposal the aspects of the installation to be included in the documentation concerning:

(a) Cabling Arrangements, routing, identification; **[I3]**

(b) Interference, susceptibility to radio frequency; **[I4]**

(c) Earthing arrangements; **[I5]**

(d) Equipment mounting, cooling. **[I6]**

Compliance with the EMC recommendations contained within EEC Directive (89/336/EC) on Suppression of Interference shall be required. **[E14]**

The Contractor will be required to demonstrate that the delivered system conforms to the EMC recommendations. The cost of this demonstration shall be borne by the Contractor. **[E15]**

The Contractor shall be responsible for all transportation and delivery of equipment to the sites where installation shall take place. **[E16]**

Commissioning will be granted after successful on site testing with a specified operational environment and acceptance of the associated deliverables specified in the plans. **[A3]**

14.13 Project Management

14.13.1 Project Management Plan (PMP)

The Tenderer shall provide in their Tender Response a PMP that clearly describes all stages of the project including flight trial, SAT, FAT etc. **[I1]**

The PMP shall include the following list as a minimum:

(a) Project Plan with milestones and timescales. **[E1]**

(b) Resource Schedule, showing the contribution from team members. **[E2]**

(c) A Work Breakdown Structure, showing the work packages, responsibilities, and expected duration. Each work package shall be described with the input needed and expected deliverables. **[E3]**

(d) Delivery Schedule, showing dates and deliverables. **[E4]**

(e) A description of the Tenderer's proposed project team including Curriculum Vitae for the key project team members. **[E5]**

(f) Organisation / Roles and Responsibilities:

The role and the responsibilities of each key member for the various project phases and steps shall be described. **[E6]**

(g) Interfaces with SubContractors and Suppliers:

Any Subcontract and/or Consortium arrangements shall be described, covering the respective involvement and responsibility. **[E7]**

(h) Key risks and jeopardise to satisfactory project progress and how these will be managed. **[E8]**

(i) Methods to manage and control the work performed under the project. **[E9]**

(j) Method used to monitor internal communication and reporting. **[E10]**

(k) Methods and procedures to manage Quality Assurance. **[E11]**

This plan shall be updated throughout the life of the Contract to continually reflect the project team organisation and the work breakdown structure. **[E12]**

Any change in the responsibilities during the project shall be formally reported to the Agency. **[E13]**

The Tenderer shall state in the Tender Response his requirements in terms of resources required from the Agency at all phases of the Project. All Agency resources required shall be scheduled into the plan. **[I2]**

If different development sites are planned, co-ordination links and procedures shall be provided. **[E14]**

14.13.2 Spare.

14.13.3 Project Support Tools

The Contractor shall ensure that it uses PC tools which are compatible with the Agency standards. **[E1]**

The Tenderer shall state any conversion methods that may be necessary for documents produced automatically by CASE tools. **[I1]**

The Agency currently uses the following support tools:

(a) Microsoft Word 97; **[A1]**

(b) Microsoft Excel 97; **[A2]**

(c) Microsoft Project 98; **[A3]**

(d) Windows NT4; **[A4]**

(e) Microsoft Access 97; **[A5]**

(f) Adobe Acrobat Reader 4.0. **[A6]**

In order to reduce the size of electronic documents sent to the Agency, and to avoid the spreading of macro-viruses, the Tenderer is advised to use a lean and safer format such as Rich Text Format (RTF) or Portable Document Format (PDF). **[A7]**

14.13.4 Control and Reporting

The Control and Reporting mechanisms are defined by the Agency responsible for the procurement. **[E1]**

14.13.5 Spare.

14.13.6 Spare.

14.13.7 Spare.

14.13.8 Configuration Management

14.13.8.1 General

Configuration Management (CM) is an essential discipline applying to all deliverable items including documentation, hardware, spares and software (Application software, system software, compilers & testing facilities). **[A1]**

CM identifies the function and physical configuration of an item. **[A2]**

CM controls changes to the item and records and reports those changes as well as implementing the changes into all identical items. **[A3]**

14.13.8.2 Preliminary Configuration Management Plan

The Tenderer as part of their Tender Response shall provide details of the hardware and software CM plans they would implement following contract award. **[I1]**

The Preliminary CM Plan shall include as a minimum:

(a) List of internal and external items of the project established as Configuration Items. **[E1]**

(b) Responsibilities and relevant procedures to be used; **[E2]**

(c) Configuration Management tools and techniques; **[E3]**

(d) Configuration Identification and modification policy; **[E4]**

(e) Configuration Status Accounting; **[E5]**

(f) Configuration Auditing; **[E6]**

(g) Software/Hardware Interface Management; **[E7]**

(h) Configuration Control for spares ranging and maintenance; **[E8]**

Change procedures shall be consistent with the configuration approach. **[E9]**

14.13.8.3 Hardware Configuration Management Plan

The Contractor shall provide a detailed hardware CM Plan for Agency approval. **[E1]**

The CM Plan shall include details of how the configuration of subcontracted hardware is dealt with. **[E2]**

The plan shall describe the Contractor's CM programme that will be used to ensure adequate control of the status of all "configured items", documentation and spares. **[E3]**

The hardware CM plan shall also identify proposals for the Agency to assume the CM responsibility post technical completion from the Contractor. **[E4]**

14.13.8.4 Software Configuration Management Plan

The Contractor shall provide a detailed software CM plan for Agency approval. **[E1]**

The plan shall describe the Contractor's software CM programme that will be used to ensure adequate control of the System software including documentation and deliverable software. **[E2]**

The software CM plan shall identify the participation of the Contractor SQA department in software CM activities. **[E3]**

Key personnel shall be identified using organisation charts. **[E4]**

The software CM plan shall also identify proposals for the Agency to assume software CM authority post technical completion from the Contractor. **[E5]**

14.13.8.5 Audit

A specific Configuration audit can be decided by the Agency e.g. if significant discrepancies are detected. This audit would be carried out by the representatives of the Agency, and/or its partners in the project, and/or a third party. **[A1]**

The Contractor shall then allow access to the necessary information, in conformity with the agreed audit objectives and process. **[E1]**

14.13.8.6 Change Control

Design records shall be maintained by the Contractor as part of his CM programme. **[E1]**

Any changes, which may alter the agreed Contract production baseline shall be referred to the Agency for their approval. **[E2]**

The Tenderer shall propose specific procedures to monitor the project and control change. **[E3]**

Shortcomings and subsequent corrective actions and/or proposed evolutions shall be described in a "Technical Issue Form" and submitted to the Agency. If the proposed amendment is accepted, a "Change Request" shall be raised using an appropriate agreed procedure. **[E4]**

Before a change is made official, its validity shall be confirmed and the effects on other items shall be identified and thoroughly examined. Methods to show the traceability and compatibility between changes and modified parts of system/software shall be provided. **[E5]**

Any change having a contractual impact shall be the subject of a formal Contract amendment. **[E6]**

Where necessary the Agency's representative will attend change control meetings at the Contractor's premises. **[A1]**

The CM Plan shall state the Configuration Management procedures to be used on the project. **[E7]**

The system for identifying the configuration shall be defined and how the identification is allocated should be documented. The Contractor shall maintain a system to ensure that the configuration of each configured item within a system may be identified. **[E8]**

The Configuration Management system should be subject to audits by the Contractor to demonstrate that it is suitable and effective. The audits shall verify the accuracy of the configuration information. **[E9]**

The results of these audits shall be made available to the Agency on request. **[E10]**

Configuration control shall also be applied to spares in the maintenance process if applicable. **[E11]**

The CM Plan shall state how this is achieved. **[E12]**

The Tenderer shall document his controls over software/hardware interfaces **[E13]**

14.13.8.7 Software Configuration Management / Configuration Control

The Contractor shall use configuration management software to ensure that only authorised changes are made to source code modules. **[E1]**

All Modules/files that make up the system and/or the development environment (compilers / linkers etc.) shall be under the control of the CM software at all times. This includes the output files from the compile/link process in addition to the input source files. **[E2]**

Compatibility between various versions of hardware and software of the Mode S ground station shall be permanently addressed in the CM Plan. **[E3]**

14.13.8.8 Operating System Configuration Management / Configuration Control

Where a 3rd party operating system is used, changes to the code shall only be allowed through formal Configuration Control procedures. **[E1]**

All such changes shall allow future operating system upgrades to be provided by the original vendor. **[E2]**

All configuration details for the operating system employed shall be supplied to the Agency. **[E3]**

For an in-house operating system, formal Configuration Control procedures shall be fully applied. **[E4]**

14.13.8.9 Documentation Configuration Management

Shortcomings and subsequent corrective actions and/or proposed evolutions to all documents shall be described in a "Technical Issue Form" and submitted to the Agency. If the proposed amendment is accepted, a "Change Request" shall be raised using an appropriate agreed procedure. **[E1]**

14.13.9 Project Risk

The Tenderer shall provide in their Tender Response a Risk Management Plan (RMP) detailing how they will manage risks associated with this project. **[I1]**

The areas to be covered in the RMP shall be, as a minimum, financial, technical (hardware and software), quality, programme, etc. **[E1]**

The Contractor shall maintain a Risk Register (RR) which shows, as a minimum:

(a) What activities may be affected by each risk; **[E2]**

(b) The probability of risk; **[E3]**

(c) The areas of impact; **[E4]**

(d) Suggested risk reduction measures; **[E5]**

(e) Ownership of the risk. **[E6]**

The Contractor shall report all risk areas, using the agreed reporting procedures. **[E7]**

14.14 Quality Assurance

14.14.1 General

Quality Assurance (QA) is a planned, controlled and systematic programme to ensure the deliverable equipment or service meets specified requirements. **[A1]**

Quality Assurance shall be applied to all activities necessary for the achievement of the Mode S ground station project. **[E1]**

Quality Assurance shall ensure the quality targets, requirements and specifications are correctly and completely fulfilled and ensure traceability and visibility throughout the project. **[E2]**

14.14.2 Quality Standards

The Tenderer shall be approved to BS EN ISO 9001/9002 or to an equivalent standard. **[E1]**

For the software elements of the Contract, approval to ISO 9000-3 or equivalent is preferred. **[A1]**

These approved Quality procedures shall apply to both hardware and software aspects of the Contract. **[E2]**

The terms of the applicable standard shall apply throughout the period of the Contract. **[E3]**

The scope of registration shall also cover the scope of the activities relating to the Contract. **[E4]**

The Tenderer not certified to these standards shall demonstrate that he is working towards such a standard and can be audited against it. **[E5]**

14.14.3 Quality Assurance Authority

The Agency shall nominate one of its representatives as the Quality Assurance Authority for the purpose of the contract. The Agency Quality Assurance Authority shall have unrestricted access during normal working

hours to verify at source that the activities, processes and techniques employed in the design and manufacture of the hardware, software and associated documentation conforms to the requirements of the contract, Quality Plan and associated documents. **[A1]**

14.14.4 Quality Plans

14.14.4.1 Preliminary Quality Plan

The Tenderer and his proposed major SubContractors shall submit, as part of their technical proposal, a Preliminary Quality Plan (QP) based on the requirements of this specification and which details the QA programme which would be implemented in the event of a Contract being awarded. **[I1]**

The Preliminary QP shall list all QA related and supporting documents. **[E1]**

A copy of QA manuals and other related documents shall be supplied to the quality authority upon request. **[E2]**

14.14.4.2 Quality Plan

A Quality Plan, in accordance with BS EN ISO 9001/9002, shall be submitted by the successful Tenderer and their major SubContractors, detailing how QA will be applied to the Contract. **[E1]**

This plan shall be submitted for approval by the Agency. The QP shall be implemented immediately. **[E2]**

The QP shall identify the product specified by the Contract and shall state the procedures of the Contractor's Quality Manual that apply to the Contract. **[E3]**

The QP shall identify additional procedures and amplifications to existing procedures that are required to meet the Contract conditions. **[E4]**

The QP shall highlight the critical control and review stages for the whole Quality task from Contract inception to final acceptance of the product by the Agency. **[E5]**

The QP shall identify the entry criteria for these milestones and define how satisfactory completion is recorded. **[E6]**

The QP shall include Quality organisation charts for the Contractor, and all major SubContractors, showing reporting and responsibility lines within the Companies. **[E7]**

Names and designations shall be provided for all staff with responsibilities for the Contract. **[E8]**

All defining documents shall be subject to document control procedures. **[E9]**

The QP shall require Agency approval at all issues. **[E10]**

The QP shall list those documents that will be submitted to the Agency for approval prior to issue. **[E11]**

The Contractor shall pass down to his SubContractors all aspects of his QP necessary to ensure the quality of the product and/or service. **[E12]**

The Contractor shall remain totally responsible for his SubContractors and shall describe how SubContractors have been selected. **[E13]**

The QP shall state which SubContractors have produced their own QP. **[E14]**

14.14.4.3 Software Quality Plan

A Software Quality Plan (SQP), in accordance with ISO 9000-3, shall be submitted by the Tenderer and their major SubContractors detailing how QA will be applied to the Contract. **[E1]**

The SQP shall describe the quality objectives, the methodologies, the quality verification and assurance activities to be implemented and the software and associated documentation to be supplied under the contract. It shall state the general procedures of the Contractor's Quality Manual that apply to the Contract. **[E3]**

The SQP shall identify additional procedures and amplification to existing procedures that are required to meet the Contract conditions. **[E4]**

The SQP shall include, but not be limited to, the following:

(a) Description of software quality objectives; **[E5]**

(b) Definition of software life cycle model to be used; **[E6]**

(c) Software staff and SQA organisation and their relationship to the project team; **[E7]**

(d) Definition of deliverable items and deliverable media; **[E8]**

(e) Verification and Quality Assurance activities throughout the life cycle; **[E9]**

(f) What techniques, notations, languages, methods, standards (internal and national), conventions and tools are to be used during the project and to which activity and deliverable each applies; **[E10]**

(g) How the quality of deliverables is assessed; **[E11]**

(h) Configuration Management and Change Control procedures; **[E12]**

(i) Documentation to be provided and to what standards; **[E13]**

(j) Procedures for subcontracting of software; **[E14]**

(k) Defect and Non Compliance reporting; **[E15]**

14.14.5 Quality Assurance Audits

The Agency reserves the right to audit the Contractor's and all major SubContractor's QA organisations against procedures agreed with the Agency at any time during the Contract. **[A1]**

The Agency will nominate a Quality Assurance Representative (QAR) for the project. **[A2]**

Reasonable access and accommodation at the Contractor's premises shall be provided to the QAR, or his representative, in order to perform assessment activity including:

(a) A Quality assessment of the Contractor's Quality Management System to the relevant standard and to the Quality Plans prior to the start of the Contract work; **[E1]**

(b) Selective Quality surveillance audits against the relevant standard and Quality Plans during the term of the Contract; **[E2]**

(c) Similar access as described above to the premises of the major SubContractors; **[E3]**

(d) Quality Progress statements, required monthly, to be provided as part of the regular project reporting procedures. **[E4]**

14.14.6 Communication and Interfaces

The Tenderer shall state what information is to be recorded to monitor the control of the manufacture and test process. **[I1]**

The Tenderer shall state how the information is to be recorded and how it will be shared with the Agency. **[I2]**

The Tenderer shall state how problems are escalated internally and how these are to be discussed with the Agency, where required, to ensure an agreed solution is reached. **[I3]**

The Tenderer shall state what quality initiatives are in place to ensure that all staff are involved in the quality process. **[I4]**

The Tenderer shall state what Quality Training their staff receive. **[I5]**

14.15 Testing and Acceptance

14.15.1 General

It is particularly important that all Test Specifications used for proving that the system fulfils the requirement shall be generated directly from the overall system requirement specification. Cross references shall be placed in the Test Specification so that any test can be traced back to the requirement that it is proving. **[E1]**

In addition, module and sub-system Test Specifications shall be generated directly from the relevant design document. Cross references shall be placed in these test specifications so that any test can be traced back to the relevant area of the design. **[E2]**

A Verification Cross Reference Index (VCRI) shall be produced to trace continuity from the Specification through the Design Document to the FAT and SAT Acceptance Test Specifications. **[E3]**

It would be acceptable for all such cross references to be placed in a separate document. **[A1]**

In this case the cross reference document shall be updated and re-issued whenever any other document changes. In addition, the cross reference document shall be updated, and distributed with the first draft issue of any other document. **[E4]**

Should a deliverable be non-conformant, the Contractor shall correct it at his own expense, and after rectification, shall resubmit it for acceptance, within a time schedule agreed by the Agency. **[E5]**

The purpose of the testing is to prove the Mode S ground equipment fulfils the performance requirements of this specification. **[A2]**

This Chapter identifies the minimum tests to be performed across all the equipment at sub-system, system, site and network level up to and including Provisional Acceptance of the equipment. **[A3]**

The Contractor shall formulate, arrange and conduct tests to satisfactorily demonstrate, to the Agency, compliance of the deliverable equipment with all the performance requirements of this specification. **[E6]**

The Tenderer shall include in the proposal a preliminary Verification and Validation Plan, as detailed in section 14.15.4, which outlines their test programme. **[I1]**

The Contractor shall develop an overall Verification and Validation Plan, as detailed in section 14.15.4, which will detail how the performance requirements of this specification will be verified, recorded and accepted. **[E7]**

It shall be the responsibility of the Contractor to arrange and perform the acceptance testing. **[E8]**

These tests shall be witnessed by Agency personnel in accordance with an agreed plan. **[E9]**

14.15.2 Test Equipment

The Contractor shall bear the cost of all resources required for testing (including personnel, and premises) to complete SAT as defined in 14.15.12.4. **[E1]**

Where possible, the equipment will be identical to that recommended for field maintenance. **[A1]**

The Contractor shall provide details in the Verification and Validation Plan to show that all resources (test equipment, procedures, personnel and premises etc.) are adequate and available to perform the testing. **[E2]**

Ideally the Contractor shall utilise live data for testing. **[A2]**

If live data is not available at the Contractor's premises the Contractor may use recorded or simulated traffic data. **[A3]**

The Tenderer shall state the methods they intend to use to perform high load testing of the system. **[I1]**

The Performance demonstration may be deferred until live data is available as part of the site acceptance testing. **[A4]**

The Contractor shall provide details in the Verification and Validation Plan of all tests that cannot be performed at the Contractors or SubContractors premises, including the reasons. **[E3]**

Agreement shall be required with the Agency of any tests that are to be deferred. **[E4]**

14.15.3 Accuracy of Testing

The Contractor shall satisfactorily prove to the Agency that the methods of testing provide confirmation that the equipment actually meets the performance requirements of this specification, and that the test procedures provide the required precision and accuracy. **[E1]**

Such proof shall be submitted with the proposed Verification and Validation Plan. **[E2]**

14.15.4 Test Methodology

14.15.4.1 Preliminary Verification and Validation Plan

The Tenderer shall include in the Tender Response a preliminary Verification and Validation Plan for the project. **[I1]**

This plan shall include at least the following:

(a) A list of the systems and sub-systems to be tested; **[E1]**

(b) A list of the types of test to be employed (e.g. QT, FAT, SAT, System) and the tools required at each stage; **[E2]**

(c) A verification matrix that will show for each paragraph of this specification which of the types of tests in (b) applies; **[E3]**

(d) The names, positions, authority, role and interrelationships of the personnel to be involved in the tests stated in (b). **[E4]**

14.15.4.2 Verification and Validation Plan

The Contractor shall develop and supply a comprehensive Verification and Validation Plan which shall include at least all of the following:

(a) List of the systems and sub-systems to be tested with identification of the hardware and software versions for the equipment under test, and for the development and testing support tools; **[E1]**

(b) Identification of all the parameters which will be tested; **[E2]**

(c) A Test Specification for FAT and SAT detailing the methods and procedures that will show compliance with the performance requirements of this specification; **[E3]**

(d) A verification matrix that relates each and every performance requirement of this specification to the specific test(s) that will be performed to demonstrate compliance with that requirement; **[E4]**

(e) A verification matrix that relates each and every requirement of this specification to the specific test(s) that will be performed to demonstrate compliance with that requirement; **[E5]**

(f) The names, positions, authority, role and interrelationships of the personnel to be involved in the tests stated in (c). **[E6]**

Each test specification shall be a standalone document specifically tailored to this Contract and shall not refer to test specifications that the Contractor has used previously for other contracts or development work. **[E7]**

The above requirement does not preclude the Contractor copying relevant test paragraphs from other test specifications into that required by the Agency. **[A1]**

The agreed procedures and test data sheets shall form the basis for the testing of the deliverable items. **[E9]**

14.15.5 Start of Testing

Testing, as identified in 14.15.12, shall not begin until the test specifications have been agreed between the Agency and the Contractor. **[E1]**

After agreement has been reached the Contractor shall provide 10 working days notice of the commencement of scheduled testing. **[E2]**

This will allow the Agency to make the necessary arrangements for witnessing the test. **[A1]**

14.15.6 Preliminary Testing

Test notification shall not be given until the Contractor has carried out preliminary tests to ensure the equipment is fully compliant with the test procedures. **[E1]**

A QA certified copy of the preliminary test results shall be provided 10 working days prior to the commencement of official testing. **[E2]**

14.15.7 Certification of Test Results

Two copies of all test results, certified by an authorised representative of the Contractor's QA organisation, shall be provided to the Agency. **[E1]**

One copy shall be sent to site with the tested equipment, the second copy shall be forwarded to the Agency's designated Project Manager. **[E2]**

The test result sheets shall clearly identify the equipment name, type, serial number, test specification number and the test date. **[E3]**

Each individual test result shall be clearly identified and the test result sheet shall be signed by the Contractor's QA representative and countersigned by the Agency witness. **[E4]**

14.15.8 Test Failures

Any failed units shall be repaired and the cause of failure shall be determined and if necessary processes and/or materials or components changed so that all requirements of the specification are met. **[E1]**

Repaired units, and all other units that may have been affected by the failed unit, shall be re-tested to demonstrate final compliance with the test specification. **[E2]**

All software shall be rectified and the cause of the error determined. All software modules that may have been affected by the failed module should be re-tested. **[E3]**

All test failures shall be logged as Problem Reports by the Contractor's QA Representative and shall be subject to closure, following explanation which shall be agreed by the Agency, or the raising of an approved engineering change order. **[E4]**

All test failures shall be categorised and agreed with the Agency. **[E5]**

14.15.9 Location of Testing

Unless otherwise agreed by the Agency, all factory testing shall occur at the Contractor's or major SubContractor's premises. **[E1]**

To confirm the performance parameters not tested at the factory the Contractor shall make provision for demonstrations of the systems functionality prior to delivering the equipment for SAT. This test site shall be nominated by the Contractor. **[E2]**

14.15.10 Damage to Equipment

Any equipment damage caused as a result of any testing shall be corrected and the equipment refurbished at the Contractor's expense prior to Agency acceptance. **[E1]**

14.15.11 Electromagnetic Compatibility

EMC requirements shall conform to EEC Directive (89/336/EEC with amendments 92/31/EEC and 93/68/EEC). **[E1]**

Each subsystem shall function to specification both in its own environment and in the full system environment. **[E2]**

This requirement shall apply for all combinations of operational and maintenance configurations, and shall include mutual interference between systems and within systems. **[E3]**

14.15.12 Stages of Testing

This section outlines the minimum testing that shall be performed **[E1]**

14.15.12.1 Spare

14.15.12.2 Factory Acceptance Tests (FAT)

Complete and thorough testing shall be conducted to demonstrate compliance with the equipment design criteria. **[E1]**

FAT testing shall be carried out using the deliverable hardware and software. **[E2]**

The FAT shall prove conclusively that the equipment meets all applicable specifications and will meet the operational and performance requirements of this specification. **[E3]**

A representative(s) of the Agency will attend the FAT. **[A2]**

Subject to agreement with the Agency FAT testing may be deferred to testing on site to demonstrate design features that cannot be performed at the Contractor's premises. **[A3]**

The Factory Acceptance Test shall include the following software/operating system aspects:

(a) Configuration Identification of every file/module under test. No file or module used in this process shall be in a development state as reported

by the CM software. All files shall be registered/authenticated before the process starts. **[E4]**

(b) Recompilation of every source file to be built into the system software followed by rebuilding the executable software loads. **[E5]**

If a Software Development Facility is one of the deliverables, every file used in the above process, at the version used in this process, shall be delivered to the Agency under the control of CM software. **[E6]**

(c) Recreation of the operating system from either:

(i) The delivery kit and configuration details if a third-party operating system is used. **[E7]**

(ii) The source code and configuration details if an in-house operating system is used. **[E8]**

(d) Validation of operating system performance. **[E9]**

(e) Confirmation that each adaptation parameter can be changed, and that the changes have the required impact on the operation of the overall system. **[E10]**

14.15.12.3 Site Acceptance Tests (SAT)

The following shall be provided to the Agency 10 working days prior to the commencement of SAT testing:

(a) Evidence of closure of all previously raised observations, or agreement of action with respect to outstanding observations. **[E1]**

(b) Records of changes made since the FAT. **[E2]**

(c) The hardware and software build states. **[E3]**

(d) All test documentation to be available and agreed. **[E4]**

(e) Justification and explanation in writing of the choice of site parameters. **[E5]**

The SAT testing shall demonstrate the accuracy, stability, electromagnetic compatibility, availability, reliability and maintainability of the deliverable hardware and software over all parameters to meet all the operational and performance requirements of this specification **[E6]**

The SAT shall utilise all the deliverable hardware and software of all sub-systems, both individually and as a complete system, and will be performed using test equipment and live target data as appropriate. **[E7]**

The SAT specification may be a sub-set of the FAT specification as agreed between the Contractor and the Agency. **[A1]**

A representative(s) of the Agency will attend the SAT. **[A2]**

14.15.12.3.1 SAT Composition

Site Acceptance testing shall comprise the following discrete elements:

(a) Software Generation; **[E1]**

(b) Deferred FAT Tests; **[E2]**

(c) System; **[E3]**

(d) Reliability Demonstration; **[E4]**

(e) Maintainability Demonstration; **[E5]**

(f) Environmental Tests. **[E6]**

In respect of PILOT and production systems to be supplied, provided any changes to the Build Standard of the equipment have been properly taken into account, and that traceability can be assured, then Site Acceptance testing may comprise only elements (b) and (c) above. **[A1]**

14.15.12.3.2 Software Generation

The deliverable Operational, run-time, software (or PROM based firmware) shall be officially generated from the deliverable source code using Agency approved generation procedures. **[E1]**

The generation shall be witnessed by the Contractor's QAR and may be witnessed by the Agency. **[E2]**

It is this build of Operational software that shall be used in all subsequent Site Acceptance Tests. **[E3]**

14.15.12.3.3 Deferred FAT Tests

The Contractor shall conclude the Factory Acceptance Testing by performing all tests deferred to site due to lack of live data or associated facilities **[E1]**

14.15.12.3.4 System

The Contractor shall perform complete and thorough testing of all units, modules and subsystems interconnected to form the whole deliverable System to demonstrate the System's compliance with all the operational and performance requirements of this specification. **[E1]**

The System tests shall include network or site to site interfaces and functional tests as necessary to prove compliance with the requirements of this specification. **[E2]**

14.15.12.3.5 Reliability Demonstration

The Reliability demonstration shall be performed in accordance with 14.2.3.5. **[E1]**

14.15.12.3.6 Maintainability Demonstration

The Maintainability demonstration shall be performed in accordance with 14.2.4.5. **[E1]**

14.15.12.3.7 Environmental Testing

The Contractor shall provide a QA-approved report which ensures that the System continues to operate and meet all the operational and performance requirements of this specification whilst operating in a steady, ambient environment of +40°C with ambient humidity. **[E1]**

14.15.12.4 Acceptance

Following satisfactory completion of all Site Acceptance Tests the Contractor shall offer the System for formal acceptance by the Agency. **[E1]**

A formal Technical Completion (TC) meeting shall be held to consider the Provisional Acceptance of the system. **[E2]**

The TC meeting will examine the following areas to establish their completion or identify outstanding observations that have to be cleared within prescribed timescales:

(a) Equipment - A complete build state will be provided for all deliverable hardware and software. Special to type test equipment and support/test software shall be included as part of the build state. A complete list of all major concessions and production permits shall be provided with their relevant build states. **[E3]**

(b) Training - All training shall be complete to ensure that adequately trained engineers are available to undertake equipment maintenance. **[E4]**

(c) Spares - A build state of all deliverable spares shall be provided. All spares shall have been tested and delivered prior to TC. The build state of spares shall be identical to that of the main equipment. **[E5]**

(d) Documentation- All deliverable documentation shall have been provided. **[E6]**

(e) Test Equipment- All deliverable test equipment including software and hardware support facilities (if applicable) shall have been provided. **[E7]**

All Problem Reports and observations shall be closed or action assigned and agreed. **[E8]**

Completion of the SAT shall be recorded on the SAT Completion Certificate. **[E9]**

Certificate of Conformance documentation shall be provided for all deliverable items (including software). **[E10]**

Technical Completion may occur on a subsystem basis, if this option is chosen then a System Technical Completion meeting shall be held to ensure all System aspects have been completed. **[E11]**

ANNEX A

GLOSSARY

°C	Degree Celsius
ACAS	Airborne Collision Avoidance System
ACP	Azimuth Count Pulses
ADLP	Airborne Data Link Processor
AICB	Air Initiated Comm B
ASTERIX	All Purpose Structured Eurocontrol Radar Information Exchange
ATC	Air Traffic Control
ATCC	Air Traffic Control Centre
ATN	Aeronautical Telecommunication Network
AU	Azimuth Unit
BDS	Comm B Data Selector
BITE	Built In Test Equipment
CC	Cluster Controller
CMP	Communication Management Process
DCE	Data Circuit-terminating Equipment
DELM	Downlink Extended Length Message
DLF	Data Link Function
DRC	Data Rate Control
DUP	Duplicated address
EASIE	Enhanced Air Traffic Management and Mode S Implementation in Europe
EATCHIP	European ATC Harmonisation and Integration Programme
ELM	Extended Length Message
E-SCAN	Electronically Scanned
FAT	Factory Acceptance Tests
FL	Flight Level (1FL = 100 ft)
FRUIT	False Replies Unsynchronised In Time
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
MTL	Minimum Triggering Level
MTTR	Mean Time To Repair
NM	Nautical Mile (1 NM = 1852 m)
OBI	Off Boresight Indication
PAF	Plot Assignor Function
PCB	Printed Circuit Board
PMB	Project Management Board
PMC	Project Management Cell
PMPP	Project Management Programme Plan
POEMS	Pre Operational European Mode S Station
PRF	Pulse Repetition Frequency
PSR	Primary Surveillance Radar
PTE	POEMS Test Equipment
RA	Resolution Advisory
RASCAL	Radar Sharing Calculation software
RASS	Radar Analysis Support System
RDIF	Radar Data Interchange Format
RDP	Radar Data Processing
RF	Radio Frequency
RMS	Root Mean Square
RSLS	Receiver SideLobe Suppression
RTCC	Real Time Channel Control
RTQC	Real Time Quality Control
SARPs	Standards And Recommended Practices
SAT	Site Acceptance Tests
sd	Standard Deviation
SCF	Surveillance Co-ordination Function
SCN	Surveillance Co-ordination Network
SICASP	SSR Improvements and Collision Avoidance Systems Panel
SLM	Standard Length Message
SMA	System Management Application
SMF	Systems Management Function
SPI	Special Position Identification pulse
SSE	Mode S Specific Service Entity
SSR	Secondary Surveillance Radar
STC	Sensitivity Time Control
SVC	Switched Virtual Circuit
TCAS	Traffic Alert and Collision Avoidance System
UELM	Uplink Extended Length Message

ANNEX B

REFERENCE DOCUMENTS

[Ref.1.] ICAO Annex 10, third edition of Volume IV (incorporating Amendments 70-77 to second 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.] 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.

ANNEX C

LIST OF RELATED DOCUMENTATION & STANDARDS

The Contractor will be required to undertake a "Standards Tailoring" exercise with a working group chaired by the Agency. The purpose of this working Group will be to state for each standard whether it is accepted in full; whether they wish to tailor it; or wish to use an alternative. **[A1]**

Agency personnel shall approve the agreed standards to be applied. **[E1]**

The Tenderer shall advise in the Tender Proposal on suitable related or alternative standards. **[I1]**

The Tenderer shall include the issue number and amended state of each document to be applied. **[I2]**

ISO 9001 (1994)	Model for Quality Assurance in design, development, manufacturing, installation and servicing
ISO 9000 3 (1991)	Quality management and quality assurance standards - part 3: Guidelines for the application of ISO 9001 to development, supply and maintenance of software.
ISO/CD 12207	Software engineering organisation.
ISO 10011	Audit of quality assurance
IEEE/EIA 12207.0	Industry Implementation of International Standard ISO/IEC 12207 1995 - (ISO/IEC 12207) Standard for Information Technology - Software Life Cycle Processes
IEEE/EIA 12207.1	Guide for Information Technology - Software Life Cycle Processes, Life Cycle Data
IEEE/EIA 12207.2	Guide for Information Technology - Software Life Cycle Processes, Implementations Considerations
MIL STD 973	Configuration Management.
RTCA DO 178 B(1992)	Software considerations in airborne systems and equipment certification.
IEEE STD 730	Software quality assurance plans
IEEE STD 829,1008 & 1012	Software specification, development, testing and validation
MIL STD 470	Maintainability Program
MIL STD 471A	Maintainability Verification/Demonstration
MIL STD 721C	Definition of Terms for Reliability and Maintainability

MIL STD 785	Reliability Program
MIL STD 1388-1A	Logistic Support Analysis
MIL STD 1388-2B	Logistic Support Analysis Record
MIL STD 1629	Failure Modes, Effects and Criticality Analysis
MIL STD 2165A	Testability Program
MIL HDBK 217F	Reliability Prediction
MIL HDBK 338	Reliability Design
MIL HDBK 472	Maintainability Prediction
MIL STD 454	Standard General Requirements for Electronic Equipment
MIL STD 498	Military Standard for Software Development and Documentation
MIL STD 882B	System Safety Program Requirements
IEC 812/BS 5760 (all parts)	Reliability of systems, equipment and components
IEC 812/BS 5760 Part 5	Guide to failure modes, effects and criticality analysis (FMEA and FMECA)
IEC 812/BS 5760 Part 7	Guide to fault tree analysis
IEC 812/BS 5760 Part 8	Guide to the assessment of reliability of systems containing software
ARP 926A	Fault/Failure Analysis Procedure

ANNEX D

OUTLINE SAFETY PLAN

The following outline shall be used as a basis for the Safety Plan for the Mode S Ground Station Tender response and to form the basis of the subsequent contractual requirements. **[E1]**

D.1 Purpose

The purpose of the safety plan is to ensure the Mode S Ground Station safety activities are clearly defined and co-ordinated with other project activities. Furthermore, the plan shall ensure that key safety related activities, procedures and responsibilities are clearly defined and understood.

D.2 Scope

The scope of the safety plan is the total scope of supply of Mode S by the Contractor.

D.3 Definitions

Contractor to provide appropriate definitions consistent with the Safety Plan terminology.

D.4 Safety Management

Contractor's approach to Safety Management including sub-Contractor's Safety Management. Include organigram, responsibilities, accountabilities, reporting structure and interfaces with the Agency.

D.5 Mode S Safety Requirements

Contractor's approach to performing a PHA and deriving the Mode S Failure Modes as detailed in 14.7.5.4.

D.6 Hazard Log

Contractor's approach to the development and maintenance of a system hazard log as detailed in 14.7.5.3.

D.7 Hazard Identification and Analysis

Contractor's approach to System and Software Hazard Analyses as detailed in 14.7.5.4.

D.8 Progress Monitoring and Reporting

Contractor's approach to progress monitoring and reporting as detailed in 14.13.4.

D.9 Independent Safety Assessment

Contractor's approach to Independent Safety Assessment as detailed in 14.7.5.6.

D.10 Safety Assurance Traceability

Contractor's approach to Safety Assurance Traceability as detailed in 14.7.5.7.

D.11 Deliverables

Deliverables are detailed in paragraphs 14.7.3, 14.7.4 and 14.7.5 and include, but are not limited to:

(a) Design Process and Assurance, paragraph 14.7.3.2

(b) Installation, Commissioning, Integration, Test and Evaluation, paragraph 14.7.3.3

(c) PHA and Failure Mode Derivation, paragraph 14.7.5.4.

(d) Hazard Log, paragraph 14.7.5.3.

(e) Hazard Identification and Analyses:

  (i) FMECA, paragraph 14.7.5.4.4 (a).

  (ii) FTA, paragraph 14.7.5.4.4 (b).

(f) Progress Monitoring and Reporting, paragraph 14.13.4.

(g) Safety Reviews.

(h) Independent Safety Assessment, paragraph 14.7.5.6.

(i) Safety Assurance Traceability, paragraph 14.7.5.7.

D.12 Standards

Standards (e.g. IEC; Mil Std etc.) pertinent to the Safety Plan, their scope and applicability.

ANNEX E

MODE S SAFETY REQUIREMENTS

Failure Modes (<10 seconds)	**Probability**
Loss of all surveillance information	No Effect
Delay of all surveillance information	No Effect
Any corruption of surveillance information	No Effect
Failure Modes (>10 seconds)	**Probability**
Loss of all surveillance information	$<10^{-7}$
Detected Loss of all Height data	$<10^{-5}$
Detected Loss of all Identity data	$<10^{-7}$
Detected Loss of all target range	$<10^{-7}$
Detected Loss of all target azimuth	$<10^{-7}$
Detected Loss of all target time	$<10^{-7}$
Detected Corrupted all Height data	$<10^{-5}$
Detected Corrupted all Identity data	$<10^{-7}$
Detected Corrupted all target range	$<10^{-7}$
Detected Corrupted all target azimuth	$<10^{-7}$
Detected Corrupted all target time	$<10^{-7}$
Undetected Corrupted Height data(for individual target reports)	$<10^{-7}$
Undetected Corrupted Identity data(for individual target reports)	$<10^{-7}$
Undetected Corrupted target range(for individual target reports)	$<10^{-7}$
Undetected Corrupted target azimuth(for individual target reports)	$<10^{-7}$
Undetected Corrupted target time(for individual target reports)	$<10^{-7}$
Undetected delay of all surveillance information	$<10^{-7}$
Failure to acquire Mode S equipped aircraft	$<10^{-7}$
Failure to release Mode S equipped aircraft	$<10^{-5}$
Undetected spurious plots	$<10^{-5}$
Undetected missing plots	$<10^{-7}$

ANNEX F

LIFE CYCLE COSTING: INPUT DATA REQUIREMENTS

F.1 SYSTEM DATA

PRODUCTION SYSTEM UNIT COST	
PREDICTED MTBF	Comes from historical data, testing, predictions or the product specification
MEAN TIME TO REPAIR	Comes from the product specification.
O LEVEL	Predicted or actual MTTR for O level.
I LEVEL	Predicted or actual MTTR for I level.
D LEVEL	Predicted or actual MTTR for D level.
% BIT/BITE FAULT DETECTION	The percent of failures that BIT/BITE is capable of detecting
% MANUAL FAULT DETECTION	The percent of failures that must be detected using manual procedures or assistance of support equipment
% BIT/BITE FAULT ISOLATION	The percent of failures that BIT/BITE can isolate to a single repairable or replaceable item
% MANUAL FAULT ISOLATION	The percent of failures that must be isolated using manual procedures

F.2 INVESTMENT DATA

INVESTMENT SPARES/REPAIR PARTS	Provisioned Spares

F.3 SUPPORT EQUIPMENT DATA

O LEVEL SE UNIT COST (CM)	Actual or estimated cost for one location
O LEVEL SE UNIT COST (PM)	Actual or estimated cost for one location
I LEVEL SE UNIT COST (CM)	Actual or estimated cost for one location
I LEVEL SE UNIT COST (PM)	Actual or estimated cost for one location
D LEVEL SE UNIT COST (CM)	Actual or estimated cost for one location
D LEVEL SE UNIT COST (PM)	Actual or estimated cost for one location
OPERATIONAL SE COST	Actual or estimated cost for one set
OPERATIONAL SE RATIO TO END ITEMS	The number of end items that one set of operational support equipment will support.
SE MAINTENANCE	Percentage of SE acquisition costs required for yearly maintenance

F.4 SPARES AND CONSUMABLES DATA

REPLENISHMENT SPARES - O LEVEL (CM)	Cost of spares for a maintenance action expressed in actual/average cost
REPLENISHMENT SPARES - I LEVEL (CM)	Cost of spares for a maintenance action expressed in actual/average cost
REPLENISHMENT SPARES - D LEVEL (CM)	Cost of spares for a maintenance action expressed in actual/average cost
CONSUMABLES PER HOUR OF OPERATION	Cost of fuels, lubricants, etc. required to operate one system for one hour.
COST OF CONTRACTOR REPAIR (PER REPAIR)	Average cost of a single repair performed by Contractor or non-standard repair facility

F.5 PERSONNEL DATA

NUMBER OF SYSTEM OPERATORS	Number of persons necessary to operate one system
NUMBER OF MAINTENANCE PERSONNEL	
O LEVEL	Number of persons assigned to a single O level maintenance unit
I LEVEL	Number of persons assigned to a single I level maintenance unit
D LEVEL	Number of persons assigned to a single D level depot

F.6 TRAINING DATA

TRAINING TIME PER OPERATOR	Duration of Operator training course
TRAINING TIME PER MAINT TECH	Duration of maintenance training course
TRAINING SUPPORT COST	Incremental cost per student for training
INITIAL TRAINING PROGRAM COST	Cost of developing training program
COST OF TRAINING EQUIPMENT	
NUMBER OF TRAINING EQUIPMENT SETS	

F.7 MAINTENANCE DATA

% FAILURES R/R AT 1 LEVEL	Percent of failures that will be fixed by removal and replacement of defective items at organisational level
% FAILURES DISCARD AT 1 LEVEL	Percent of failures resulting in discard of the failed item
% FAILURES REPAIR AT 2 LEVEL	Percent of failed items that will be repaired at 2 Level
% FAILURES DISCARD AT 2 LEVEL	Percent of failed items repaired by removal and discard of a lower level assembly
% FAILURES REPAIR AT 3 LEVEL	Percent of failed items that will be repaired at Depot 3 level
% FAILURES REPAIR AT CONTRACTOR	Percent of failed items repaired by Contract
3 LEVEL/CONTRACTOR REPAIR CONDEMNATION RATE	Percent of items that will not be repaired

F.8 PREVENTIVE MAINTENANCE DATA

NUMBER OF DAILY PM TASKS	TASKS
AVG DAILY PM TASK TIME	HOURS
COST OF RESOURCES CONSUMED	
NUMBER OF WEEKLY PM TASKS	TASKS
AVG WEEKLY PM TASK TIME	HOURS
COST OF RESOURCES CONSUMED	
NUMBER OF MONTHLY PM TASKS	TASKS
AVG MONTHLY PM TASK TIME	HOURS
COST OF RESOURCES CONSUMED	
NUMBER OF SEMI-ANNUAL PM TASKS	TASKS
AVG SEMI-ANNUAL PM TASK TIME	HOURS
COST OF RESOURCES CONSUMED	
NUMBER OF ANNUAL PM TASKS	TASKS
AVG ANNUAL PM TASK TIME	HOURS
COST OF RESOURCES CONSUMED	
NUMBER OF PM TASKS PERFORMED AT 2 LEVEL	TASKS
AVERAGE 2 LEVEL PM TASK TIME	HOURS
TIMES 2 LEVEL PM PERFORMED IN 5 YEARS	TIMES
COST OF RESOURCES CONSUMED	
NUMBER OF PM/OVHL TASKS PERFORMED AT 3 LEVEL	TASKS
AVG 3 LEVEL PM/OVHL TASK TIME	HOURS
TIMES 3 LEVEL PM/OVHL PERFORMED IN 5 YEARS	TIMES
COST OF RESOURCES CONSUMED	

F.9 PHS&T DATA

INITIAL SPARES TRANSPORTATION COST	% OF SPARES COST
PACKAGING COST PER REPAIR	K PER ONE-WAY SHIPMENT
TRANSPORTATION COST PER REPAIR	K PER ONE-WAY SHIPMENT

F.10 SOFTWARE MAINTENANCE DATA

NUMBER OF SW LINES/MODULES	LINES/MODULES
ESTIMATED ANNUAL GROWTH	% PER YEAR
COST OF MAINTENANCE PER LINE/MODULE	
COST OF SW MAINTENANCE FACILITY PER YEAR	
COST OF SW MAINTENANCE EQUIPMENT	
SW MAINTENANCE EQUIPMENT MAINTENANCE PER YEAR	% OF COST

COST OF DOCUMENTATION PER MAINT ACTION	

F.11 INFLATION / ESCALATION DATA

ANNUAL ESCALATION RATE	% PER YEAR

ANNEX G

GENERAL OPERATING MODEL FOR MODE S GROUND STATION

G.1 System Parameters

G.1.1 Zenithal gap

Not below 45° above horizontal upper limit of cover >40 000ft

G.1.2 Vertical coverage

66,000 ft

G.1.3 Azimuth coverage

360°

G.1.4 Gap Free Cover

0.5 NM to 256 NM

G.1.5 Maximum Operating Range

256 NM at 4.5,7.5 and 10 rpm

150 NM, 80 NM at 15 rpm

G.1.6 Rotating Antenna Turning Rates

4.5,7.5, 10 and 15 rpm

G.1.7 IRF

2 Mode Interlace 3/A,C, nominal IRF is 150 Hz

Mode S Only All Call interrogations, nominal IRF is 50 Hz

G.1.8 IRF vs Range/Turning Rate

256 NM; 4.5 rpm; 70Hz

256 NM; 7.5 rpm; 115Hz

256 NM; 10 rpm; 150 Hz

150 NM and 80 NM; 15 rpm; 150 Hz

G.1.9 Transmitted modes

2 Mode Interlace 3/A,C

Intermode (P4 - long and short)

Mode S Only All-Call Mode S Selective

Interrogations Uplink Format 4, 5, 20, 21 and 24

G.1.10 Transponder Sensitivity

-69dBm for SSR Mode 3/A,C transponders

-71dBm for SSR Mode S transponders

G.1.11 Transponder Output Power

21dBW

18.5 dBW (for aircraft < 15,000')

G.1.12 Round Trip Reliability[1]

0.9 SSR Modes 3/A,C

G.2 Environmental Parameters

G.2.1 Mean FRUIT rate[2]

11000 FRUIT /second in the 3dB beamwidth (each of which exceeds a power level of -79 dBm referred to the sum channel RF port).

G.2.2 Number of SSR code pulses

At least 7 per FRUIT reply.

G.2.3 Target load

As in section G.4, equally distributed in azimuth and randomly distributed in range.

G.2.4 45° sectors

[1] Defined in [Ref.13] as "the probability of receiving a correct reply from an SSR interrogation".
[2] Note that it is anticipated that the level of Mode 3/A,C FRUIT is significantly higher than the level of Mode S FRUIT. The Tenderer may assume a figure of 1000 Mode S FRUIT (of which half are short and half are long replies), and assume 11,000 per second FRUIT rate is equivalent to 1/3 total; remaining 2/3 distributed over the backlobe and sidelobes.

4 off, 1 per 90°

G.2.5 3.5° sectors[3]

4 off, each centred in a diametrically opposite 45° sector.

G.2.6 Reflection False Targets

The greater of 40 targets/scan or 12% of target load.

G.3 Airborne Equipment Models

G.3.1 Model one, 100% Mode S Aircraft

(a) Mode Responses

(i)	S	100% of all aircraft

(b) Mode S Responses

(i)	Aircraft with a 24 bit aircraft address identical to that of another aircraft:	1% of all aircraft
(ii)	Aircraft with ACAS broadcast:	5% of all aircraft
(iii)	Aircraft with special flight status:	2% of all aircraft

Note: For the Mode S aircraft it can be assumed they reply initially to All-Call interrogations and are then locked out to All-Calls and reply only to selective interrogations.

G.3.2 Model Two, 50% Mode A/C and 50% Mode S Aircraft

(a) Mode Responses

(i)	3/A and C	40% of all aircraft
(ii)	3/A or C (exclusive)	10% of all aircraft
(iii)	S	50% of all aircraft

(b) Mode A/C Responses

(i)	Non-unique identity	25% of all aircraft
(ii)	Same identity	5% of all aircraft
(iii)	Same identity, no mode C	2.5% of all aircraft
(iv)	Mil Emergency	1% of all aircraft
(v)	Codes 7500, 7600, 7700	1% of all aircraft
(vi)	SPI (3/A)	4% of all aircraft
(vii)	Number of code pulses	at least 5 per reply

[3] Four 3.5° sectors total, two separated by at least 20°,
within each of two large sector peaks, diagrammatically opposite in 360° (see figure 16).

(c) Mode S Responses

(i) Aircraft with a 24 bit aircraft address identical to that of another aircraft 1% of Mode S aircraft

(ii) Aircraft with ACAS broadcast 5% of Mode S aircraft

(iii) Aircraft with special flight status 2% of Mode S aircraft

Note: For the Mode S aircraft it can be assumed they reply initially to All-Call interrogations and are then locked out to All-Calls and reply only to selective interrogations.

G.3.3 Model Three, 25% Mode A/C and 75% Mode S Aircraft

(a) Mode Responses

(i) 3/A and C 22.5% of all aircraft

(ii) 3/A or C (exclusive) 2.5% of all aircraft

(iii) S 75% of all aircraft

(b) Mode S Responses

(i) Aircraft with a 24 bit aircraft address identical to that of another aircraft 1% of Mode S aircraft

(ii) Aircraft with ACAS broadcast 5% of Mode S aircraft

(iii) Aircraft with special flight status 1% of Mode S aircraft

Note: For the Mode S aircraft it can be assumed they reply initially to All-Call interrogations and are then locked out to All-Calls and reply only to selective interrogations.

G.4 Target Load Model

Range (NM)	**5**	**10**	**20**	**40**	**60**	**80**	**90**	**130**	**150**	**200**	**256**
Aircraft Capacity	45	105	180	270	382	495	540	638	800	850	900
Large Sector Peak (45°)	12	26	45	68	96	124	135	160	200	211	222
Small Sector Peak (3.5°)	3	6	11	16	23	30	32	38	48	51	54

G.5 Volumes to be used for site performances requirements

In the table below, C means the Commissioning Volume and M the Measurement Volume.

Volume	Measurement	Requirement summary	Requirement
C	False Targets Distribution	False plots ratio < 0.1 % Multiple plot rate < 1/scan	4.2.5.1 E2 4.2.5.2 E2
C	Mode S Pd on duplicated addresses.	>=97%	7.3.2.2 E2 & 4.2.3.1 E1

Volume	Measurement	Requirement summary	Requirement
C	Range Error Distribution	Bias < 14 m	4.2.6.2 E1
C	Azimuth Error Distribution	Bias < 0.022 deg	4.2.6.3 E1
C	Overall SSR Pd	>=97%	4.2.3.1 E1
C	Overall SSR Pv&cA	>=98%	4.2.3.1 E1
C	Overall SSR Pv&cC	>=96%	4.2.3.1 E1
C	SSR Pd with Garbling	>=60% >=98% >=98%	4.2.7.1.2.1 E1 4.2.7.1.2.2 E1 4.2.7.1.2.3 E1
C	SSR Pv&cA with Garbling	>=30% >=90% >=98%	4.2.7.1.4.1 E1 4.2.7.1.4.2 E1 4.2.7.1.4.3 E1
C	SSR Pv&cC with Garbling	>=30% >=90% >=98%	4.2.7.1.4.1 E1 4.2.7.1.4.2 E1 4.2.7.1.4.3 E1
C	SSR Pv&cA for not close aircraft	>=98%	4.2.4.1.4 E1
C	SSR Pv&iA for not close aircraft	<0.1%	4.2.4.1.7 E1
C	SSR Pv&cC for not close aircraft	>=96%	4.2.4.1.4 E2
C	SSR Pv&iC for not close aircraft	<0.1%	4.2.4.1.8 E1
C	Overall Mode S Pd	97%	4.2.3.1 E1
C	Overall Mode S PcS	>=99%	4.2.4.2.1 E1
C	Overall Mode S Pv&cA	>=99%	4.2.4.2.1 E1
C	Overall Mode S Pv&cC	>=99%	4.2.4.2.1 E1
C	Jumps rate	<0.05%	4.2.6.6 E1
M	SSR Pd for not close aircraft	>=99%	4.2.3.2.2 E2
M	SSR Range Error RMS for not close aircraft	<30m	4.2.6.2 E2
M	SSR Azimuth Error RMS for not close aircraft	<0.068deg	4.2.6.3 E3
M	SSR Azimuth Bias for not close aircraft (elevation < 6°)	<0.022deg	4.2.6.3 E1
M	SSR Azimuth Bias for not close aircraft (elevation 6-10°)	<0.033deg	4.2.6.3 E2
M	Mode S Pd	>=99%	4.2.3.3.2 E4
M	Mode S Range Error RMS	<15m	4.2.6.2 E3
M	Mode S Azimuth Error RMS	<0.068deg	4.2.6.3 E3
M	Mode S Azimuth Bias (elevation < 6°)	<0.022deg	4.2.6.3 E1
M	Mode S Azimuth Bias (elevation 6-10°)	<0.033deg	4.2.6.3 E2

ANNEX H

SYSTEM ERROR ANALYSIS

H.1 General

As required in Chapter 4, Sections 4.2.6.1 the Tenderer shall include in the proposal a fully detailed error analysis with calculations and quoting assumptions. **[I1]**

This shall take into account the appropriate contributory effect of at least all of the sources of error detailed below on the overall system range, azimuth and position error for the Mode S sensors with:

(a) No radome; **[E1]**

(b) Above with rain falling at a rate of 25mm/hr and 60mm/hr. **[E2]**

The mean and standard deviation for each individual item, for range and azimuth as appropriate, shall be stated over the full range of operating and environmental conditions defined within this specification. **[E3]**

The cumulative range and azimuth error, with both mean and standard deviation values for each, shall be stated. **[E4]**

From the values for range and azimuth errors the system positional error shall be stated as a function of target range. Mean and standard deviation values shall be stated. **[E5]**

H.2 Error sources

As a minimum, the following sources of error for the radar sensor shall be stated and included in the system error analyses:

H.2.1 Antennas

(a) Wind deflection where appropriate **[E1]**

(b) Beam skewing **[E2]**

(c) Mechanical alignment **[E3]**

(d) Turning moment **[E4]**

(e) Target elevation angle **[E5]**

(f) Beam defocusing **[E6]**

H.2.2 Antenna Turning Gear

(a) Tower deflection/twist **[E1]**

(b) Drive gear backlash **[E2]**

(c) Drive shaft twist **[E3]**

(d) Azimuth encoding **[E4]**

H.2.3 Rotating Joint

(a) Insertion loss variation per channel and cross channel mis-match. **[E1]**

(b) Phase variation per channel and cross channel mis-match. **[E2]**

H.2.4 Mode S Cabling - Antenna to Tx/Rx

(a) Cable delays. **[E1]**

(b) Insertion loss per channel and cross channel mis-match. **[E2]**

(c) Phase variations per channel and cross channel mis-match. **[E3]**

(d) Insertion loss/phase variation with age. **[E4]**

(e) Insertion loss/phase variation with temperature. **[E5]**

H.2.5 Mode Transmitter-Receiver/PAF

(a) Interrogator mode to mode jitter. **[E1]**

(b) Receiver signal/noise ratio. **[E2]**

(c) Receiver gain, frequency and phase drift. **[E3]**

(d) Cross channel receiver gain, frequency and phase mis-match. **[E4]**

(e) Local oscillator drift. **[E5]**

(f) Quantisation clock drift. **[E6]**

(g) Target input signal strength. **[E7]**

(h) Target input frequency. **[E8]**

(i) Pulse sampling error. **[E9]**

(j) Analogue to digital conversion error. **[E10]**

(k) Off boresight angle table calibration error. **[E11]**

(l) Pulse quantisation error. (Mode A/C) or synch phase reversal (Mode S) **[E12]**

(m) P3 (mode A/C) or synch phase reversal (Mode S) start range error. **[E13]**

(n) Range clock accuracy. **[E14]**

(o) Pulse to reply OBA averaging error. **[E15]**

(p) Reply to plot azimuth calculation error. **[E16]**

(q) Transponder delay variation. **[E17]**

It should be noted that trials have shown some Mode S transponder replies to SSR Mode 3/A,C interrogations with a transponder delay of between 3.1 and 3.5 µs. **[A1]**

H.3 Applicability

The Tenderer shall state whether the values provided in responses to the preceding paragraphs apply to both stationary and moving targets. If they do not, two sets of values shall be provided, one set for stationary targets and one set for moving targets. **[I1]**

H.4 Verification

Verification of the overall system errors will be carried out for each of the sites on target data obtained from each system, which will be evaluated using independent software analysis tools (e.g. PTE) together with measurements made on a stationary target (e.g. Mode S Monitor). **[A1]**

Separate calculations for the on-mounted PSR/Mode and free-standing Mode S systems shall be provided in the proposal. **[I1]**

In the case of the on-mounted systems (or where the supplier is interfacing with an existing LVA/Turning Gear/Rotating Joint/cabling), where error details are required for system elements not being proposed by the Tenderer, the Tenderer shall state and clearly indicate the error limits required for their proposed system to meet the requirements of this specification. **[I2]**

ANNEX I

DESCRIPTION OF THE POEMS TEST ENVIRONMENT (PTE)

I.1 Introduction to PTE tools

The Figure 17 illustrates the different radar processing levels accessed by the PTE tools

I.2 PTE P1-P2B

I.2.1 General

The PTE-P1 and P2B tools will be built around an enhancement of the existing RASS-S system, as developed by Intersoft Electronics. As such it will comprehensively test the radars functioning by simulating radar returns, recording data present at various processing stages within the radar, verifying interfaces and conducting limited data analysis. This test tool will permit the evaluation of Mode S stations as part of FAT. Through the nature of its design it is possible for the operator to 'follow' a target reply through the various processing stages that the PTE P1-P2B system monitors - this capability is defined as multi-level analysis.

The verification of the Asterix syntax of the messages generated by the Mode S station will be performed by RAPS II. RAPS II is a COTS product developed by Comsoft and which has been qualified by Eurocontrol. A specific configuration of the RAPS II tool has been defined to be able to record and analyse all the Asterix messages produced by the Mode S stations. This configuration is called RAPS-PTE.

I.2.2 PTE-P1

The main enhancements of PTE-P1 regarding RASS-S are relating to the specific capabilities of a Mode S ground station compared to a classical SSR. They are listed below:

(a) Data link functionality;

(b) Enhanced RF accuracy;

(c) Specific Mode S protocol;

(d) FRUIT environment simulation using the RFT (RF Test set) as a BSG (Basic Scenario Generator);

(e) FRUIT environment simulation using one RES (Radar Environment Simulator) channel;

(f) Number of targets (1080) and maximum number of overlapping targets (4);

(g) Exporting of recorded data to PTE-P4;

(h) Figure of merit calculation (Mode S probability of detection and accuracy);

(i) Serial communication protocol viewer (separate investigation tool).

Consequently the main functions of RASS-S (scenario generation, environment simulation and data analysis) have been upgraded within PTE-P1 to allow Mode S station testing.

PTE-P1 recording capabilities:

(a) ACP (Azimuth Change Pulse) / ARP (Antenna Reference Pulse);

(b) Interrogations;

(c) Simulated scenario;

(d) Video;

(e) Primary Radar inputs;

(f) Asterix Cat 48 (Target report message) and 34 (Sector message);

(g) Asterix Cat 17 (Surveillance Co-ordination Function message);

(h) Asterix Cat 18 (Data Link Function message).

PTE-P1 generation capabilities :

(a) Target replies (according to the simulated target scenario (trajectories + datalink) and to the interrogations performed by the Mode S station);

(b) FRUIT environment (according to the FRUIT environment defined in the scenario) either using a RFT/BSG or using one RES channel;

(c) Simulated ACP/ARP;

(d) Cat 18 (according to the simulated data link scenario);

(e) Exporting of data to PTE-P4.

PTE-P1 figure of merit calculation capabilities:

(a) Mode S probability of detection;

(b) Mode S positional accuracy.

PTE-P1 Protocol viewer display capabilities:

(a) OSI layer 1 messages;

(b) LAPB (OSI layer 2) messages;

(c) X.25 (OSI layer 3) messages;

(d) Asterix (application layer) messages (Mode S categories 017, 018, 034 & 048 are supported).

PTE-P1 Protocol viewer will appear as an independent tool in the PTE top level menu.

I.2.3 PTE-P2B

The PTE-P2 (Phase B) additional capabilities are the following:

(a) PSR scenario preparation to define the characteristics of the PSR information that will be provided through the real time PSR data bsimulation;

(b) Additional scenario preparation capabilities (including simulation of either Amendment 69 or 71 transponders as specified in ICAO Annex 10 Volume III Part 1);

(c) Real time PSR data simulation;

(d) Importing of data from various sources;

(e) Merging, filtering and managing the imported data;

(f) Various data analysis computation (data link performance, sector message delay, etc...);

(g) Display and output of analysis results.

PTE-P2B generation capabilities:

(a) Primary Radar inputs (from a simulated primary radar and according to the simulated scenario).

I.3 RAPS-PTE

This tool is a standard RAPS II platform including specific Mode S and PTE Asterix categories detailed below.

The RAPS-PTE recording capabilities are the following :

(a) Asterix Cat 48 (Target report message) and 34 (Sector message)

(b) Asterix Cat 17 (Surveillance Co-ordination Function message)

(c) Asterix Cat 18 (Data Link Function message)

The RAPS-PTE will then perform Asterix verification of the recorded data.

The RAPS-PTE will also be able to check the Asterix format of PTE-P1/P4 interface file (Category 48/34, Reference scenario, Reference DGPS, Reference video extractor).

I.4 PTE-P2A - TRANSMITTER TEST TOOL

I.4.1 General

PTE-P2A is a specific transmitter test tool that can generate a range of scenarios to test the interrogation load as specified in Datalink Model A (4.2.7.4.2). It records and analyses the outputs of the transmitter of the Mode S station either when inputs are provided by the Mode S station or when inputs are provided by the transmitter test tool. The context of PTE-P2A is briefly summarised in Figure 18.

I.4.2 Functions

PTE-P2A recording capabilities:

(a) Interrogations either in passive (interrogations requested by the Mode S interrogation scheduler) or active (interrogations requested by PTE-P2A scenario replay) context. The recording is performed in compressed mode (user defined samples of each interrogation) and/or in detailed mode (recording at 16 MHz rate of interrogations during user defined period of times);

(b) Scenario of interrogation requests.

PTE-P2A generation capabilities:

(a) Interrogation requests (according to the simulated scenario of interrogation requests).

PTE-P2A analysis capabilities:

(a) In case of scenario replay, the tool will check whether the requested interrogations have been actually correctly performed by the transmitter (based on ICAO and PILOT requirements) and will calculate a global rate of success for the whole scenario.

PTE-P2A will appear as an independent tool in the PTE top level menu.

I.5 PTE-P3 - CLUSTER SIMULATION AND TESTING

I.5.1 Introduction

The role of PTE-P3 is to test (including FAT) the compliance of the SCF (Surveillance Co-ordination Function) of a Mode S station against its requirements. It will be performed through the real time simulation of adjacent Mode S stations with which the tested station form a cluster. A functional schematic of the system PTE-P3 and its interfaces is given in Figure 19.

The role of the SCF is to support surveillance co-ordination between the local Mode S station and the other Mode S stations forming a cluster and connected to a WAN (SCN, Surveillance Co-ordination Network).

This co-ordination is based on a series of protocols to be established between the different Mode S stations forming a cluster, which are :

(a) The X25 Connection Management protocol which is at the network layer;

(b) The Network Monitoring Protocol (NMP) which is at the transport/session layer;

(c) The Central Mode System Control Protocol which is at the application layer;

(d) The Track Acquisition and Support Protocol (TASP) which is at the application layer;

(e) The New Node Change Over Protocol (NNCOP) which is also at the application layer.

So, the role of PTE-P3 is to simulate the establishment of those protocols between a Mode S station under test and adjacent stations forming a cluster.

In order to provide a representative behaviour of the two application layer protocols (TASP and NNCOP) PTE-P3 will only work in conjunction with PTE P1 which simulates targets detection at the RF level of the Mode S station, in order to provide surveillance co-ordination data consistent with what the Mode S station is detecting.

An on-line assessment will be undertaken during simulation and statistics will be provided at the end of simulation run.

In parallel, the system will record, time stamp and mark all the messages exchanged between PTE-P3 and the Mode S station under test.

By processing the above information the operator will be able to quantify various performance levels for the Mode S station under test.

I.5.2 The Scenario Preparation Task

This scenario preparation encompasses the definition of the following elements:

(a) Characteristics of the simulated stations (scan rate, radar name, etc.);

(b) Characteristics of the Mode S station under test (radar name, etc.);

(c) Mode S surveillance coverage map of the simulation domain;

(d) Scenarios coming from PTE-P1;

(e) Events scenario for the simulated stations (e.g. connection, disconnection, failure, tracking request, etc.).

I.5.3 The Simulation Processing Task

The first step includes the simulation of the low level X25.3 Connection Management protocol which establishes the logical links between stations, the

second step include the simulation of the NMP protocol by which a station under test joins the simulated running cluster and the third step includes the TASP and NNCOP protocols (distributed mode) or the Central Mode System Control protocol and the track acquisition and support process (central mode) which correspond to the exchanges between running applications on different stations in a cluster.

PTE-P3 recording capabilities:

(a) Asterix Cat 17;

(b) Asterix Cat 48.

PTE-P3 generation capabilities:

(a) Asterix Cat 17 (from simulated adjacent sensors and according to the simulated scenario).

The PTE-P3 tool kit consists of one SUN Workstation including standard devices and specific interface cards.

I.6 PTE-P4

I.6.1 Introduction

The function of this site analysis tool (PTE-P4) is to provide additional mono-radar analysis capabilities to those available in the PTE-P1/P2B phase for site analysis.

This analysis will be run off-line and will derive it's information from a number of sources, namely:

(a) Measured target reports recorded by the PTE-P1 system, which means that at least the PTE P1 EDR (Extended Data Recorder), including an Apple PowerMac is required.

(b) Data from an external source:

  (i) DGPS positions declared by the aircraft (if available)

  (ii) The reference trajectory derived by the Video Reference Extractor from the radar video (if available)

  (iii) The PTE-P1 scenario generator output

  (iv) Map Data

  (v) RASCAL Maps providing terrain information.

  (vi) Mode S Maps to support the analysis, detailing particular Mode S constraints applied to the radar (power levels, lockout etc.).

By processing the above information the operator will be able to quantify various performance levels for the radar under test. Of particular interest to

this phase of the development will be the accuracy of the radar and the Probability of Detection it achieves.

The PTE-P4 system is designed to allow the user to analyse and validate conventional PSR and SSR radar data as well as Mode S radar data in a flexible and efficient manner. (Please note that interfaces to PSR and conventional monopulse SSR have not been developed). To do this, the system is broken down into a number of separate functional components. The relationships and high level data flows between these components are shown in the figure below. The user is able to control the system by carrying out the available functional operations in any appropriate order. The user will be prevented, however, from attempting to carry out functional operations in an inappropriate order (e.g. attempting internal reference generation prior to object correlation).

The outline of the individual functions in the PTE-P4 system (see figure below) are shown joined by solid lines to indicate data flow and dashed lines to indicate control flow.

I.6.2 Functional Architecture

The PTE-P4 functional architecture is as in Figure 20.

I.6.3 PTE-P4 functions

These PTE-P4 functions may be broadly grouped:

(a) Data acquisition (DA) - is the process that allows the user to import data, including target reports, radar service messages and external references (DGPS, reference extractor output, scenario generator data) from the PTE-P1 system via file transfer. The imported data is checked and added to the database as part of the current data set. Chained and tagged target report data may also be re-exported to the PTE-P1 tool for further analysis.

(b) Display filter (DF) - allows the user to select a subset of the current data for display on the screen. The filtering of the data is carried out by specifying one or more filters (e.g. time window, Mode S address range, SALADT screening angle volume) when the data matching the current filtering criteria are selected.

(c) Analysis filter (AF) - performs a similar role to the display filter, but is used for selecting data for input to the analysis functions.

(d) Graphical user interface (GUI) - allows the user to control the operation of the tool and displays the various results of the analyses.

(e) Object correlator (OC) - forms a key element in the PTE-P4 tool as it links target reports into target report chains, which are believed to be associated with a single aircraft, and associates them with the external reference data.

(f) Analysis reference generator (ARG) - calculates the bias model parameters (e.g. range gain) between data sets originating from different sources (e.g. target reports and DGPS data). The bias model parameters may then be used to effect target report position corrections. ARG also has the task of “completing” those external references requiring addition of velocity/acceleration data.

(g) Internal reference generator (IRG) - calculates a smoothed internal reference trajectory with full state vector information from the chained target report data.

(h) Plot accuracy analysis (PAA) - calculates statistics for the residual positional errors between the target reports and the reference trajectories, resolved onto the radar’s frame of reference.

(i) Plot resolution analysis (PRA) - identifies and calculates statistics on target reports from portions of trajectories which are within the resolution of the Mode S ground station (i.e. likely to give rise to co-channel interference within the radar’s plot extractor processing).

(j) Plot detection analysis (PDA) - calculates detection probabilities for target reports and the probabilities of successfully extracting the correct SSR codes and/or Mode S address information when applicable.

(k) False plot analysis (FPA) - calculates statistics for false plots, i.e. target reports arising from radio frequency (RF) propagation pathways other then direct path main lobe to transponder to main lobe.

(l) Airborne parameter analysis (APA) - calculates the frequency of extraction of MB fields reported by the radar and the frequency of interrogations required for extraction.

(m) Load measurement analysis (LMA) - calculates statistics to measure the work load of the radar in terms of the numbers of targets as functions of azimuth and range.

I.7 Physical Configuration

I.7.1 PTE-P1

The PTE-P1 tool kit consists of the following hardware items:

(a) 3 Apple PowerMac Laptops;

(b) 1 Apple PowerMac Desktops;

(c) 1 RVR (Radar Video Recorder) steel box, including an RVI (Radar Video Interface);

(d) 1 EDR SGR (Extended Data Recorder Scenario Generation Recorder) steel box;

(e) 1 RES (Radar Environment Simulator) consisting of:

(i) an ESG (Extended Scenario Generator) steel box;

(ii) a RIU (Radar Interface and Upconvertor) steel box.

(f) 1 RIU (Radar Interface Unit) steel box;

(g) 1 RFA (Radar Field Analyser) steel box;

(h) 1 RFT (RF Test set) steel box;

(i) 1 ACC (ACCessories) steel box, including a Gyroscope, a GPS unit and an AFU (Acp/arp Fanout Unit).

I.7.2 PTE-P2A

The PTE-P2A tool kit consists of the following hardware items :

(a) 1 RTI (Radar Transmitter Interface);

(b) 2 PDMs (Power Detector Module).

Those items will be included in a single steel box.

In order to operate the PTE-P2A tool the following PTE-P1 items are also needed:

(a) 1 RVR equipment and 1 RVI (Radar Video Interface) equipment, included in the RVR steel box;

(b) 1 Apple PowerMac (Desktop or Laptop).

I.7.3 RAPS-PTE

The RAPS-PTE platform consists of the following hardware items :

(a) 1 RAPS II standard platform (Portable x86 PC running under SCO Unix);

(b) 1 serial line extension;

(c) 1 Ethernet extension.

I.7.4 PTE-P2B

PTE-P2B will be implemented purely as a software solution, running partly on the PTE-P1 platform (PSR simulation) and partly on a platform yet to be chosen, but constrained to be identical to one of the existing ones (PowerMac as for P1, SUN as for P3 or x86/NT4 as for P4).

I.7.5 PTE-P3

The PTE-P3 tool kit consists of one SUN Workstation including standard devices and specific serial interface cards.

I.7.6 PTE-P4

The PTE-P4 tool kit consists of one x86 PC running under Microsoft Windows NT4, with standard devices.

ANNEX J

FIGURES

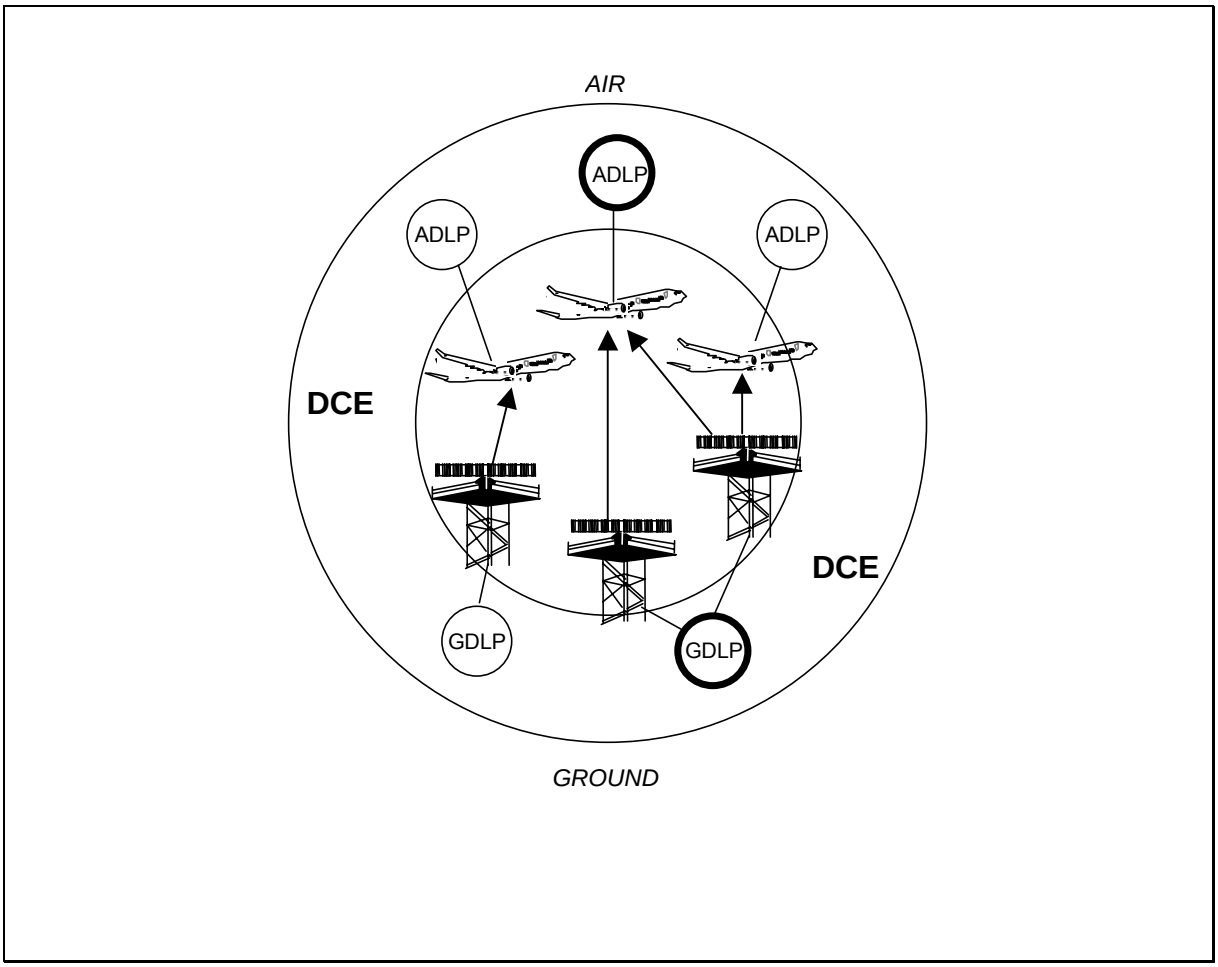


Figure 1 Mode S Subnetwork Environment

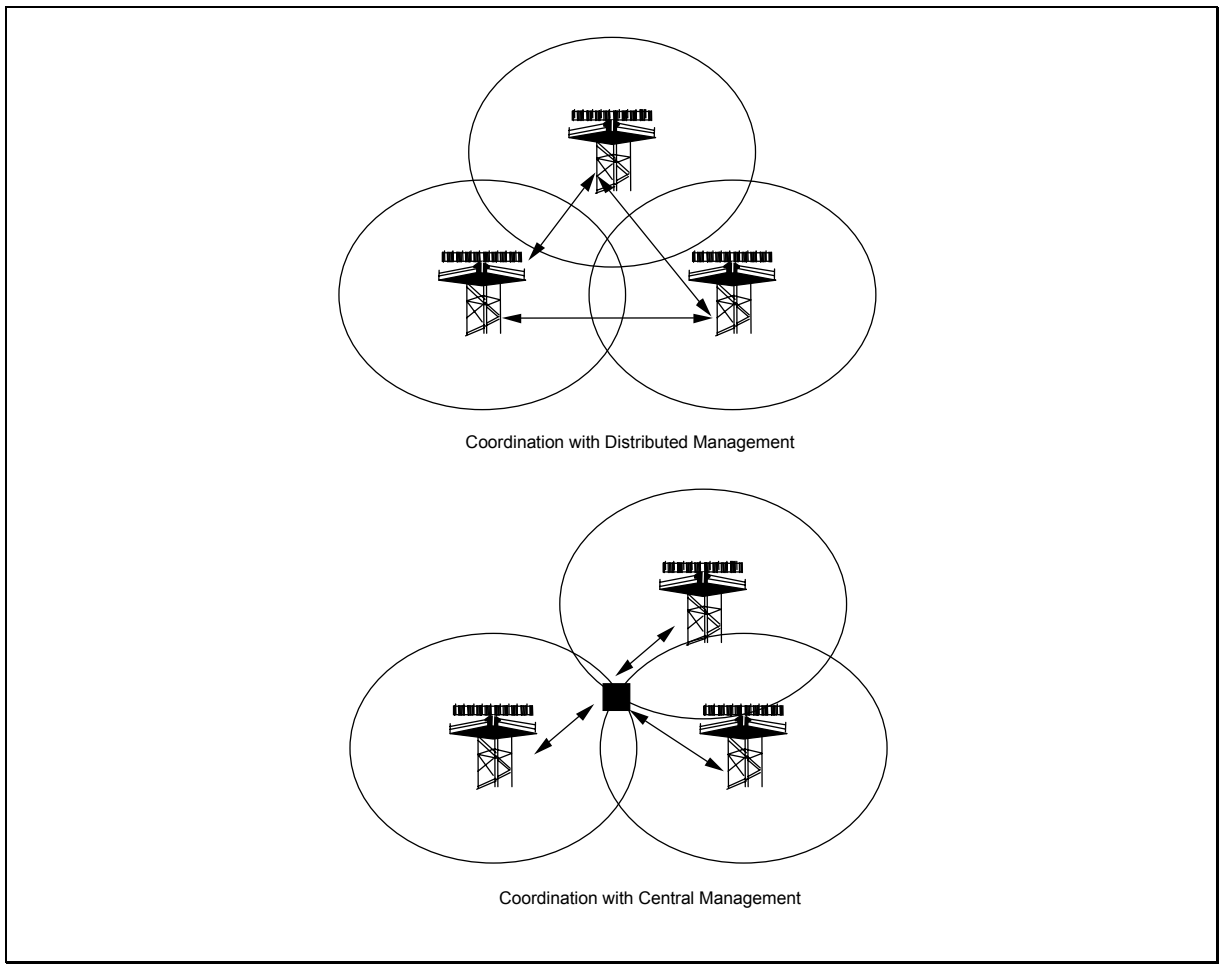


Figure 2 Cluster Co-ordination Options

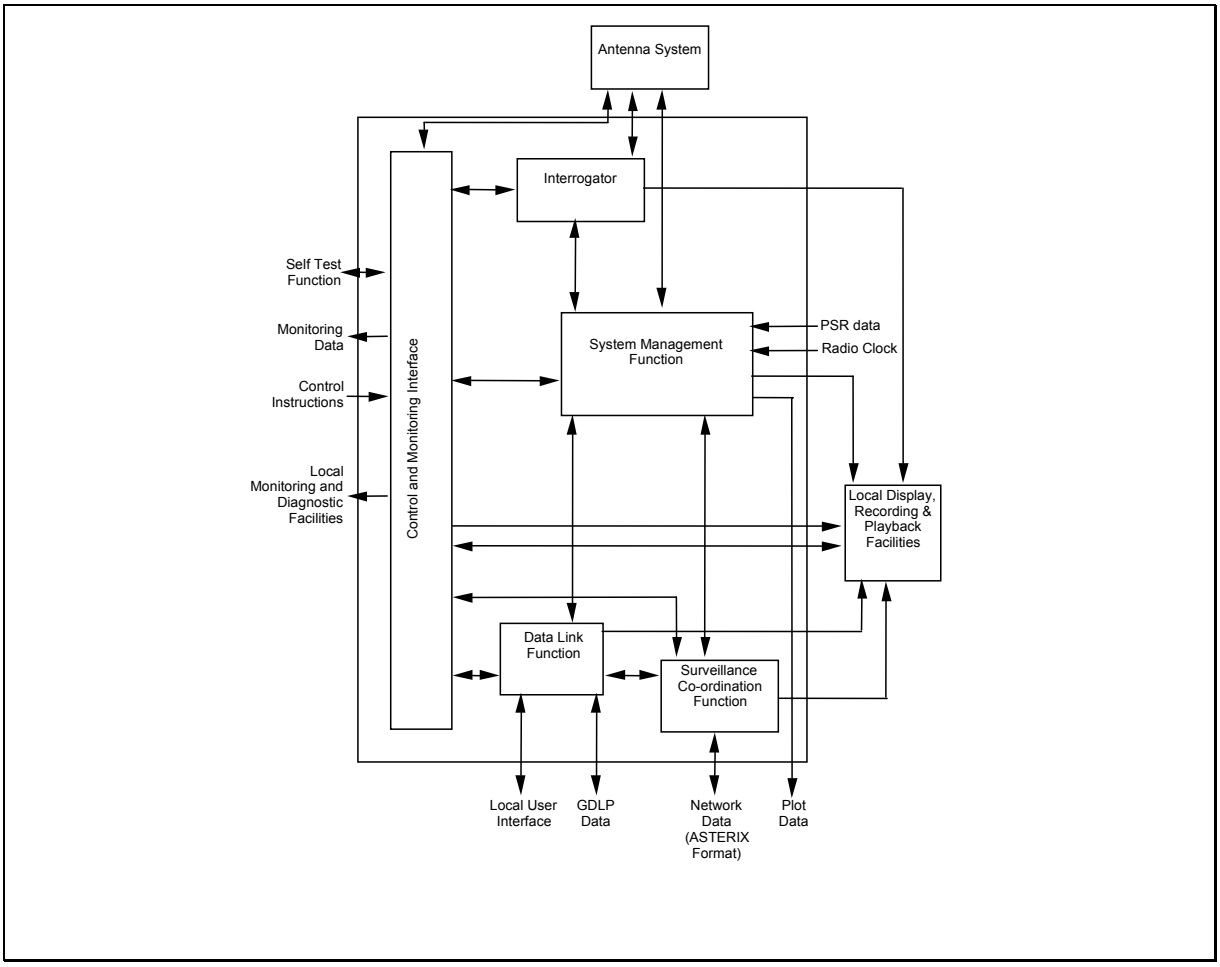


Figure 3 Mode S Ground Station Functional Overview

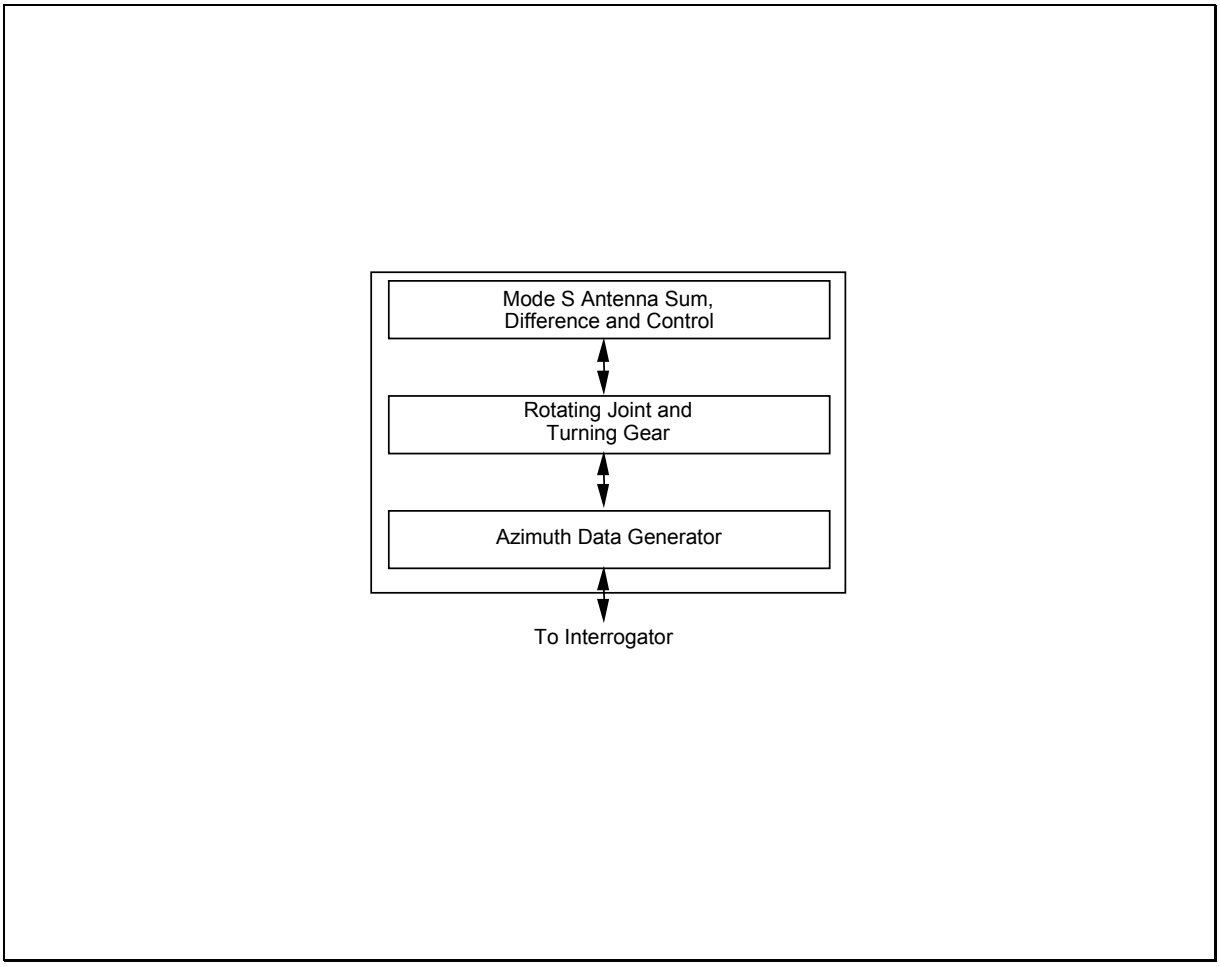


Figure 4 Antenna Functional Overview

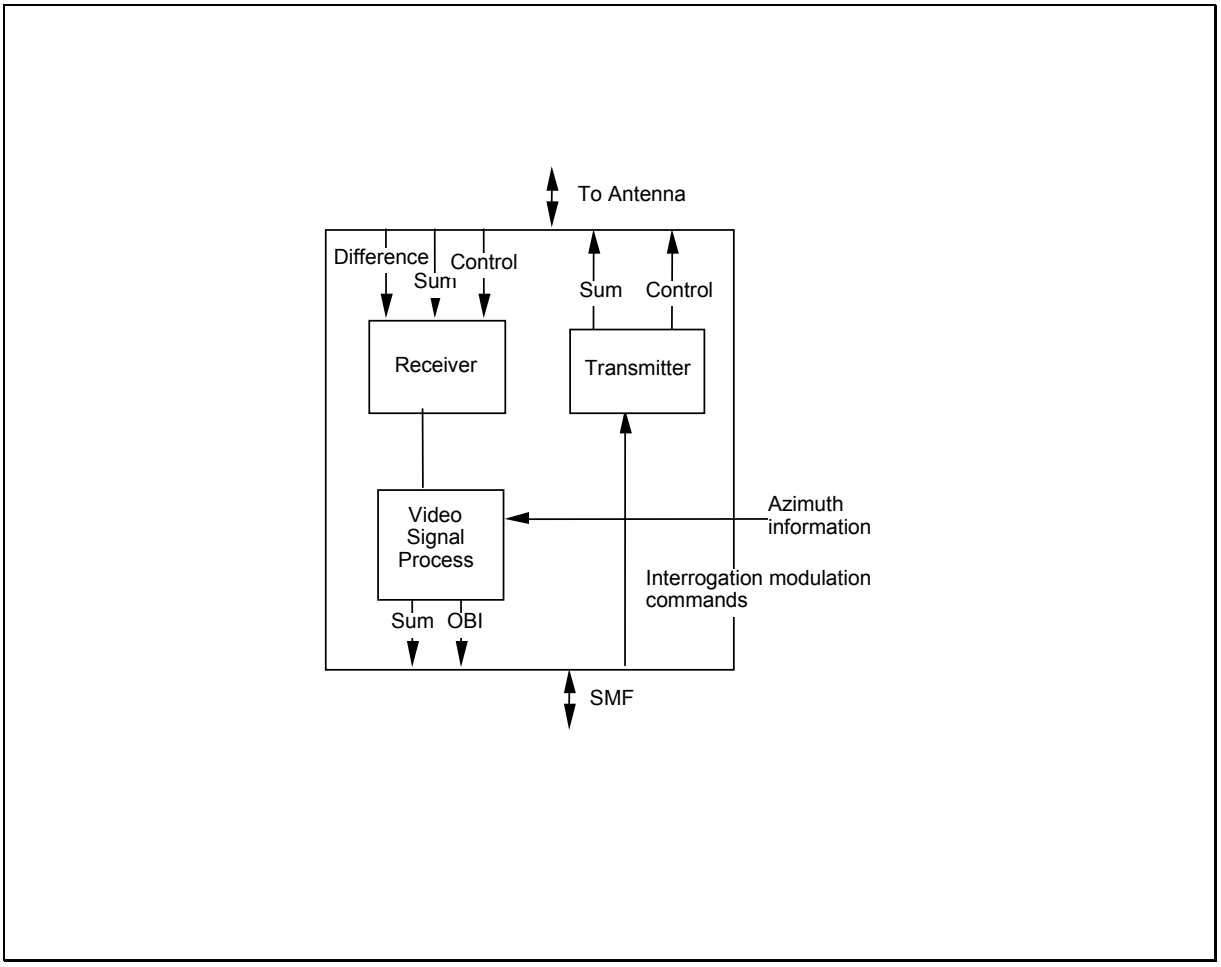


Figure 5 Interrogator Functional Overview

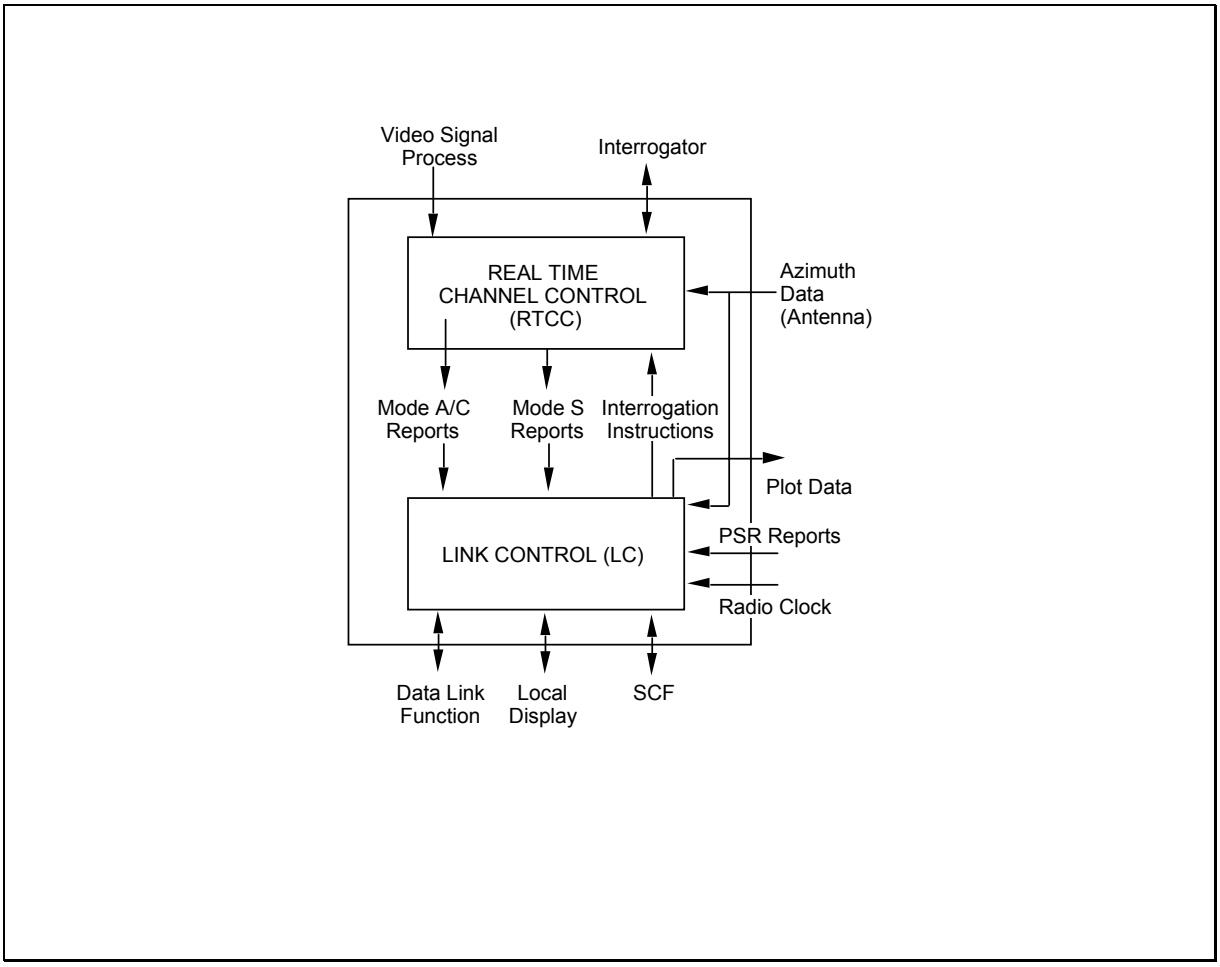


Figure 6 System Management Function (SMF) Overview

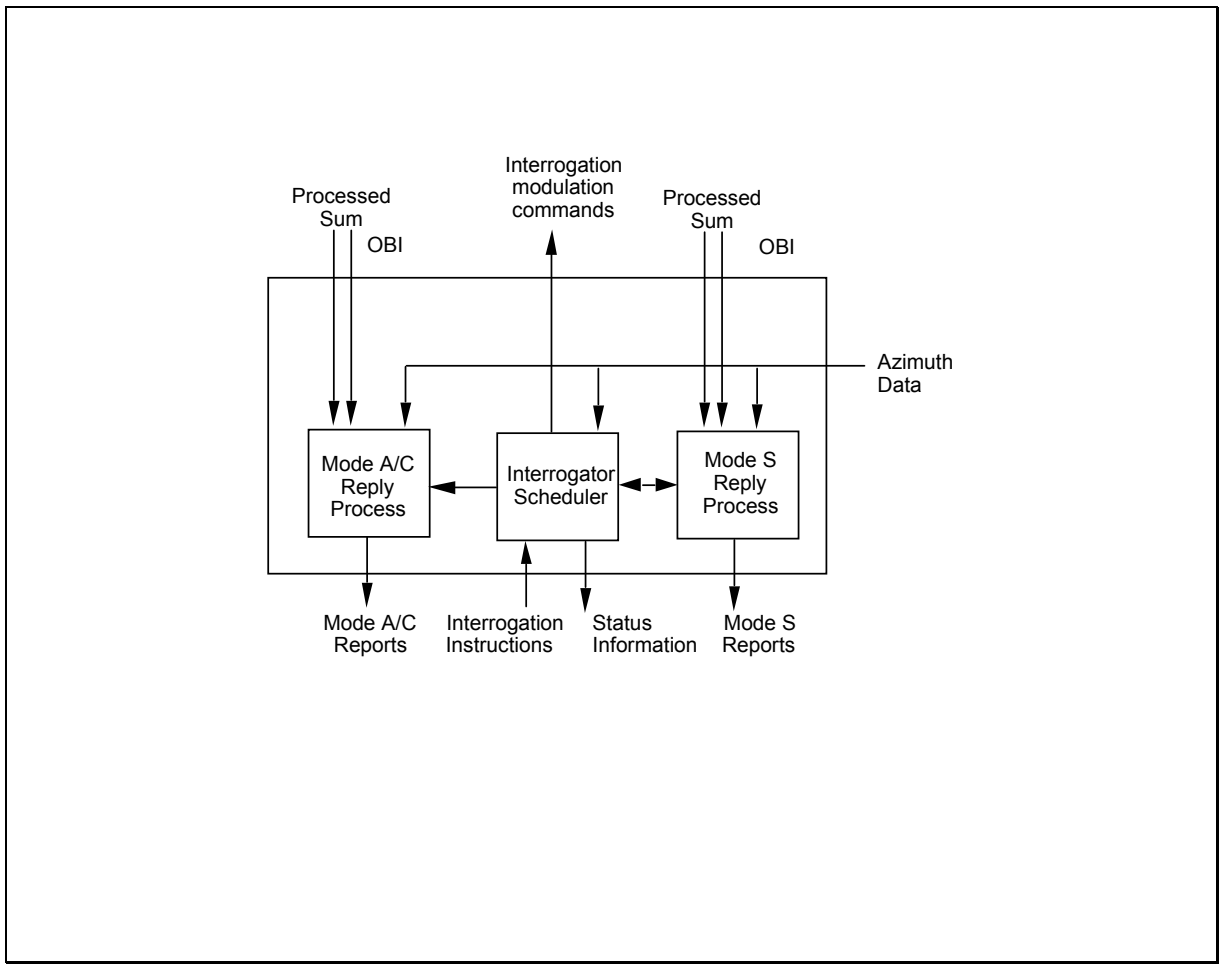


Figure 7 Real Time Channel Controller (RTCC) Functional Overview

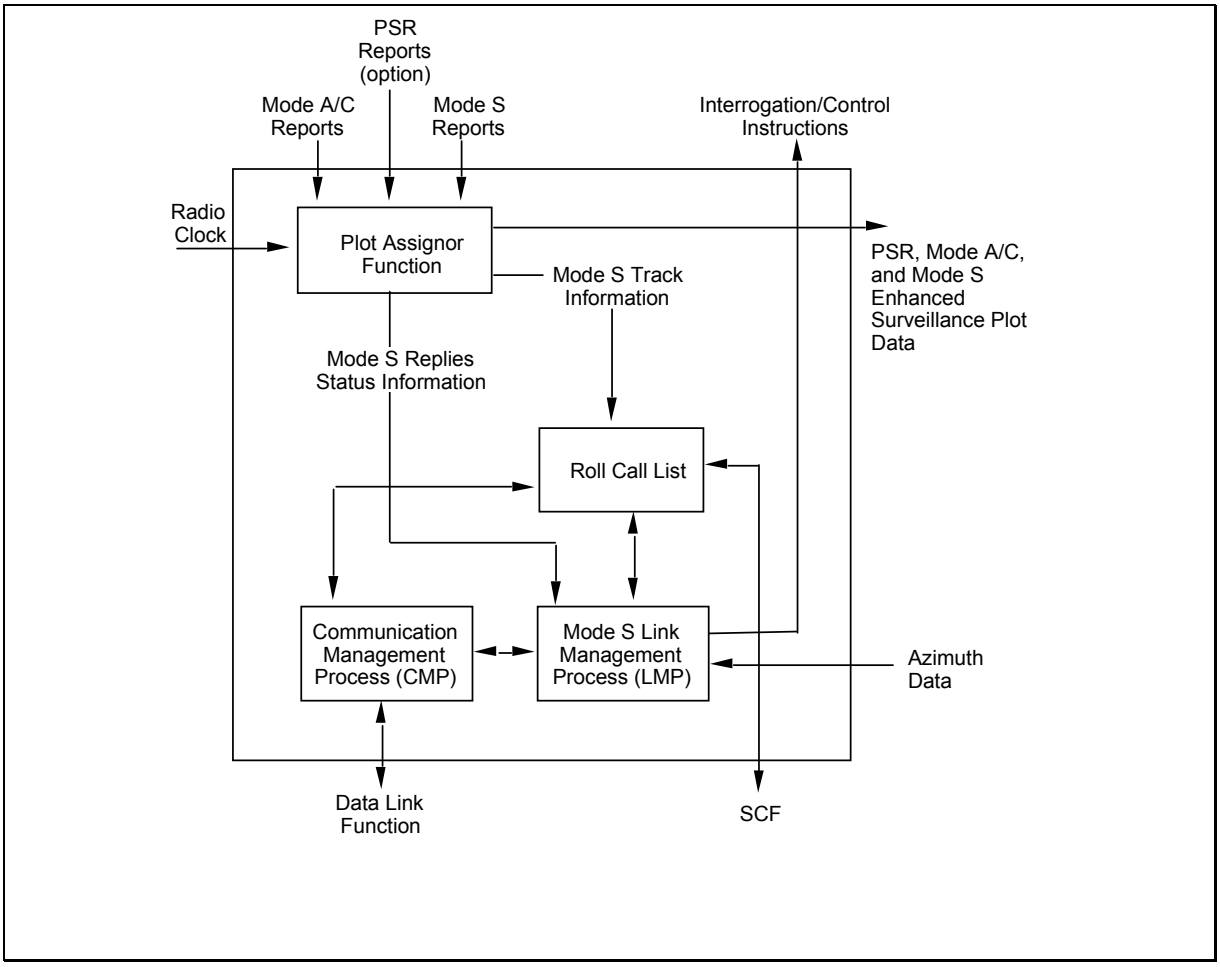


Figure 8 Link Control Functional Overview

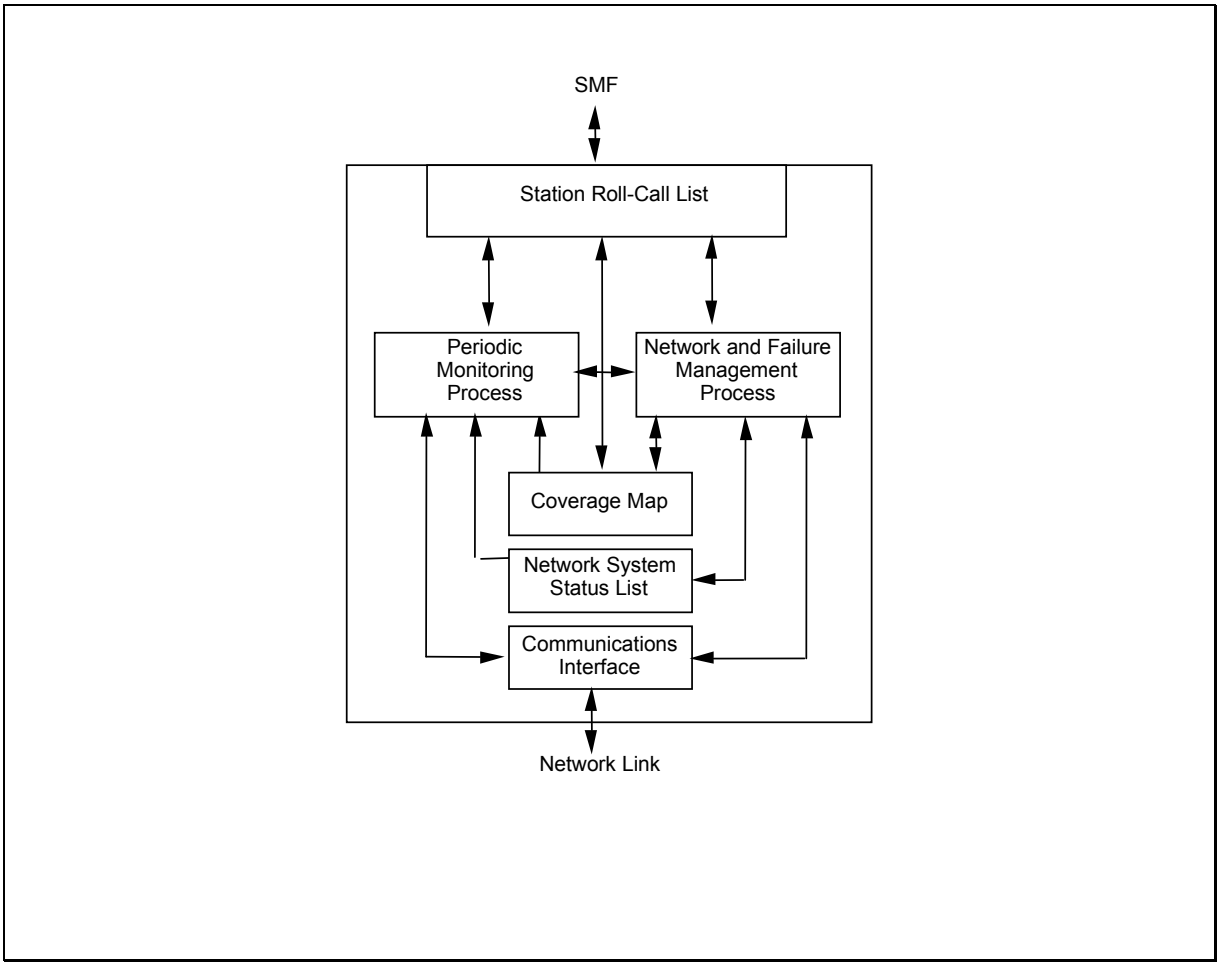


Figure 9 Surveillance Co-ordination Function (SCF) Overview

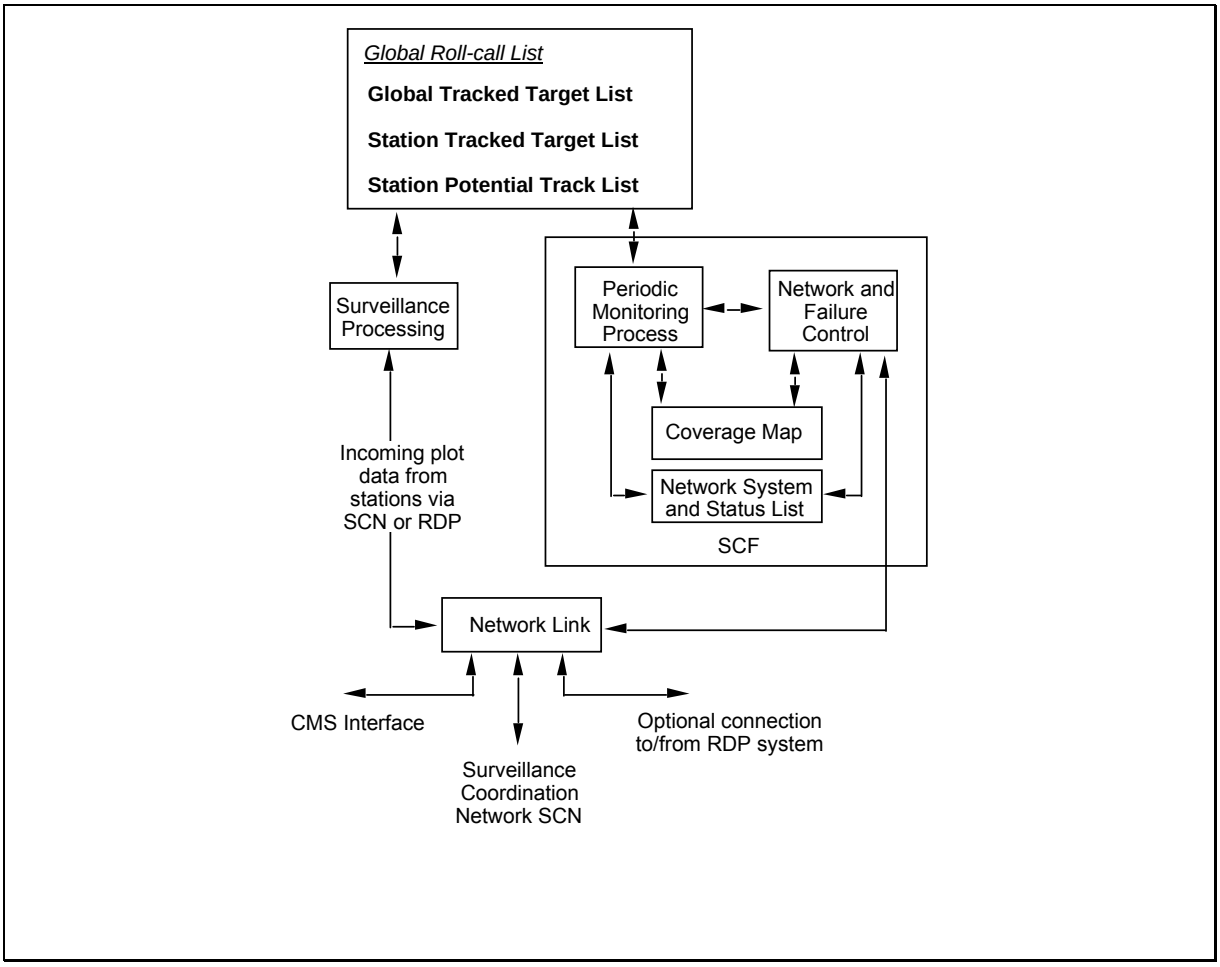


Figure 10 Cluster Controller (CC) Functional Overview

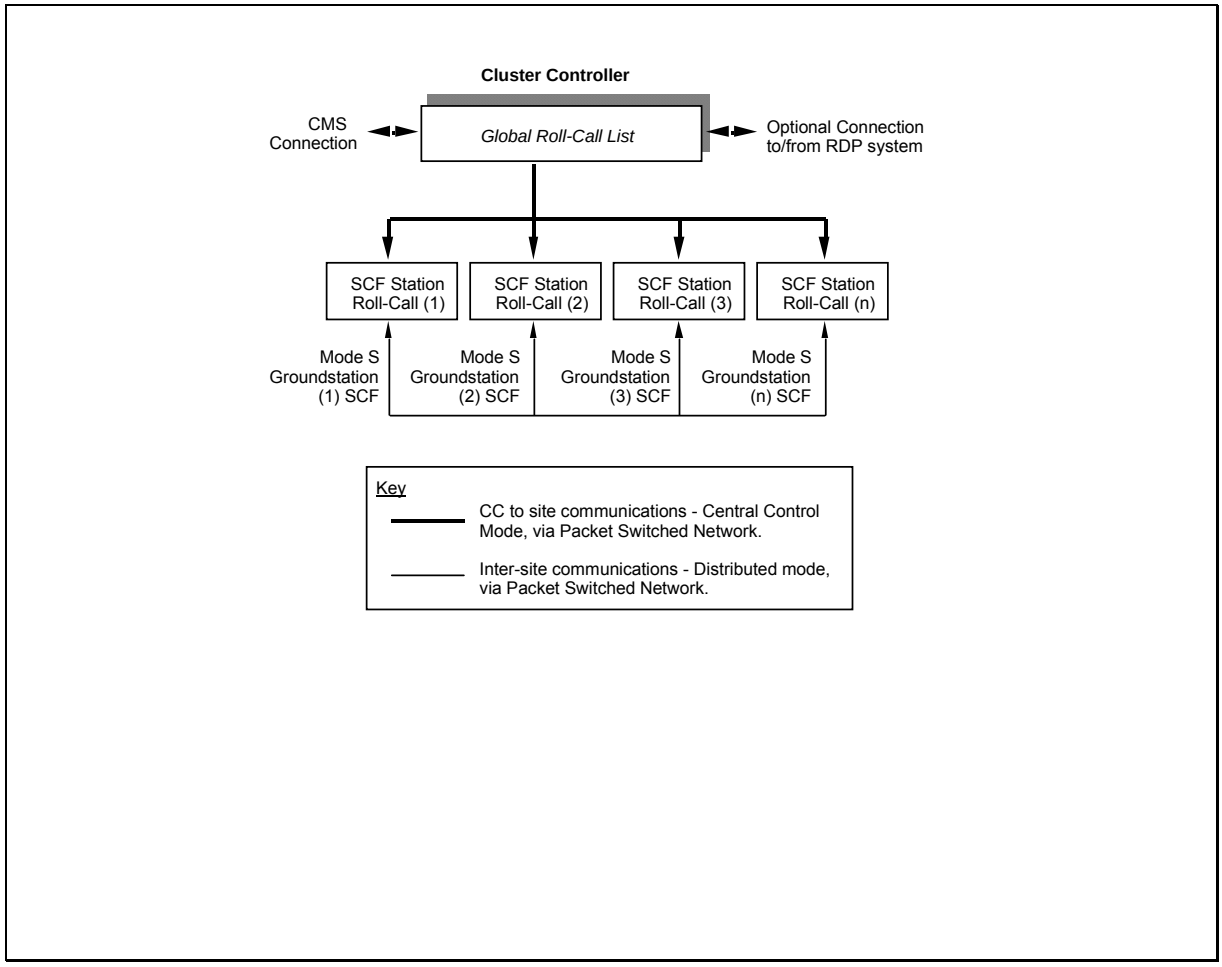
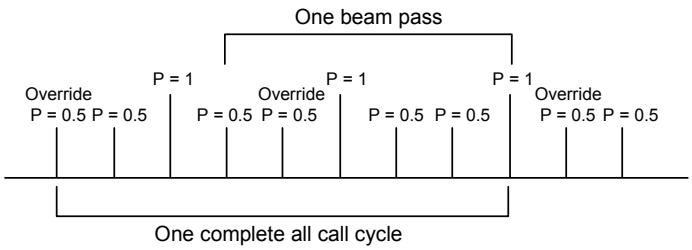
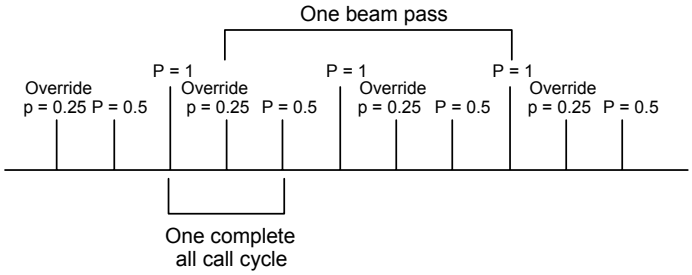


Figure 11 Surveillance Co-ordination Network (SCN)



Pattern A to achieve 90% probability in two aerial revolutions



Pattern B to achieve 90% probability in three aerial revolutions

Note:

Pattern A always gives four interrogations with a probability of 0.5 but every fourth pattern has two override interrogations instead of one. Pattern B always gives two interrogations with a probability of 0.5 and two override interrogations with a probability of 0.25

Figure 12 Stochastic All Call Example

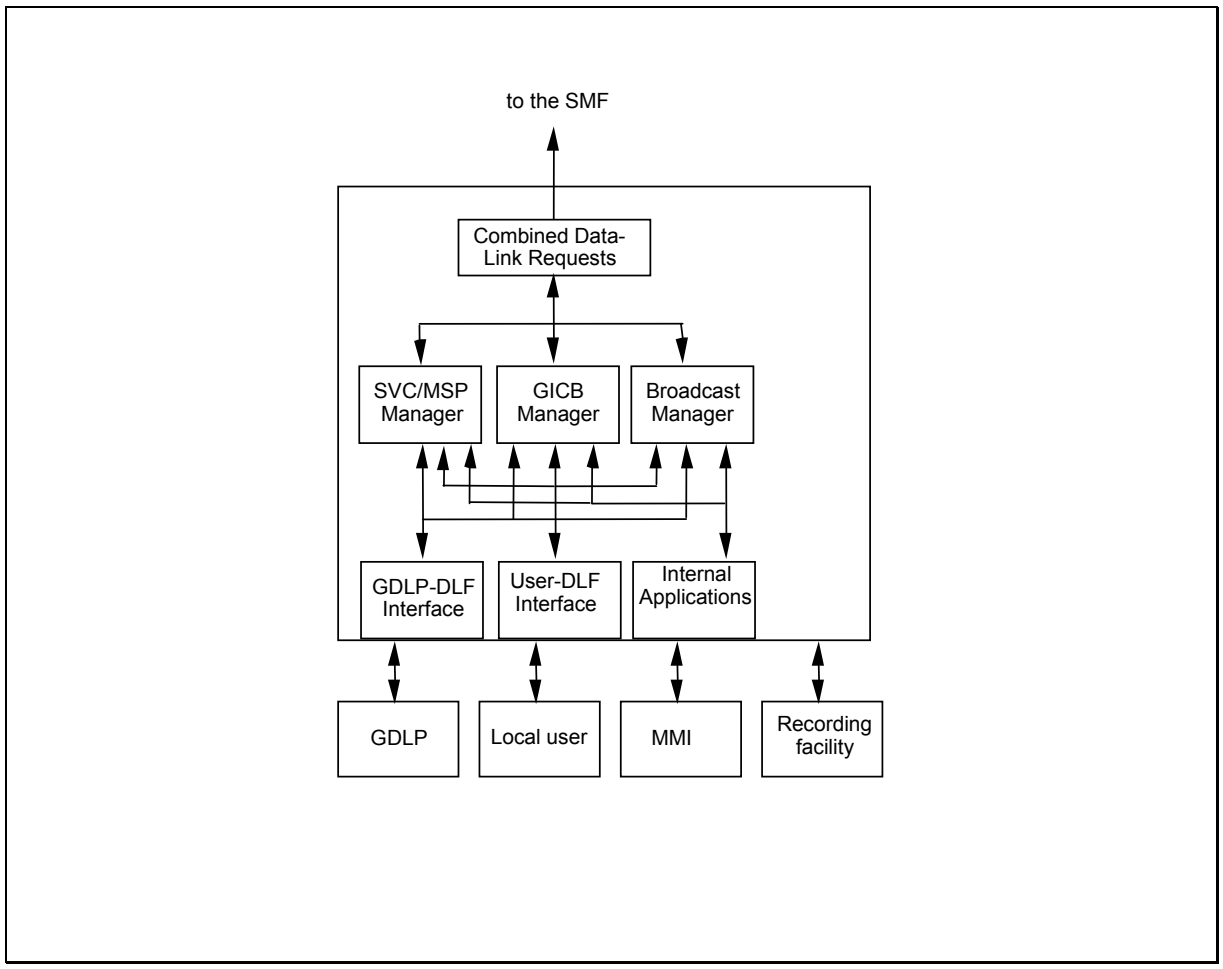


Figure 13 Datalink Function (DLF) Overview

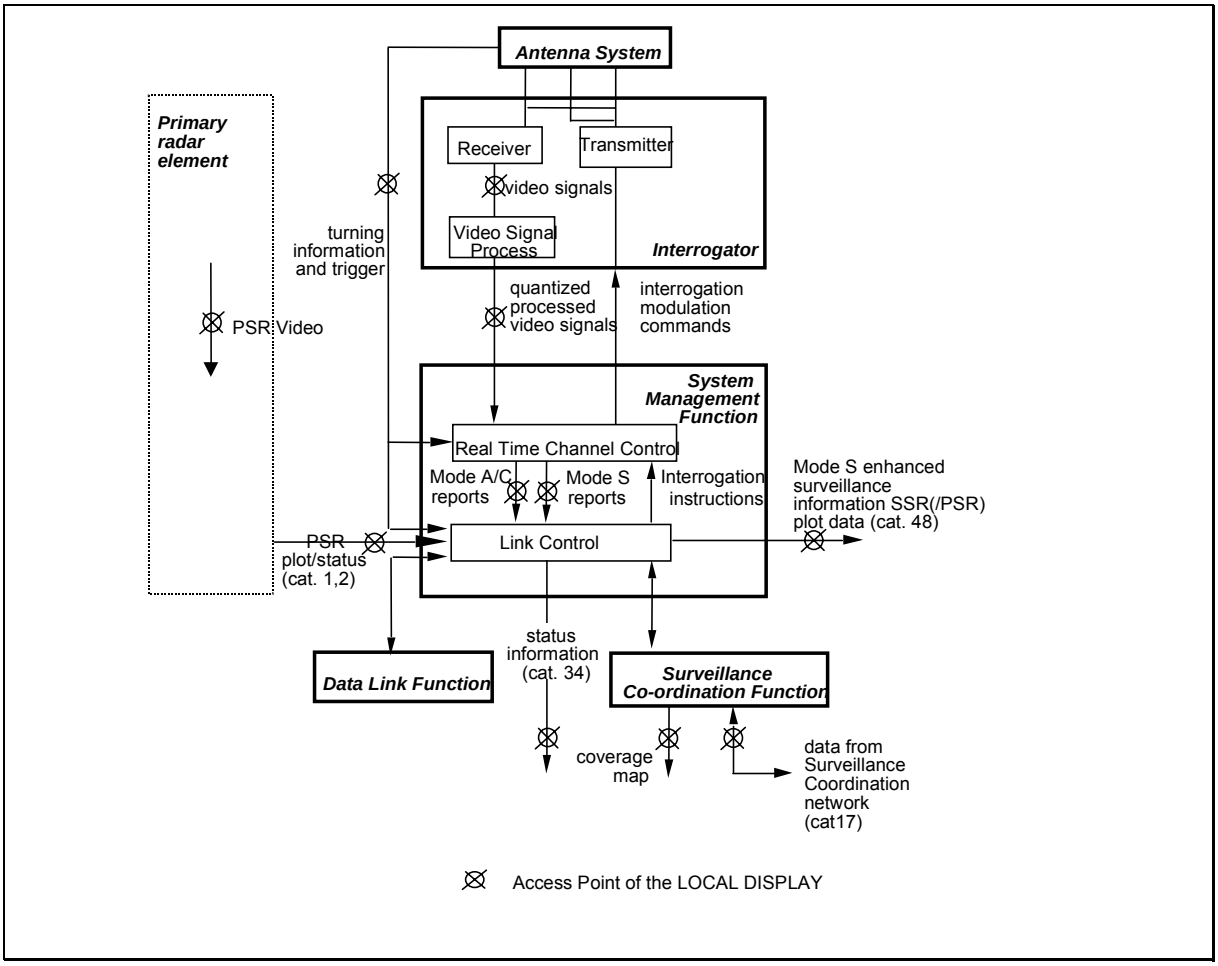


Figure 14 Local Display (LD) Acces Points

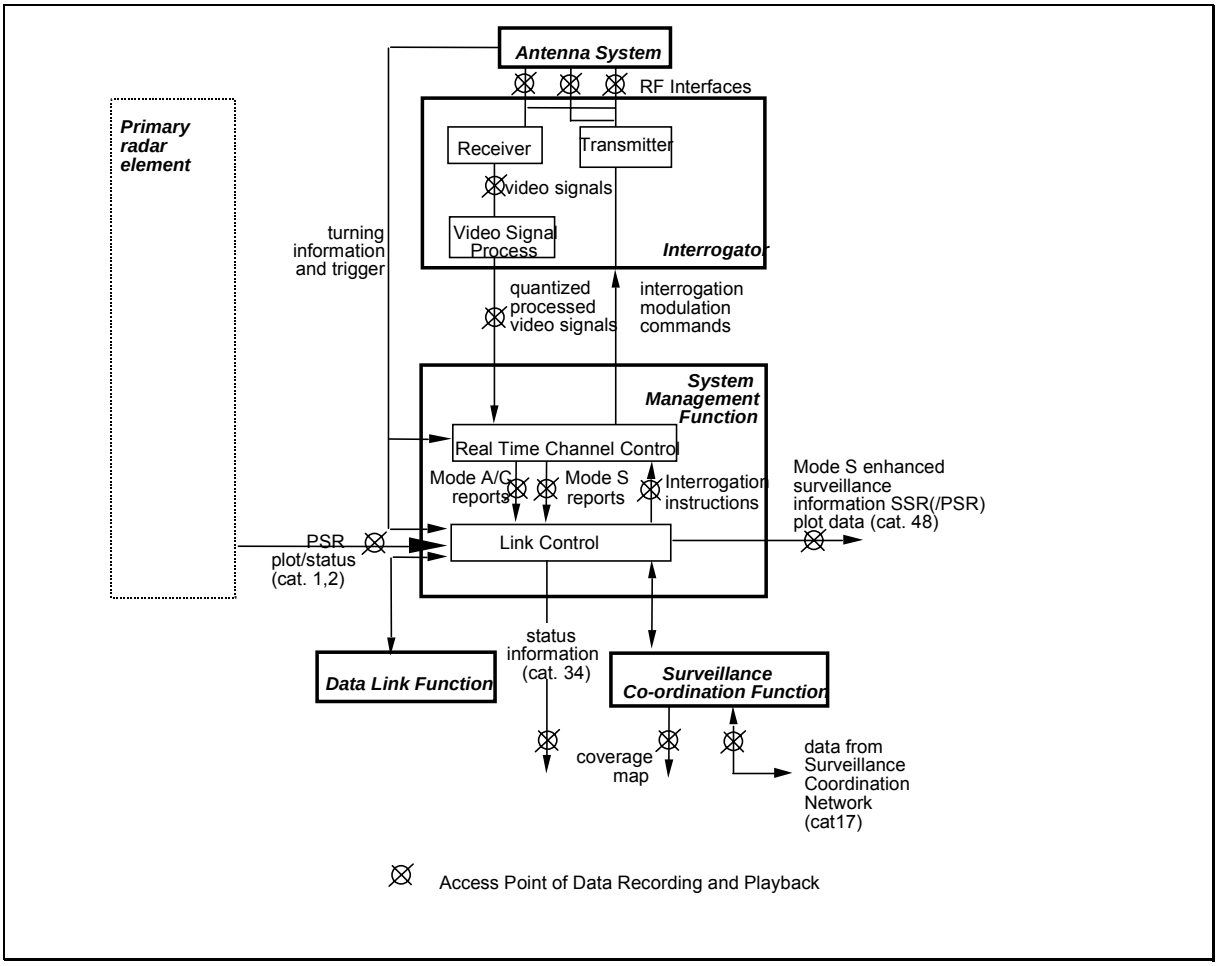


Figure 15 Data Recording and Playback Access Points

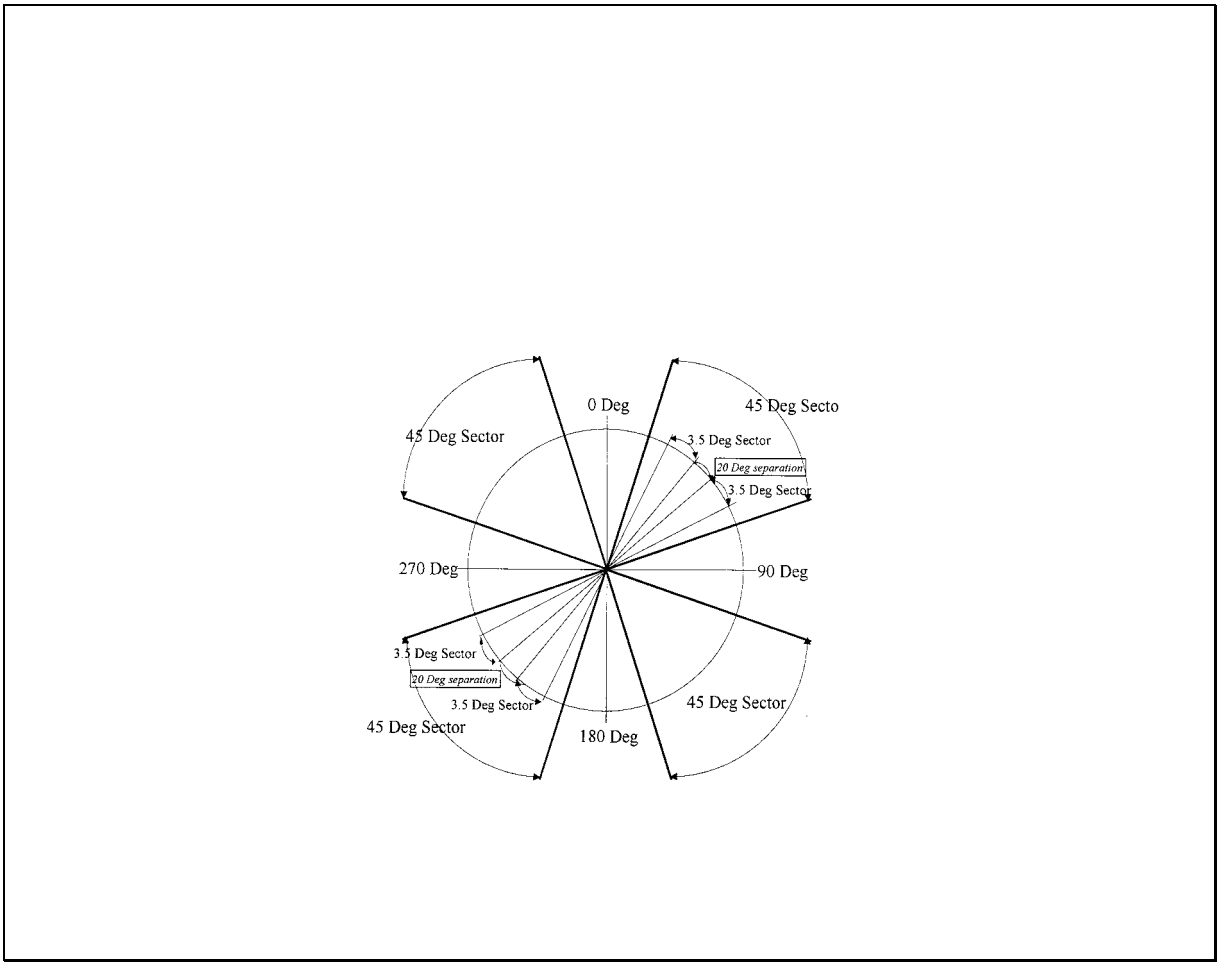


Figure 16 Illustration of Sector Distribution

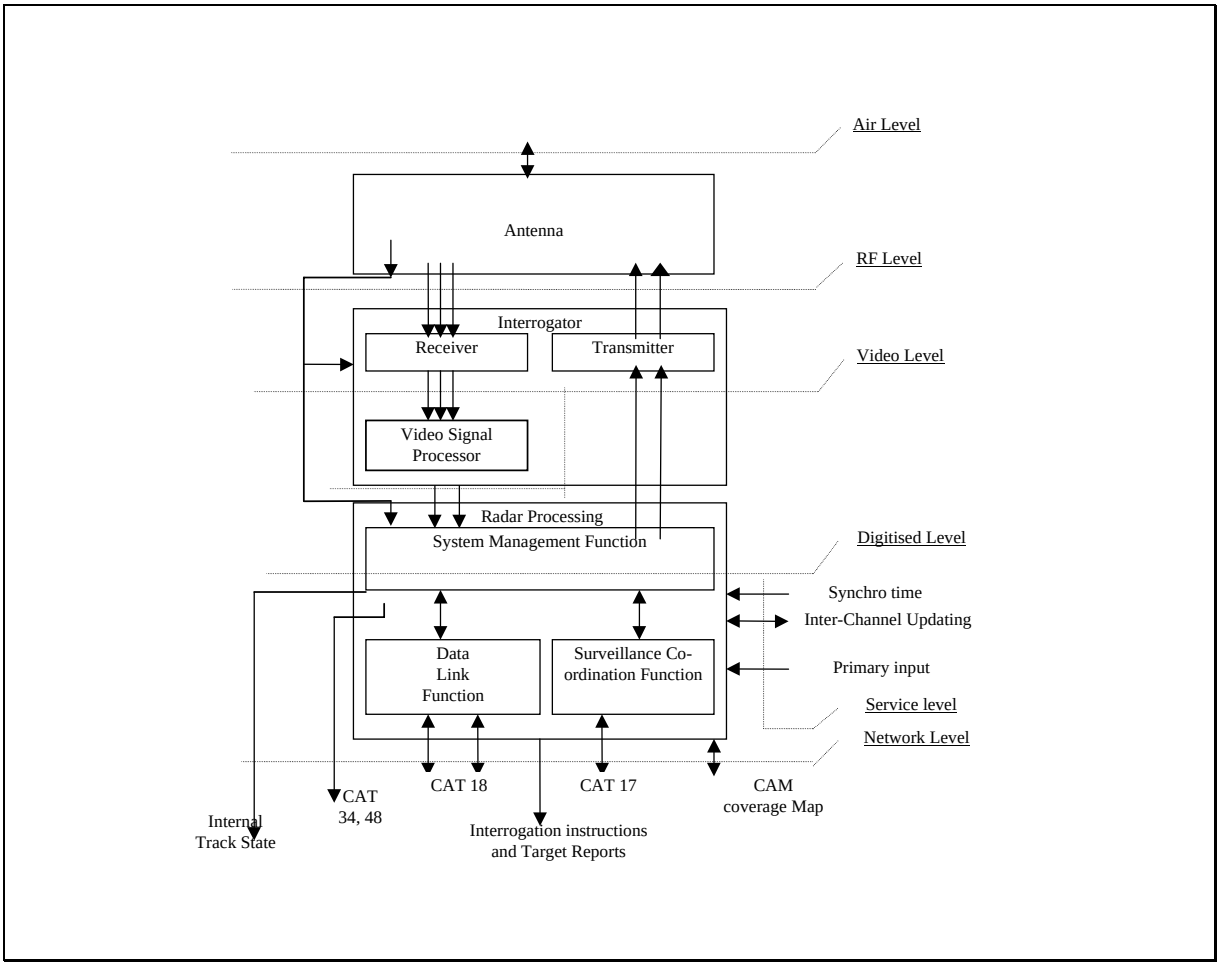


Figure 17 PTE Access Level Overview

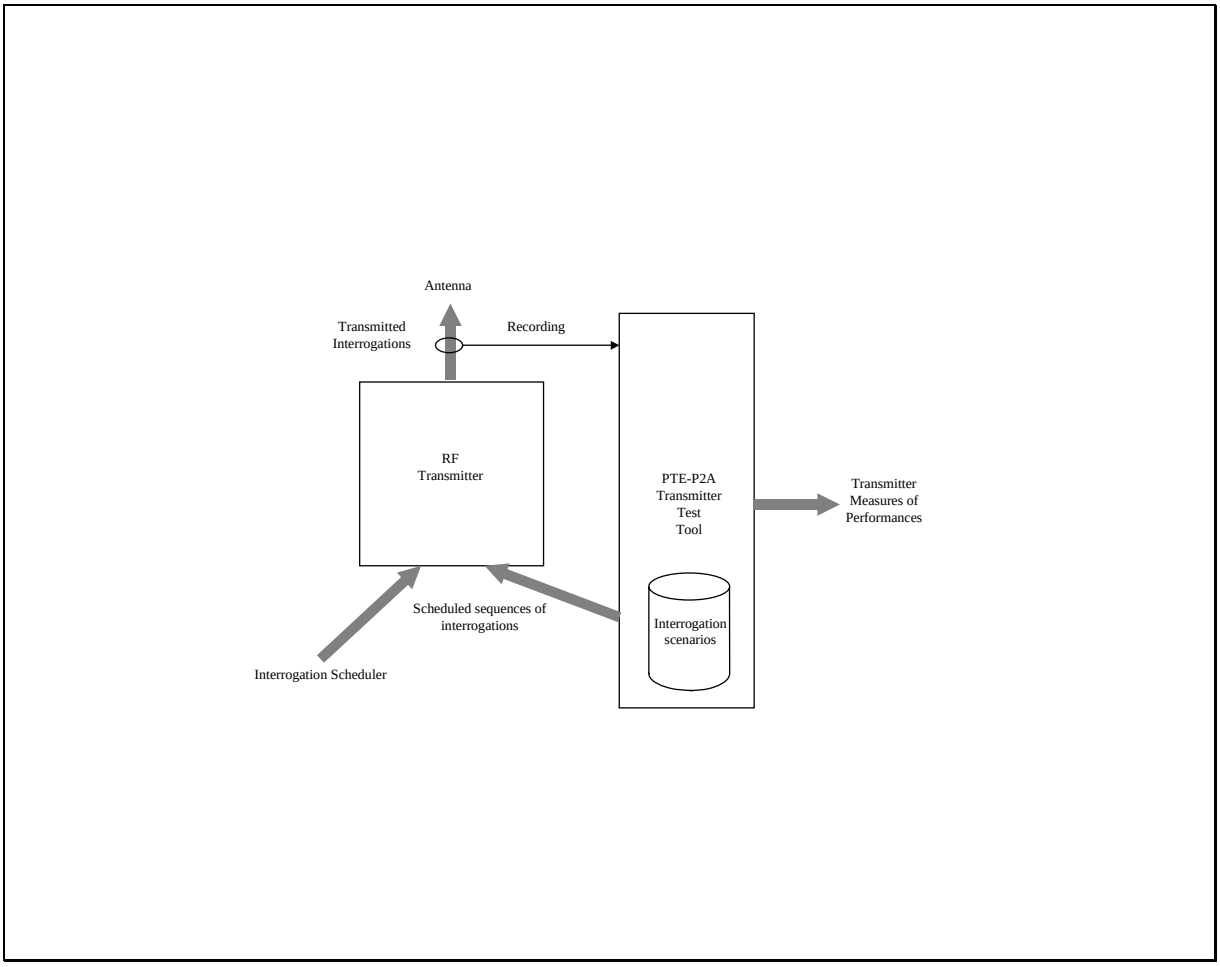


Figure 18 PTE-P2A Context

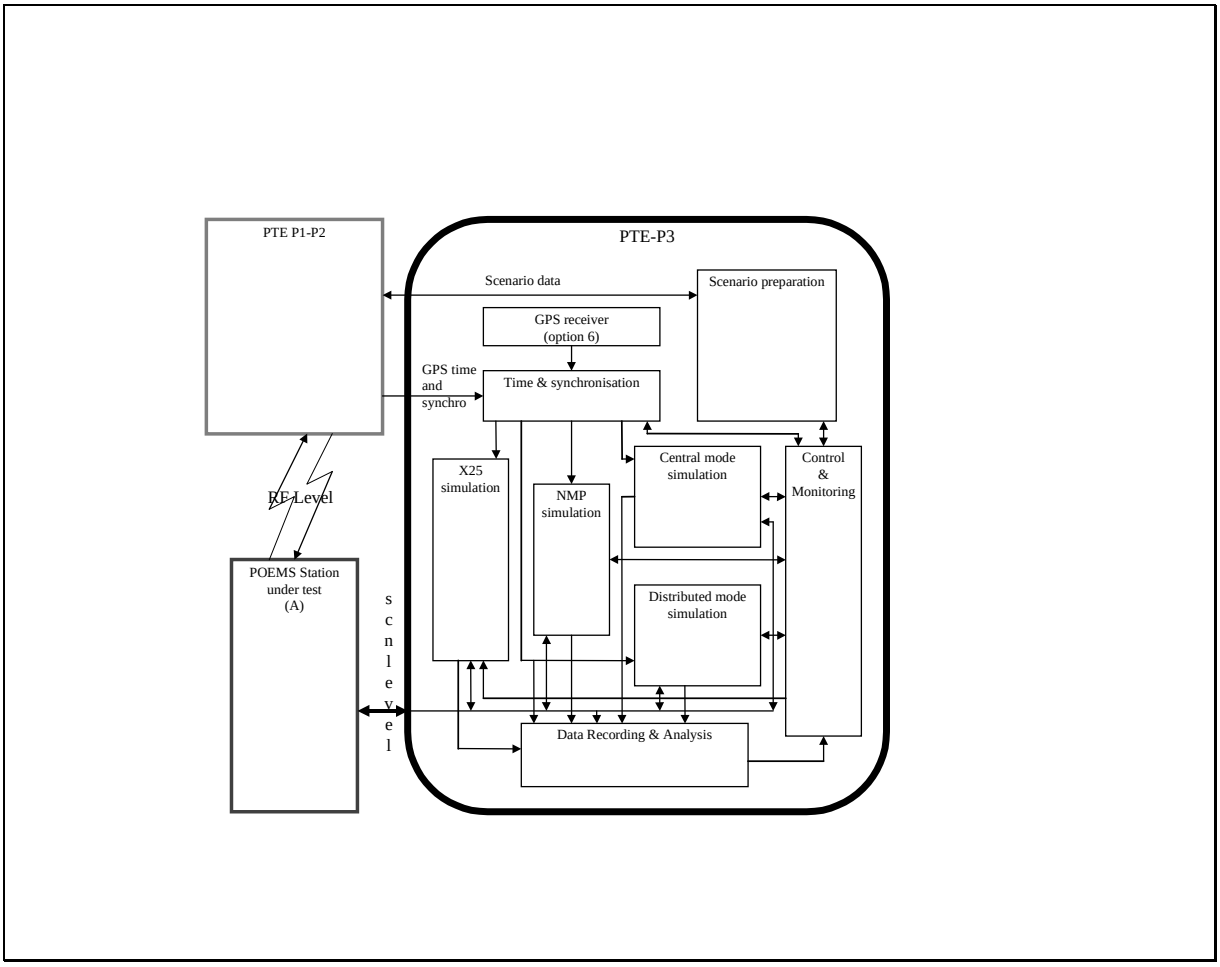


Figure 19 PTE-P3 Functional Overview

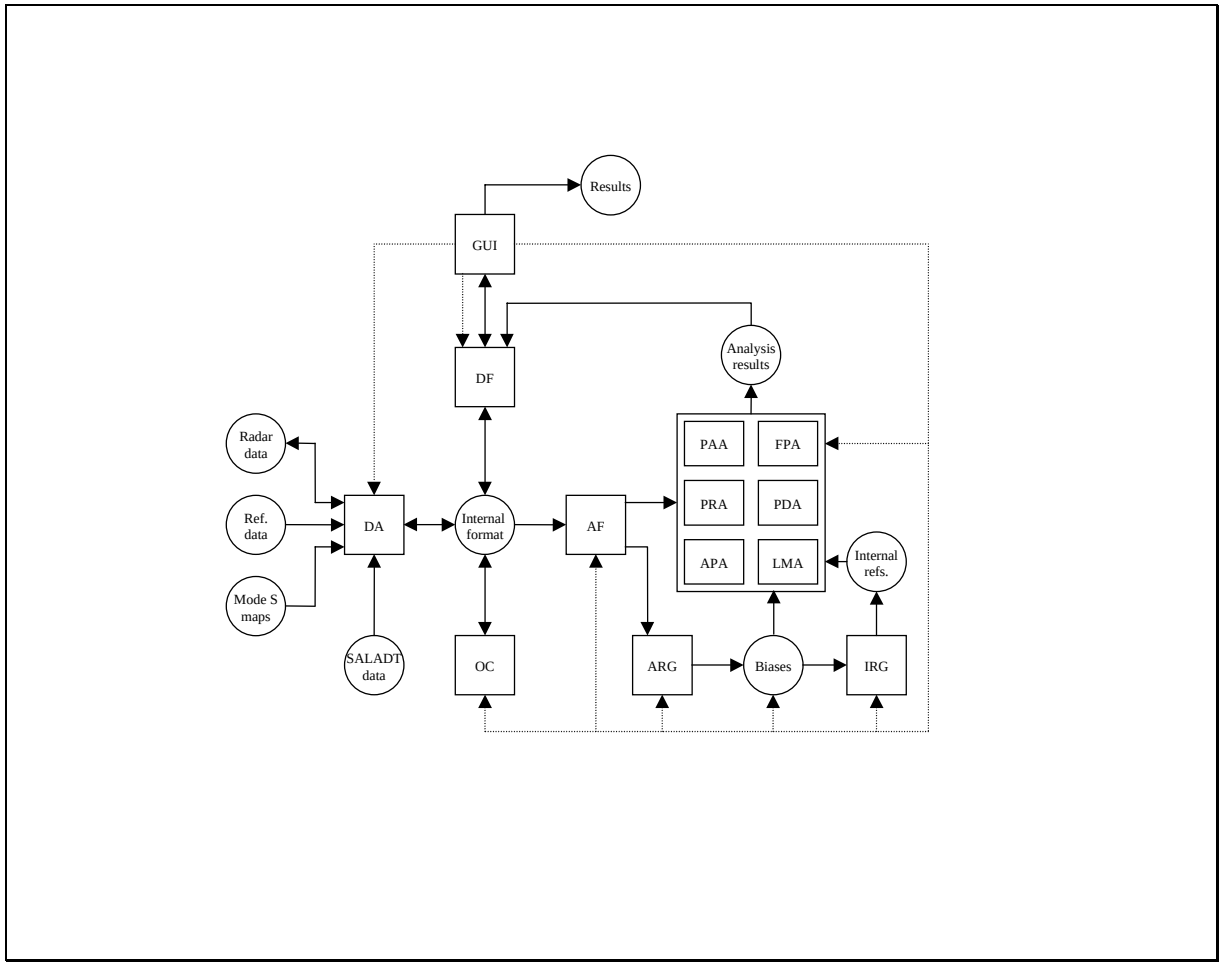


Figure 20 PTE-P4 Functional Architecture