

**Kingdom of Saudi Arabia
General Authority of Civil Aviation**

GACA REGULATION

Section 10

Aeronautical Telecommunications

Edition 4.0

FOREWORD

FOREWORD

The following Regulations governing Air Navigation Services (ANS) are based on Articles 1, 2, 3, 4, 5, 89, 90, 94, 175 and 177 of the Civil Aviation Act as approved by Council of Ministers Resolution No. 185, dated 17/07/1426 H, and are in accordance with ICAO Annex 10 – Aeronautical Telecommunications and its related documents.

The promulgation of this regulation is based on the authority granted in Article 179 of the Civil Aviation Act, and is issued under the authority of the President, General Authority of Civil Aviation, as a duly delegated representative of the GACA Board of Directors, in accordance with Order No.T-41, dated 30/12/1429H (28/12/2008G).

The General Authority of Civil Aviation is responsible for the preparation and distribution of all regulations and procedures in sufficient quantities so that all service providers and aircraft operators based in the Kingdom of Saudi Arabia are able to obtain an authentic copy prior to the effective date of the Regulation.

APPROVED:

Original Signed by

Fahad Bin Abdullah Al-Saud
President, General Authority of Civil Aviation

Effective Date: 13 November 2014

CONTENT RULES**(1) Organization Structure:**

- (a) GACA has established an Air Navigation Services Safety Division (ANS Safety) within the Safety Department (SD) of the Safety and Air Transport Sector (S&AT) with the following responsibilities:
 - (a) Ensure and enforce compliance with the applicable regulations and procedures of GACAR Section 10 including the identification of conditions and circumstances under which GACA-Air Navigation Services are allowed to deal with, and resolve, events involving certain deviations internally, within the context of the GACA-ANS safety management system (SMS);
 - (b) Perform safety oversight functions include audits, inspections, investigations and data analysis;
 - (c) Conduct on site facilities audits based on pre-established annual audit program and frequent inspections of areas of greater safety concern or need, as identified by the analysis of Data, or as instructed by Senior Management;
 - (d) Ensure the capture and storage of data on safety risks and deviations;
 - (e) Perform analysis of the stored data and actively exchange safety information with the concerned departments within Air navigation services;
 - (f) Organize internal training, communication and dissemination of Safety information;
 - (g) Promote dissemination of Safety information to support the development of an organizational culture that fosters an effective and efficient Safety Management System within GACA-ANS;
- (b) Under current arrangements for aeronautical telecommunications activities in the Kingdom of Saudi Arabia, GACA-ANS is responsible of the design, installation, testing, operation and maintenance of telecommunications facilities. All these activities shall comply with ICAO Standards and Recommended Practices. GACA-ANS has assigned these activities to Systems Engineering Department, Maintenance Engineering Department and Air Traffic Management Department with an involvement of Safety System and Quality Assurance Department;
- (c) This regulation covers all Aeronautical Telecommunications requirements that should be observed in the design, installation, testing, operation and maintenance, performed by GACA Air Navigation Services.

2) Rules of Construction

(a) To avoid any misunderstanding within this regulation, certain words are to be interpreted as having specific meanings when they are used, unless the context requires otherwise:

- (a) words importing the singular include the plural;
- (b) words importing the plural include the singular; and
- (c) words importing the masculine gender include the feminine.

(b) In this regulation, the following protocol is used:

- (a) the words "**shall**" and "**must**" indicate that compliance is compulsory;
- (b) The word "**should**" indicates a recommendation. It does not mean that compliance is optional but rather that, where insurmountable difficulties exist, the GACA- S&AT may accept an alternative means of compliance, provided that an acceptable safety assurance from the Air Navigation Services shows that the safety requirements will not be reduced below that intended by the requirement.
- (c) The word "**Can**" or "**May**" is used in a permissive sense to state authority or permission to do the act prescribed, and the words "no person may * * *" or "a person may not * * *" mean that no person is required, authorized, or permitted to do the act prescribed;
- (d) The word "**will**" is used to express the future; and
- (e) The word "**includes**" means "**includes but is not limited to**".

AMENDMENT PROCEDURE

The existing General Authority of Civil Aviation Regulations (GACAR) will be periodically reviewed to reflect the latest updates of International Civil Aviation Organization (ICAO) Standards and Recommended Practices (SARP's); it will be also amended to reflect the latest aviation safety provisions issued by GACA and other regional and international civil aviation organizations. A complete revised edition incorporating all amendments will be published every three years from the original effective date of this regulation. The amendment procedure shall be as follows:

- a) When the General Authority of Civil Aviation (GACA) receives an amendment to any of the current ICAO Annexes that can affect the provisions of this regulation, it will be forwarded by the Vice President of International Organization Affairs to the Assistant Vice President, Safety and Air Transport (S&AT) who in turn will forward it to Aviation Regulation Department to coordinate with the concerned department to study and comments, taking into account the ICAO deadline for the reply.
- b) When any GACA department or stakeholder proposes an amendment to this regulation, it will send a letter with the proposed amendment including a clear justification and argument for such amendment. Following the receipt of an amendment proposal, the S&AT will analyze this proposal and forward its comments and any proposed decision action to the S&AT Assistant Vice President.
- c) An accepted amendment proposal will be prepared as draft amendment to the GACAR Section 10 and forwarded to the originator of the amendment proposal and concerned GACA department (s) for further review and comment within a specified timeline.
- d) All accepted amendments will be drafted in the form of Notices of Proposed Amendments (NPA) and forwarded to all concerned parties including stakeholders for comment within a two-month reply period. The NPA shall indicate the proposed Amendment's effective date.
- e) Following the receipt of NPA replies, the S&AT will analyze the comments received and produce a new draft in consultation with the concerned GACA department. The final draft will be submitted to President of the General Authority of Civil Aviation for formal approval prior to publication.
- f) The Amendment's effective date will take into account the comments of all the concerned parties and stakeholders.
- g) Any differences between the GACAR Section 10 new amendment and ICAO Annex 10 Standards and Recommended Practices will be forwarded to ICAO as a Difference and published as it is in the Aeronautical Information Publication (AIP).
- h) All concerned parties and stakeholders will be provided a copy of the new amendment and will be requested to update their copy of the GACAR Section 10 accordingly.
- i) It is the responsibility of all concerned parties to keep their copy of GACAR Section 10 and other GACA regulation publication up to date.

SUPPLEMENTARY REGULATIONS

From time to time it will be necessary to issue regulations which supplement or augment the GACA Regulations. The following procedures will apply:

- a. Supplementary regulations will be issued in the form of a GACA Regulation Circular (RC).
- b. The GACA Regulation Circular will be approved by the President.
- c. The process for preparation and publishing of the GACA Regulation Circular will be addressed in the GACA Quality System Manual.

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AMENDMENT RECORD

This edition incorporates all amendments to ICAO Annex 10 (Volumes I-V) up to and including amendment 89

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LIST OF CURRENT DIFFERENCES TO ICAO SARPS

GACA Regulation Section 10 is based on ICAO Annex 10 Volumes I-V. The following is a list of differences between the GACA Regulation and the ICAO Standards and Recommended Practices (SARPS). Differences have been notified to ICAO and are also published in the KSA Aeronautical Information Publication (AIP-GEN 1.7).

ICAO Annex 10 – AERONAUTICAL TELECOMMUNICATIONS**Volume I – Amendment 89****Volume II – Amendment 89****Volume III –Amendment 89****Volume IV – Amendment 89****Volume V – Amendment 89**

SARP Identifier	Regulation Reference	Difference
		No differences

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CHAPTER 1 – AERONAUTICAL TELECOMMUNICATIONS**1.1 Establishment of Authority**

- (a) The General Authority of Civil Aviation (GACA) is responsible for the provision of aeronautical telecommunications (ATEL) services and aeronautical radionavigation (ANAV) services within the airspace of the Kingdom of Saudi Arabia (KSA) in accordance with the obligations imposed by the Convention on International Civil Aviation (Chicago Convention) and Regional Air Navigation Agreements.

1.2 Applicability

- (a) Except as provided in paragraph 1.3, the provision of ATEL and ANAV equipment and services shall be in accordance with the Standards and Recommended Practices promulgated in the current edition and amendment of Annex 10 to the Chicago Convention (ICAO Annex 10):
- a. Volume I – Radio Navigation Aids;
 - b. Volume II – Communications Procedures, including those with PANS status;
 - c. Volume III – Communications Systems;
 - i. Part I – Digital Communications Systems;
 - ii. Part II – Voice Communications Systems;
 - d. Volume IV - Surveillance and Collision Avoidance Systems; and
 - e. Volume V – Aeronautical Radio Frequency Spectrum Utilization.
- (b) Except as provided in paragraph 1.3, all Recommended Practices have been adopted as Standards.
- (c) Where indicated, GACA is designated as the Civil Aviation Authority.
- (d) Where indicated, GACA is designated as the appropriate State authority.
- (e) Where indicated, GACA is designated as the appropriate ATS authority.

1.3 Exceptions and Differences

- (a) Where indicated, the exceptions and differences to Standards and Recommended Practices of ICAO Annex 10 listed below shall apply within the Kingdom of Saudi Arabia:
- (i) Nil differences or exceptions.
- (b) Where GACA has filed differences to SARPs, these will be published in the KSA AIP.

1.4 Technical Standards and Compliance

- (a) Technical standards and compliance requirements supporting the provision of ATEL and ANAV services are detailed in Appendix A.

**APPENDIX A STANDARDS RELATING TO THE PROVISION OF
AERONAUTICAL TELECOMMUNICATIONS AND
AERONAUTICAL RADIONAVIGATION SERVICES**

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Section 1 Reserved

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Section 2 **Aeronautical Telecommunication and Radio Navigation Services and Facilities**

2.1 **Aeronautical telecommunication services**

2.1.1 Aeronautical telecommunication services are the ground-based stations of those services defined hereunder supporting an Air Traffic Service provided under GACAR Section 11. Airborne stations are not included.

- (a) **Aeronautical Broadcasting Service.** A broadcasting service intended for the transmission of information relating to air navigation. This does not include automated weather information broadcast stations.
- (b) **Aeronautical Fixed Service.** A telecommunication service between specified fixed points provided primarily for the safety of air navigation and for the regular, efficient and economical operation of air services.
- (c) **Aeronautical Fixed Telecommunication Network Service.** A worldwide system of aeronautical fixed circuits provided, as part of the aeronautical fixed service, for the exchange of messages and/or digital data between aeronautical fixed stations having the same or compatible communication characteristics.
- (d) **Aeronautical Telecommunication Network Service.** An inter-network that allows ground, air-ground and avionics data sub-networks to inter-operate by adopting common interface services and protocols based on the International Organization for Standardization (ISO) Open Systems Interconnect (OSI) reference model.
- (e) **Aeronautical Mobile Service.** A mobile service between aeronautical ground stations and aircraft stations, in which survival craft stations may participate; emergency position-indicating radio-beacon stations may also participate in this service on distress and emergency frequencies. This service does not include ground stations that are provided for other than ATS purposes.
- (f) Any telecommunication service which processes or displays air traffic control data (including aviation meteorological data) for use by an ATS provider under GACAR Section 11.
- (g) Electronic briefing and flight plan lodgement service for the use of pilots.

2.2 **Aeronautical radio navigation services**

2.2.1 An aeronautical radio navigation service is a radio navigation service intended for the benefit, and for the safe operation of aircraft.

2.2.2 Radio navigation services include radio determination (radar and related surveillance services) supporting ATS.

2.3 **Aeronautical telecommunication and radio navigation facilities**

2.3.1 The following list classifies the kinds of facilities used for the provision of aeronautical telecommunication and radio navigation services:

- (a) Very High Frequency (VHF) air/ground voice communication facilities;
- (b) High Frequency (HF) air/ground voice communication facilities;
- (c) Ultra High Frequency (UHF) air/ground voice communication facilities;
- (d) Precision approach radio navigation aids;
- (e) Instrument Landing System (ILS) facilities;
- (f) Non-precision radio navigation aids;
- (g) Distance Measuring Equipment (DME);
- (h) VHF Omni-Range (VOR) facilities;
- (i) Non-directional beacons (NDB);
- (j) Flight data processing facilities;
- (k) Flight information facilities;
- (l) Radar data processing facilities;
- (m) Primary surveillance radar facilities;
- (n) Secondary surveillance radar facilities;
- (o) Multilateration radar facilities;
- (p) Surface movement radar facilities;
- (q) Precision runway monitor facilities;
- (r) Automatic dependent surveillance system facilities;
- (s) Voice switching and control facilities;
- (t) ATS point to point communication facilities;
- (u) Air/ground data links;
- (v) Ground to ground data interchange networks;
- (w) Human Machine Interface systems, including Tower Consoles, ATS Work Stations, and Display facilities;
- (x) Uninterruptable and emergency power supplies;
- (y) Essential services in buildings and in equipment shelters housing facilities (electrical power supplies, air-conditioning, and security facilities);
- (z) Global Navigation Satellite System ground based augmentation stations or facilities;
- (aa) Aeronautical databases used in or by a facility;
- (bb) Meteorological Display Systems used for ATS;
- (cc) Voice and Data Recording facilities;
- (dd) Any other facilities supporting ATS provided under GACAR Part 11.

Section 3 Safety management system

3.1 Standards for the safety management system

3.1.1 A provider of a ground-based aeronautical telecommunication (ATEL) or aeronautical radionavigation (ANAV) service must establish, maintain and operate a safety management system which complies with the requirements of GACAR Section 21, and which, as a minimum, has the following elements:

- (a) the ATS provider's safety policy and objectives;
- (b) the organizational and staff responsibilities for safety matters;
- (c) the establishment of the levels of safety that apply to the services, and the monitoring of the levels of safety achieved;
- (d) the process for internal safety reviews;
- (e) the process for the internal reporting and management of safety concerns and incidents;
- (f) the process for the identification, assessment, control and mitigation of existing and potential safety hazards in service provision;
- (g) the definition of the interface arrangements, for safety management and related responsibilities and procedures, with internal functional groups and with aerodrome operators and support service providers;
- (h) the processes for the management of changes to existing services.

3.1.2 An ATS service provider must publish details concerning its safety management system as part of its Operations Manual.

3.2 Standards for safety case preparation

3.2.1 Internal safety assessments for changes must be undertaken in accordance with the service provider's safety management system.

3.2.2 Where safety cases are conducted they must be based on a recognised methodology for safety risk assessment.

3.2.3 The safety risk assessment in a safety case must:

- (a) identify all potential safety hazards associated with the operation of each service, in normal and abnormal modes of operation;
- (b) assess the safety risk of each hazard;
- (c) identify the means of mitigation of unacceptable safety risks.

3.2.4 Reserved

Section 4 Reserved

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Section 5 Technician qualifications, training and certification

5.1 Minimum academic qualifications

5.1.1 The minimum academic qualification for technicians performing operation and maintenance functions associated with aeronautical telecommunication facilities and/or radionavigation facilities is a diploma of technology (or approved equivalent) in one of the following:

- (a) radio engineering;
- (b) communications engineering;
- (c) electrical engineering;
- (d) electronic engineering;
- (e) computer science;
- (f) information technology; or
- (g) qualifications equivalent to the above qualifications.

5.1.2 For those technicians that carry out or supervise electrical and mechanical trades work only, the minimum qualification is an electrical or mechanical trades qualification, as relevant.

5.1.3 Where an organization considers, and the President agrees, that the operation and maintenance of a particular type of facility is not technically complex, lesser qualifications may be acceptable for those technicians who operate and maintain that type of facility.

5.2 Technician training and certification - authorizing certificate

5.2.1 An approved ATEL or ANAV organization must provide technicians with an authorizing certificate which:

- (a) establishes the identity of the technician;
- (b) details the scope of the authorization granted to the technician by listing the facilities, or types of facilities, which the technician is authorized to operate and/or maintain; and
- (c) includes a date of effect, and the period of time for which each of the authorizations remain current.

5.2.2 An organization must not grant a technician an authorizing certificate in respect to a particular facility or a class of facility unless it has established that the technician:

- (a) has undergone a competency based course of instruction or on-the-job training specific to that facility or that class of facility; and
- (b) has been assessed to be competent in the operation and maintenance of the facility or the class of facility by an assessor who:
 - (a) has been trained and accredited in workplace assessment and training at an appropriate technical training facility or institution; and
 - (b) holds formal recognition of competency in the unit being assessed, at or above the level being assessed; and has current knowledge of the workplace and job/role of the person being assessed.
- (c) However, if an assessor alone does not have all the competencies required, he may work together with another assessor who has the additional competencies to conduct assessments.

5.3 Refresher training and recency checking procedure

5.3.1 Approved organizations must have a process for refresher training and recency checking of technicians to ensure the on-going retention of technician's competency on the facility types for which an authorizing certificate has been granted.

Section 6 Test equipment and test facilities**6.1 Minimum Standards**

6.1.1 Test facilities for aeronautical telecommunication or radio navigation services and facilities must meet the following minimum standards:

- (a) An approved organization must have available all of the test facilities necessary for use in the operation and maintenance of the services and facilities for which they are responsible.
- (b) An approved organization must use documented procedures to control, calibrate, and maintain test equipment.
- (c) An approved organization must ensure that only calibrated test equipment is used in maintenance of a service or facility.
- (d) An approved organization must ensure that calibration is carried out at prescribed intervals for each type of test equipment and the calibration is traceable to KSA national measurement standards or an equivalent approved by the President.
- (e) Records of the calibration status of each item of test equipment must be retained.
- (f) Each item of test equipment must carry a visual identification of its calibration status, the date that the equipment was last calibrated, and the prescribed calibration periodicity.
- (g) An approved organization must assess the validity of previous test results whenever an item of test equipment is found to be out of calibration.

Section 7 Document data availability and control**7.1 Documents to be held by the provider**

7.1.1 An approved organization must hold and maintain certain documentation essential to the safe provision of ATEL or ANAV services. These documents form part of the Operations Manual.

- 7.1.2 Documents that are essential for the provision of services under the certificate include:
- (a) ICAO Annex 10 Volumes I to V inclusive, as amended from time to time;
 - (b) ICAO Annex 11, as amended from time to time;
 - (c) the functional specification and technical specification of services and facilities that are operated and/or maintained by the service provider;
 - (d) records of the configuration of facilities;
 - (e) facility operation and maintenance plans;
 - (f) interface agreements with other organizations;
 - (g) facility technical manuals or instructions;
 - (h) local instructions and technical procedures; and
 - (i) safety cases.

7.2 Document and data control processes

7.2.1 An approved organization must establish a document control system which covers the authorization, standardization, publication, distribution and amendment of all documentation issued by the organization, or required by the organization for the provision of ATEL or ANAV services.

- 7.2.2 These processes must ensure:
- (i) authorization of documents and records is made by a designated authority appropriate to the provider's management and safety accountability structures;
 - (ii) that the currency of documents can be readily determined and that only current versions are available for operational use;
 - (iii) availability at locations where needed by the provider's personnel;
 - (iv) a master copy of relevant documents and records is securely held;
 - (v) archival of documents and records where they have been superseded.

7.2.3 All documents that are related to and referenced in the Operations Manual are to be indexed in the Operations Manual.

Section 8 Records

8.1 Records system and procedures

8.1.1 An approved organization must establish a system for records which covers identification, collection, indexing, storage, security, maintenance, access and disposal of records necessary for the provision of ATEL or ANAV services.

8.1.2 The records system must provide an accurate chronicle of activities for the purpose of reconstruction of events for air safety investigation, and for system safety analysis. Records kept include:

- (a) records of design, manufacturing, procurement, installation, testing, commissioning, modification, and decommissioning;
- (b) records of the designated authorities for the design, operation and maintenance for each system;
- (c) records of hazard analysis and risk assessments;
- (d) records of facility performance and facility maintenance history including performance parameter values, test facilities utilised, identity of authorised technicians conducting operation and maintenance, changes to maintenance procedures;
- (e) records of facility failures and faults;
- (f) records of defect reports and associated defect investigations;
- (g) records of technician's competencies, including details of experience, qualifications, training, competency assessments, and facility authorisations.

8.2 Site logs

8.2.1 An approved provider must maintain a site log for all facilities used to provide an aeronautical telecommunication service or a radionavigation service.

8.2.2 The site log must record all occurrences and actions relating to operation, maintenance, modification, failure, faults, and removal from and restoration to service.

8.2.3 Entries in site logs must include the date/time of the entry and the occurrence and must be signed by the technician or other person making the entry.

8.2.4 Site log records must be retained for at least five years.

Section 9 Security

9.1 Security program for aeronautical telecommunication and radio navigation facilities

9.1.1 An approved organization must establish an appropriate security program designed to minimise the risk of unauthorised access, entry by animals, or malicious damage to a service or facilities.

9.1.2 The security program must include the physical security measures, and the procedures to be followed, for:

- (a) preventing and detecting intentional or unintentional damage to any facility or equipment used for providing an aeronautical telecommunication or radionavigation service;
- (b) responding to a threat of intentional damage to a facility or equipment;
- (c) preventing unauthorised people from having access to any facility or equipment used by the provider in providing an aeronautical telecommunication or radionavigation service.

Section 10 Technical Requirements – Communications Systems**Sub-Section 10.1 Introduction**

10.1.1 This section contains the standards, rules, procedures and practices for the provision of Aeronautical Telecommunication (ATEL) services that are additional to, or expand upon, or specify additional conditions for, the standards, rules and procedures contained in ICAO Annex 10 (Volumes I-V), Annex 11, Annex 14 (Volumes I and II), PANS-ATM (Doc 4444) and related documents.

10.1.2 These standards, rules and procedures are applicable to all ATEL providers.

Sub-Section 10.2 Communications Systems – Voice and Data Recording**10.2.1 General**

10.2.1.1 This section sets out the operational requirements for communications systems – voice and data recording.

10.2.1.2 Recording equipment must provide a complete, identified, intelligible and accurate record of the communications to be recorded which may be used, in the event of an incident, in any investigation by the Aviation Investigation Bureau of the Kingdom of Saudi Arabia (AIB).

1. The recording equipment must comply with the Minimum Performance Specification described in the Sub-Section 10.3.

10.2.1.4 The recording equipment or system must employ voice coding techniques which ensure the replay quality of previously archived radio communication messages will achieve a minimum Mean Opinion Score (MOS) of 4.0 (Good).

10.2.1.5 The voice coding scheme must be able to cope with different types of voice, multiple voices, background noise without any significant deterioration in quality.

10.2.1.6 An ATEL service provider must coordinate with the GACA-S&AT to ensure that the recording equipment is compatible with the replay facilities and working practices in use and must present evidence to support this.

10.2.2 Time-Recording Devices

10.2.2.1 Voice/Data Recording equipment must include time-recording devices or techniques to ensure the 'time-stamping' of ATS communications.

10.2.2.2 ATS Unit Clocks and Time-Recording Devices must use Coordinated Universal Time (UTC) and must express the time in hours and minutes and seconds of the 24-hour day. Midnight must be designated as 2400 for the end of the day and 0000 for the beginning of the day.

10.2.2.3 ATS Unit Clocks and Time-Recording devices must be checked as necessary to ensure correct time to within plus and minus 15 seconds of UTC.

10.2.2.4 The clock or time-recording device in the recording equipment must be checked as necessary to ensure that the time-stamps are maintained within plus and minus 2 seconds of either the ATS Unit master clock source where this exists and another common reference source, or Global Positioning System signals.

10.2.2.5 Wherever Data Link Communications are in operation, clocks and time-recording devices must be accurate to within plus and minus 1 second of UTC.

10.2.3 Communications to be Recorded - Air-Ground Communications (Aeronautical Mobile Service)

10.2.3.1 Direct pilot-controller communications between aircraft stations and aeronautical stations, must be recorded.

10.2.3.2 The voice communications to be recorded must be derived from a receiver in the aeronautical station providing 'off-air' signals of the pilot and controller transmissions.

10.2.3.3 Where the voice communications to be recorded are routed via a Voice Communications System (VCS) or other air traffic service equipment to the recording equipment, the continuity of recording must be ensured in the event of a failure of either the VCCS or air traffic

service equipment.

10.2.3.4 Voice communications derived from appropriate points at the controller's operating position should be recorded.

10.2.4 Ground-Ground Communications (Aeronautical Fixed Service).

Communications within Jeddah Flight Information Region

10.2.4.1 Direct communications between ATS Units and between ATS Units and appropriate Military units must be recorded.

10.2.4.2 Direct communications, which are not already covered, may be recorded.

Communications between adjacent ATS units

10.2.4.3 Direct communications, between Area Control Centres serving contiguous control areas, must be recorded.

10.2.4.4 Direct communications, between adjacent Area Control Centres, must be recorded.

10.2.5 Surface Movement Control Service

10.2.5.1 Surface Movement Control Service Communications, used for the control of vehicles and personnel on the manoeuvring area, must be recorded.

10.2.6 Communications within an Air Traffic Control Unit.

10.2.6.1 Communications between operational positions at an Air Traffic Control unit must be recorded.

10.2.7 Recoding Equipment Installation

10.2.7.1 All recording equipment must be installed in accordance with manufacturer, supplier or agent instructions so as to ensure correct and reliable operation.

10.2.7.2 The archival media storage facilities must be constructed, maintained and operated in accordance with manufacturer, supplier or agent instructions so as to ensure the reliable retention of data and achievement of expected media lifetimes.

10.2.8 Equipment and Power Supply Configuration

10.2.8.1 The equipment and power supply configuration must be such as to ensure the availability of recording, without interruption, when ATS is being provided. Backup power supply from either a central battery system or individual UPS units must ensure the availability of power to the recording equipment and other essential equipment in the event of a mains power interruption.

10.2.8.2 The equipment configuration must take into account such factors as the hours of operation of the ATS Unit, provision for maintenance/repair, ability to replay recorded archival media while continuing to record, exchange of media.

***Note:** the provision of main and standby equipment will be necessary to achieve the required availability. The incorporation of suitable mains conditioning devices as part of the mains / backup power supply arrangements may be useful in preventing equipment malfunction due to surges, spikes and noise on the power supply.*

10.2.8.3 Where the equipment and power supply configuration is such that the availability of recording, without interruption, cannot be ensured while ATS is being provided, then either the provision of ATS ceases within a time period defined in the Local Instructions for the Air Traffic Control Unit or a written record must be kept. The traffic must be transferred to another ATS unit.

10.2.9 Alarm / Status Indications

10.2.9.1 The local and remote alarm / status indications of the recording equipment must be used as appropriate to alert Air Traffic Control and maintenance Staff to take the necessary actions to ensure the continued operation of the equipment.

10.2.9.2 The remote alarm / status indications must be 'latching' such that they require positive intervention to check that the recording equipment is operating correctly before any alarm can be cancelled.

10.2.10 Working Facilities

10.2.10.1 Working facilities must be provided to enable authorized personnel to operate the equipment and undertake other duties such as replay and copying, maintenance, repair and inspection.

10.2.11 Disposal of Recording Equipment

10.2.11.1 Before the disposal of any recording equipment, the AIB and GACA-S&AT must be consulted to determine whether there is a need to retain the equipment as a replay facility for any impounded recordings.

10.2.12 Operating and Maintenance Manual and Procedures

10.2.12.1 The operating and maintenance operations manual of the recording equipment must describe, for each telecommunication or radio navigation service provided:

- a. the kind and location of each facility;
- b. the technical specification of each kind of facility;
- c. how each facility interconnects with any other facility or service; and
- d. the way in which the aeronautical telecommunication service provider monitors each facility to ensure that it is operating in accordance with its technical specification.

10.2.12.2 Procedures for the operation and maintenance of the recording equipment must be produced and incorporated into the operations and maintenance instructions associated with each ATC unit.

10.2.12.3 Details of the operation and maintenance of the recording equipment, the management of the archival media, and visits by authorized persons must be recorded in a logbook and preserved for a period of one year.

10.2.12.4 A daily check must be made of the serviceability and recording function of the recording equipment without interrupting the recording of any active communications and including intermediate and archival media storage devices. The results of these checks must be recorded in the logbook.

10.2.12.5 An ATEL service provider must take any one or more of the following precautions during a test transmission:

- (a) a reasonable time before commencing the transmission, the AIS provider must be informed about the transmission. The AIS provider must issue a NOTAM on the test transmission;

- (b) at the commencement of the transmission, the aeronautical telecommunication service provider identifies the transmission as a test transmission;
- (c) the transmission contains information identifying it as a test transmission.

10.2.12.6 Each aeronautical telecommunication service facility or facilities must be tested and maintained using test equipment that is maintained and calibrated in accordance with this part.

10.2.12.7 A regular check must be made of the time and date function of the recording equipment, at intervals appropriate to the accuracy of the ATS unit Clock or Time- Recording Device used as the source. The results of these checks must be recorded in the logbook.

10.2.13 Management of Archival Media Identification

10.2.13.1 Archival media must each have a unique identity, which must be used in entries made in the logbook, and must be shown by the use of an indelible written or printed label firmly attached to the media.

10.2.14 Storage Capacity

10.2.14.1 The use of the maximum storage capacity available on the archival media, where this equals or exceeds 60 days, must only be used where the reliability of the recording equipment and the archival media has been demonstrated and the risk of losing data due to the failure of the recording equipment, archival drive or media itself has been minimized.

10.2.14.2 The archival media should be changed on a daily basis, at appropriate times related to the provision of the ATS Service, or corresponding to ATC and maintenance staff duty changes.

10.2.15 Lifetime of Archival Media

10.2.15.1 The archival media must be replaced before any deterioration results in the loss of recorded data.

10.2.16 Retention of Recordings

10.2.16.1 Recordings on archival media must be retained for a minimum period of 60 days from the date of the last recorded message.

10.2.17 Impounding of Recordings

10.2.17.1 On receiving a detailed request concerning recorded transmissions from either the AIB or GACA-S&AT, normally within the 60 day retention period, archival media containing the specific recorded transmissions must be removed from normal storage or taken out of use and placed in a separate and secure storage area pending further instructions.

10.2.18 Access to Recording Equipment

10.2.18.1 Access to the Recording Equipment must be permitted to authorized persons from the AIB or GACA-S&AT for the purposes of replaying and making copies of original recordings.

10.2.19 Prevention of Inadvertent Loss of Recorded Communications

10.2.19.1 The inadvertent loss of recorded communications, while operating the recording equipment, must be prevented by means of procedures in conjunction with equipment security

functions where available.

Sub-section 10.3 Minimum Performance Specifications for Voice and Data Link Recording Equipment

10.3.1 General

10.3.1.1 This section sets out the minimum performance specifications for analogue and digital recording equipment used at Air Traffic Control units for the recording of voice and data link communications.

10.3.2 Equipment Configuration

10.3.2.1 The equipment must be designed with appropriate options to ensure the uninterrupted availability of communications recording. The appropriate options might include the duplication of critical internal units such as electronic modules, power supply units, intermediate and archival storage media drives and the ability to interconnect main and standby recording equipment.

10.3.2.2 Where an option to interconnect main and standby equipment is available, an automatic changeover function must be provided, which operates the main and standby equipment in parallel to ensure continuity of recordings, for an adjustable time period with a recommended minimum of 10 minutes.

10.3.3 Alarm / Status Indications

10.3.3.1 The equipment must provide appropriate local and remote alarm / status indications including an output to indicate the overall operational status of the equipment.

10.3.3.2 The remote alarm / status indications must not be affected by any loss and/or subsequent restoration of electrical power to the equipment. Urgent and non-urgent alarms may be used to distinguish between problems which require immediate attention, such as failure of the recording equipment, and those which do not, such as an impending recording archival media change.

10.3.4 Time and Date Information

10.3.4.1 The equipment must automatically record time (hours/minutes/seconds) and date (day/month/year) information.

10.3.4.2 Coordinated Universal Time (UTC) in hours, minutes and seconds of the 24-hour day beginning at midnight must be used.

10.3.4.3 The time must have an accuracy such that it can be maintained within plus and minus 15 seconds (UTC), except when data link communications are utilized, when the accuracy must be plus and minus 1 second (UTC), within a reasonable period of time and at least for the duration of recording time on a single archival storage media.

10.3.4.4 The time must have a resolution of 1 second.

10.3.4.5 Where an external source is used to derive time and date information the equipment must incorporate an internal source to be used in the event of failure of the external source or temporary loss of signal from radio time code receivers.

10.3.5 Line Interface

10.3.5.1 Line interfaces must be provided which are compatible with telephone connections made via the Public Switched Telephone Network or private lines.

10.3.5.2 Line interfaces must be provided which are compatible with radio connections made via the Public Switched Telephone Network or private lines to transmitter, receiver and associated control equipment at 2 Wire or 4 Wire level.

10.3.5.3 Optional modules to provide telephone connection Off-Hook and Ring Detect signals for the contact activation circuits may be incorporated into the line interfaces.

10.3.6 Recording Initiation

Voice Activation

10.3.6.1 Voice Activation or Voice Operated Switch (VOX) can be used to initiate recording of telephone signals or other ground-ground communications.

10.3.6.2 The sensitivity of the voice activation circuit must be adjustable.

10.3.6.3 An adjustable time delay must be provided after the voice activation circuit releases before recording stops.

10.3.6.4 An adjustable minimum time period must be provided for the voice activation to prevent spurious responses to noise pulses.

Compliance Note:- Due to the inherent delay with the voice activation circuit responding to initial syllables of speech and delays due to the mechanical inertia in the magnetic tape transport system of analogue equipment, it is possible that initial syllables of speech may not be recorded. The use of a circuit to buffer the signals to be recorded may be used to reduce this effect. The setting of the voice activation sensitivity is more critical for varying input levels, such as radio signals, which may result in communications not being recorded. Voice activation is not generally acceptable for radio signals due to these possible effects.

Contact Activation

10.3.6.5 Contact activation derived from on / off hook, ring detect or other signaling conditions, may be used to initiate recording of telephone signals or other ground-ground communications.

10.3.6.6 Contact activation derived from transmitter push-to-talk (PTT) and receiver squelch or mute lift conditions must be used to initiate recording of radio signals.

10.3.7 Analogue Signal Conditioning

10.3.7.1 Options for adjusting or disabling Automatic Gain Control (AGC) for individual inputs should be provided where it is used to compensate for variations in line interface levels.

10.3.7.2 Compression and Expansion techniques may be used to match the dynamic range of the line interface levels to that of the recording equipment.

10.3.8 Human Machine Interface

Audio Output

10.3.8.1 A front panel loudspeaker, volume control and on/off switch must be provided on the equipment or on a separate remote control panel if this option is provided.

10.3.8.2 A front panel standard headphone jacks and volume control must be provided on the equipment or on a separate remote control panel if this option is provided.

Copy Output

10.3.8.3 A front panel or easily accessible output connector for making copy recordings must be provided, which may have a preset output adjustment.

10.3.8.4 The output must comprise one audio channel, which must be the selected recorded channel, and another audio channel which must have either a voice synthesized (spoken) time output or tone coded time markers from, or derived from, the time and date information of the original recording.

Security of Recordings

10.3.8.5 Techniques must be used to reduce the possibility of inadvertent erasure of recorded information. The use of software controlled password, electronic or mechanical key switch access or other measures may be appropriate.

10.3.8.6 Where the use of such devices is not feasible, for example with analogue reel to reel magnetic tape recording equipment, then the disabling of the recording/erase mechanism may be necessary, which would then require the provision of a separate bulk erase machine.

10.3.8.7 The use of a single action to record without verification or protection should be avoided.

10.3.9 Archival Media

10.3.9.1 The equipment must utilize removable archival media for the recording of communications.

10.3.9.2 Guidance on the handling and storage of media must be provided, as appropriate, with the equipment documentation.

10.3.10 Replay Functions

10.3.10.1 The equipment must be capable of replaying the original recorded communications on archival media in a continuous 'real time' mode and presenting the time and date information separately from but synchronized with the recorded communication.

***Note:** The capability to replay in a continuous 'real time' mode means that the messages can be replayed continuously without interruption or any operations manual intervention, with any periods of silence or absence of recorded messages re-inserted.*

10.3.11 Analogue Equipment

10.3.11.1 Analogue recording equipment is classified as that which records analogue signals in real time directly onto the archival media. Typically magnetic tape reel to reel or cassette transport systems utilizing electronic, electrical and mechanical devices are used.

Recording Check

10.3.11.2 Devices and/or techniques must be incorporated to provide a check for successful recording onto archival media.

Note: Magnetic tape transport systems can employ off tape monitoring to establish that successful recording has taken place.

Recording Quality

- 10.3.11.3 When compared with a reference of -10dBm at 1,200 Hz, the amplitude variation from 300 Hz to 3,400 Hz must not exceed $\pm 3\text{dB}$.
- 10.3.11.4 Signal to noise ratio must be better than 40 dBA (38dB) when the reference signal is replayed.
- 10.3.11.5 Harmonic distortion of the reference signal, replayed at 0dBm, must not exceed 2.5%.
- 10.3.11.6 Crosstalk from adjacent channels must not exceed 40 dB.
- 10.3.11.7 Wow and Flutter must not exceed 1%.

10.3.12 Digital Equipment

Digital equipment

10.3.12.1 Digital recording equipment is classified as that which records digital signals onto intermediate storage media and then regularly transfers the data onto the archival storage media. Magnetic / Optical media archival storage drives utilizing electronic, electrical and mechanical devices are used.

Analogue to Digital Conversion

- 10.3.12.2 The voice coding scheme must comply with the following:
- (a) The voice coding scheme must use coding techniques which provide a Mean Opinion Score (MOS) of 2 (Unreadable), 3 (readable), 4 (Good) or 5 (Excellent), also known as "high quality network speech" or "toll quality speech".
 - (b) The voice coding scheme must be able to cope with different types of voice, multiple voices, background noise without any significant deterioration in quality.
 - (c) The voice coding scheme should comply with published International standards where available.

Note: Voice coding schemes using waveform coding techniques include CCITT G.711 - A/ μ -law PCM, CCITT G.721 - ADPCM and CCITT G.728 - LD-CELP.

Data Compression

10.3.12.3 The amount of data compression applied at the analogue to digital conversion either as part of the voice coding scheme or as a separate process, should not significantly degrade the recorded communications.

Intermediate Storage

10.3.12.4 Where an intermediate storage device is used, the process by which the communications are transferred onto the archival media must be automatic (not requiring human intervention) and must be secure from attempts to select, alter or interfere in any way with the data.

Note: Digital recording equipment may utilize an intermediate storage device such as a hard disk drive (HDD), on which the communications are recorded in real time, before being transferred onto the archival media at regular intervals.

10.3.12.5 The information on the intermediate storage media must be transferred onto archival storage media via an appropriate drive mechanism at regular intervals.

10.3.12.6 The intermediate storage media equipment must use a safe shutdown mode, in the event of power failure or equipment malfunction, to ensure that intermediate storage data is not lost and that the communications can be replayed normally from the archival storage media.

Archival Media

10.3.12.7 The equipment must use a safe shutdown mode, in the event of power failure or equipment malfunction, to ensure that any necessary file management information can be written to the archival media, so that the communications can be replayed normally from the archival storage media.

10.3.12.8 Devices and/or techniques must be incorporated to provide a check for successful recording onto archival media.

Note: Read after write verification for the intermediate and archive storage media can be used.

Recording Quality

10.3.12.9 The recording quality must meet the requirements as for analogue equipment as appropriate.

Note: It is anticipated that a suitable measure of recording quality will be defined for digital recording equipment but in the absence of this the quality must be comparable with that of analogue equipment.

Sub-section 10.4 VHF Aeronautical Radio Stations**10.4.1 General**

10.4.1.1 This section sets out the requirements applicable to fixed, stationary, vehicle, portable and hand held equipment categories comprising transmitter, receiver and transceiver equipment types operating in the VHF Aeronautical Mobile (R) Service allocation 118 MHz to 136.975 MHz, using Double Sideband (DSB) Amplitude Modulation (AM) full carrier with 8.33 kHz or 25kHz channel spacing, intended for analogue voice and data link communications.

10.4.1.2 The equipment and systems at Aeronautical Radio Stations must provide complete, identified, accurate and uncorrupted voice and data link communications for Air Traffic Services

10.4.1.3 The equipment, systems, services and facilities must comply with the applicable:

- (a) requirements of this Part and its appendices;
- (b) standards prescribed in Annex 10, Volume III, Part II, Chapter 2 to the Convention on International Civil Aviation, and
- (c) radio regulations of the International Telecommunications Union.

10.4.2 Radio Spectrum Management

10.4.2.1 The equipment and systems must be designed and constructed to operate within the Aeronautical Mobile (R) Service allocation 117.975 MHz to 137.000 MHz. The first and last assignable frequencies being 118.000 MHz and 136.975 MHz.

10.4.2.2 For radiotelephony channel spacing is either 25 kHz or 8.33 kHz using Double Sideband (DSB) Amplitude Modulation (AM) full carrier with ITU emission designator 6K80A3EJN for 25 kHz and 5K00A3EJN for 8.33 kHz channel spacing.

10.4.2.3 For data link communications channel spacing is 25 kHz using Double Sideband (DSB) Amplitude Modulation (AM) full carrier with ITU emission designators 13K0A2DAN for ACARS using MSK modulation, 14K0G1D for VDL Mode 2 using D8PSK modulation and 13K0F7D for VDL Mode 4 using GFSK modulation.

10.4.2.4 The equipment and systems must be installed, operated and maintained in compliance with the terms of specific location dependent or general frequency assignment(s) and any additional terms and conditions established by the President.

10.4.2.5 The designated operational coverage (DOC) associated with the frequency assignments must be published to enable aviation users to restrict the use of Air to Ground Communications to the designated airspace.

10.4.2.6 The effective radiated power must be such to provide minimum field strength of 45 dB μ V/m within the radio service area for Air Traffic Services, or such a minimum field strength or minimum effective radiated power.

10.4.3 Aeronautical Radio License

10.4.3.1 All Aeronautical Radio Stations must be suitably licensed under the Saudi Communication and Information Technology Commission prior to any transmissions being made.

10.4.4 Maintenance of Aeronautical Radio Stations

10.4.4.1 Maintenance arrangements must be established for equipment and systems at

Aeronautical Radio Stations associated with the provision of Air Traffic Control Services.

10.4.4.2 Maintenance procedures must be established for equipment and systems at Aeronautical Radio Stations associated with the provision of Flight Information Service (FIS) and Air-Ground Communication Service (AGCS).

10.4.4.3 Appropriate actions must be taken to ensure the continued compliance with the Aeronautical Radio License and other applicable standards or requirements.

10.4.4.4 Regular functional and performance checks, including measurements to verify transmitter frequency, modulation depth, output power and a determination of effective radiated power using calibrated measurement equipment, should be undertaken.

10.4.4.5 A record of any functional test, flight checks and particulars of any maintenance, repair, overhaul, replacement or modification must be kept in respect of the equipment and systems at Aeronautical Radio Stations, as required and the records must be preserved for a period of one year or longer as directed by the President.

10.4.5 Specific Requirements Communications Availability

10.4.5.1 The design, installation, operation and maintenance of equipment and systems must be such as to ensure an availability of communications appropriate for the Air Traffic Services being provided.

10.4.6 Radio System Design

10.4.6.1 Communications of a specified quality of service must be provided within the radio service area appropriate to the services being provided. The maximum field strength outside the Designated Operational Coverage (DOC), as specified in the frequency assignment, must not be exceeded.

10.4.6.2 Where co-channel and adjacent channel interference are the limiting factors, signal quality is directly related to the desired-to-undesired (D/U) signal ratio criteria used in the frequency assignment planning process, the results of which give a minimum field strength within the DOC which should be achieved and a maximum field strength outside the DOC which must not be exceeded.

***Note:** The signal quality at the receiver can be affected by local noise and interference effects such as man-made noise and precipitation static.*

10.4.6.3 The Radio Service Area should be published to provide aviation users with information on the anticipated service volume within which reliable communications may be expected. The antennas must be installed such as to provide vertically polarized radiation.

10.4.7 Equipment Configuration

10.4.7.1 The equipment configuration must be such as to ensure the availability of communications appropriate to the service being provided.

10.4.7.2 The configuration of equipment includes associated antennas, cables, filters, commutation units and other equipment necessary for the operation of the equipment and systems.

***Note :** Equipment provided in addition to the above would be considered to be Contingency Equipment.*

10.4.7.3 The equipment type must be appropriate for the service being provided and be compatible with the equipment configuration.

10.4.7.4 For Flight Information Services, a transceiver or separate transmitter and receiver are considered suitable as main equipment, with a hand held or portable transceiver being used for emergency equipment.

10.4.8 Duty Cycle - Radio Transmitters / Power Supply Units

10.4.8.1 The duty cycle for Radio Transmitters and associated Power Supply Units must be appropriate for the service being provided.

10.4.9 Power Supply

10.4.9.1 For an Air Traffic Control Service, the power supply for the emergency equipment must be independent of that for the main equipment.

10.4.9.2 Users must be provided with an indication of failure of the power supply to the emergency equipment and instructions must be provided in Part 2 of the ATS procedures manual required under GACAR Section 11 for user actions in the event of failure.

10.4.9.3 For an Air Traffic Control service a primary and alternative power supply must be provided to increase the availability of power to equipment and systems in the event of an interruption to one of the power supplies.

10.4.9.4 Change over between power supplies should be on a 'no break' basis.

10.4.9.5 The primary and alternative supplies should be independent of each other for a known period of time.

10.4.9.6 An indication of failure for each power supply should be provided to the user and corrective action taken in the event of failure.

10.4.10 Alarm / Status Indications

10.4.10.1 For an Air Traffic Control Service, the system must provide an indication of system failure that may have an effect on the service being provided, in a timely manner, so that actions can be taken to ensure the safe continued provision of an ATC service or if necessary the controlled withdrawal of the service.

10.4.10.2 The significance to the user of the indication of failure must be obvious from the indication given.

10.4.10.3 The failure indication must remain obvious to the user while the condition causing the failure indication remains.

10.4.11 Interface to Voice / Data Recording Equipment

10.4.11.1 The system at Aeronautical Radio Stations must provide all the necessary signals and information to the Voice / Data Recording Equipment in compliance with the provision of sub-section 10.2.

10.4.11.2 If a separate receiver is used to record aircraft station transmissions, the antenna and receiver combination must provide a signal comparable in strength and reception area to that of the main antenna and transceiver.

10.4.12 Provision of Off-Air Sidetone

10.4.12.1 Where off-air sidetone is provided for Air Traffic Services, it must be a replica of the transmitted voice communications without any degradation of quality such as to cause annoyance or disturbance to the operator.

10.4.13 Provision of Emergency Frequency 121.500 MHz

10.4.13.1 The emergency frequency 121.500 MHz must be provided at area control centers and flight information centers, and at aerodrome control towers and approach control offices serving international aerodromes and international alternative aerodromes.

10.4.14 Unintentional or Continuous Transmissions

10.4.14.1 The equipment and systems at Aeronautical Radio Stations must not fail in a manner such as to cause unintentional or continuous transmissions.

10.4.14.2 New equipment and systems at Aeronautical Radio Stations must incorporate features to prevent unintentional or continuous transmissions, unless this is contrary to the intended purpose for which they have been designed.

10.4.14.3 For existing equipment and systems, consideration should be given to incorporating such devices by retrofit, modification or add-on circuitry where appropriate.

Sub-Section 10.5 Voice Communications Systems (VCS)**10.5.1 General**

10.5.1.1 This section sets out the engineering requirements for VCS communications facilities established or used at locations within the Kingdom of Saudi Arabia providing Air Traffic Services.

10.5.1.2 The VCS must enable direct, rapid, continuous and intelligible two-way voice communications for Air Traffic Services.

10.5.1.3 The equipment, systems, services and facilities must comply with the applicable international standards and procedures for air navigation services.

10.5.2 Communications Facilities

10.5.2.1 The operator must have clear visual and audible indication of the status of all available lines of communication.

10.5.2.2 The operator must have the ability to select or deselect independently lines of communication or facilities in any combination, without affecting the operation of other lines of communication or facilities available at that or any other position.

10.5.2.3 Where the system configuration can be changed, a means of quickly restoring the last set option configuration before any failure must be provided.

10.5.2.4 Headsets must be provided except at units with very low density operations where loudspeaker and free-standing microphone (i.e. no headset capability) may be used.

10.5.2.5 Loudspeaker and headset earphone volume must be audible at the operating position when set to their minimum level.

Compliance Note: The air-ground communications may be switchable between headset and loudspeaker as traffic conditions dictate.

10.5.2.6 Split headset mode shall mean the following:

- (a) RTF Communications only – Transmissions heard in both earpieces.
- (b) RTF Communications and Ground-Ground Communications – RTF transmissions heard in one earpiece and Ground-Ground Communications heard in the other earpiece.
- (c) When the operator makes an RTF Communications transmission sidetone is heard in both earpieces.

10.5.2.7 Handsets, desk or hand microphone may be used in combination with the desk loudspeaker where the ambient noise or traffic levels permit such operations.

10.5.2.8 Operating positions must have a loudspeaker which will allow selected lines of communication to be monitored.

10.5.2.9 Operating positions must have provision for the connection of a number of headsets enabling instructor/student, dual operator and supervisor monitoring facilities.

10.5.2.10 The instructor/trainee facility, where provided, must enable direct communications via headsets.

10.5.2.11 The instructor/trainee facility, where provided, must enable the instructor to interrupt any trainee communications at any time.

10.5.2.12 The instructor/student interrupt may be achieved by use of a dedicated instructor

Press-To-Talk (PTT) control incorporating separate switches for RTF Communications and Ground-Ground Communications.

10.5.2.13 Operating positions must have provision for at least two momentary action PTT controls, one of which must permit 'hands-free' operation. The controls must be used to control RTF communications transmissions.

Compliance Note: Typical PTT controls may be panel mounted switches, headset in-line switches, foot switches, switches incorporated into desk or handheld microphones and handsets.

10.5.2.14 The audio level of each audio outlet must be independently adjustable and any communications must still remain audible and intelligible to the operator when the minimum level is selected.

10.5.2.15 Separate controls for the audio level of RTF Communications and Ground-Ground Communications must be provided with the setting in use being apparent to the operator.

10.5.2.16 All lines of communication must incorporate an automatic gain control function in order to maintain adequate speech signal levels.

10.5.2.17 Where an automatic gain control function is used, only one device or function must operate on any signal path.

10.5.2.18 Where such devices or functions are incorporated, a signal gain path memory or similar feature can be used to prevent distortion of the initial syllables of speech at the beginning of a transmission or after pauses in speech. The principle of operation being that the last dynamic gain/attenuation setting is stored and used for subsequent transmissions.

10.5.2.19 The design and implementation of the voice switch must be such that any input can be connected to any output without the possibility of blocking occurring.

10.5.3 RTF Communications

10.5.3.1 Communications on appropriate frequencies must be provided.

10.5.3.2 Two-way radiotelephony communication facilities must be provided for aerodrome (surface movement) control service for the purpose of controlling vehicles on the maneuvering area, except where communication by a system of visual signals is deemed to be adequate.

Compliance Note: This communication facility is normally provided by UHF radio equipment and systems but the use of VHF Aeronautical Mobile Service frequencies may be permitted for ground to ground communications in specific circumstances. (Currently achieved via VHF and UHF channels)

10.5.3.3 Where conditions warrant, separate communication channels should be provided for the control of vehicles on the maneuvering area.

Compliance Note: Cross-coupling between the VHF air-ground communications used for the control of aircraft and the UHF two-way radiotelephony communications used for the control of vehicles provides situational awareness for the aircrew, controller and operator of the vehicle. The vehicle operator is aware of any aircraft transmissions by monitoring the cross-coupled VHF Air-Ground Communications and has direct two-way radiotelephony communications with the controller. In some cases the transmissions from vehicles are re-transmitted to aircraft. As separate transmit and receive frequencies are used at UHF between the base station and vehicles, talk through facilities may be used to enable vehicles to hear one another.

10.5.3.4 RTF communications which have been selected must always be available irrespective

of the state of other lines of communication.

10.5.3.5 The operator must be provided with a degree of assurance that Air-Ground Communications transmissions have been successful.

Compliance Note: The normally accepted method of implementing this is to provide off-air sidetone to the operator's headset derived from either the radio receiver associated with the transmitter for that radio channel, or from a separate receiver. It is recognized that the future widespread implementation of digital telecommunications systems may mean that off-air sidetone cannot be implemented in all situations, in which case alternative ways of indicating the successful transmissions may be used.

10.5.3.6 The operator must be provided with a degree of assurance that two-way radiotelephony communications for the control of vehicles on the maneuvering area transmissions have been successful.

Compliance Note: The normally accepted method of implementing this is to provide off-air sidetone to the operator's headset. Where UHF Radio Equipment and Systems are used, it may be necessary to provide a separate receiver in addition to the base station receiver, in order to derive the off-air sidetone signal for both directions of transmission.

10.5.3.7 The operator must be provided with the facility to select more than one air-ground communications frequency simultaneously.

10.5.3.8 When the PTT control is operated communications must be transmitted on all selected frequencies to aircraft.

10.5.3.9 When the PTT is released the operator must be provided with the combined audio signals from all selected frequencies.

10.5.3.10 When frequency coupling technique is used, only one transmission is passed to the controller.

Compliance Note: The operator will normally be provided with off-air sidetone derived from a combination of all the received audio signals from all selected frequencies. It is recognized that the operator is unlikely to be able to determine whether transmissions on each and every selected frequency have been successful; alternative ways of indicating the successful transmissions may be required. It is also acknowledged that the combination of the received audio signals may result in distortion of the overall off-air sidetone. Particular attention may be required in the design and implementation.

10.5.3.11 When two or more ATS frequencies are being used by a controller, consideration must be given to providing facilities to allow ATS and aircraft transmissions on any of the frequencies to be simultaneously retransmitted on the other frequencies in use thus permitting aircraft stations within range to hear all transmissions to and from the controller.

10.5.3.12 The operator must be provided with the facility to select the state of any available radio channel and an appropriate visual/aural indication must be given to indicate the selection made.

Compliance Note: Typical states normally found:

- a. channel off (not if configured to any position);
- b. channel receive only;
- c. channel transmit and receive;
- d. selection of duplicated transmitters and/or receivers; and
- e. selection of Cross-coupling.

10.5.3.13 The operator must be provided with a visual/aural indication of the status of available radio channels.

Compliance Note: Typical status reports normally found:

- (1) Aircraft or vehicle call/receiver mute lift; and
- (2) PTT operation.

10.5.3.14 The delay between operating the PTT control and the appropriate electrical or electronic signal being present at the interface with the VCS must be as low as practical.

Compliance Note: A delay of 20ms or less should be achievable.

10.5.3.15 The delay between receiving the appropriate electrical or electronic signal at the interface with the VCS and the activation of any electrical or electronic device, visual or aural indication must be as low as practical.

Compliance Note: A delay of 20ms or less should be achievable.

10.5.3.16 When Air-Ground Communications transmissions to aircraft are in progress, Ground-Ground Communications also in progress at the same time must not be transmitted to the aircraft. An indication must be given to the other party that Air-Ground Communications are in progress and this may be achieved by relaying the operators' speech. (The VCS automatically re-route signals to a selected position transducer)

10.5.3.17 The VCS must not fail in a manner such as to cause unintentional or continuous transmissions.

10.5.4 Ground-Ground Communications

10.5.4.1 The ATS provider must be consulted to ensure that the Aeronautical Fixed Services equipment is adequate for the task for which it is to be used. Among other things, consideration must be given to reliability, integrity, levels of redundancy, and hours of service, classification of airspace and complexity of traffic.

10.5.4.2 Ground-Ground Communications must be provided for the telecommunications services required by the air traffic control unit.

10.5.4.3 There must be provision for direct and immediate break-in (override call) interposition communications (intercom) between supervisors/operators at different positions which must be possible irrespective of the state of other lines of communication.

Compliance Note: In some cases it may be necessary to provide an indication of the receipt of an intercom call and to identify the operating position from which the call originated.

10.5.4.4 Intercom communications must not be transmitted on any RTF frequency or Ground-Ground Communications.

10.5.4.5 An adequate number of connection(s) to the public telephone system must be provided.

10.5.4.6 Other Aeronautical Fixed Services are to be provided as appropriate.

Compliance Note 1: They may include a means of communicating to positions within the unit or directly with adjacent Air Traffic Service units including the parent Area Control Centre.

Compliance Note 2: In certain circumstances an automated dialing system may satisfy the requirements.

10.5.4.7 Operating positions must have provision for connection to the Public Switched Telephone Network.

Compliance Note: Access to Telecommunications Network Operators is essential to the implementation of a Ground-Ground Communications network required for the operation of

an Air Traffic Control Unit. Access may be via the Public Switched Telephone Network or via private lines and networks.

10.5.4.8 Where mobile, cellular or personal communications networks are used to fulfill the requirement to access the Public Telecommunications Network, the availability under conditions of congestion must be considered and a priority access facility arranged with the network operator.

Compliance Note: *The method of access to a Telecommunications Network Operator is not limited to landline connections and may be by means of optical fiber, microwave radio or by mobile cellular or personal communications networks.*

10.5.5 Interface to Voice / Data Recording Equipment

10.5.5.1 The VCS must provide all the necessary signals and information to the Voice/Data Recording Equipment in compliance with the provision of sub-section 10.3.

10.5.6 System Performance

10.5.6.1 The clarity and volume of communications must be 'readable' or 'perfectly readable'.

10.5.7 Voice Transmission Quality – Radio Transmissions

10.5.7.1 The voice transmission quality of those communications facilities that utilize radio transmissions, the Aeronautical Mobile Service and the Surface Movement Control Service, must meet or exceed a quality defined by the following:

- a. the frequency response must be such that the gain at any frequency between 300Hz and 3.4 kHz must be within ± 3 dB of the gain at 1kHz;
- b. the Total Harmonic Distortion (THD) must not exceed 2% at any frequency between 300Hz and 3.4kHz with any gain controls adjusted to give the maximum permitted audio level at the headset or handset; and
- c. residual noise and hum on any correctly terminated idle voice circuit must not exceed -60dBm.

10.5.7.2 The minimum voice channel audio frequency bandwidth for Air-Ground Communications using VHF Aeronautical Mobile radio frequencies has been determined as 400 Hz to 2.7 kHz for 25 kHz channel spacing.

10.5.7.3 The voice transmission quality requirements apply to the voice channel only and do not include microphone and headset characteristics.

10.5.8 Voice Transmission Quality – Non-Radio Transmissions

10.5.8.1 The voice transmission quality of non-radio transmissions must meet or exceed those requirements as may be defined in standards for systems which are connected to the Public Switched Telephone Network.

10.5.8.2 In the absence of any such standards referred to in (a), the following must be met:

- a. The frequency response must be such that the gain at any frequency between 300Hz and 3.4 kHz must be within ± 3 dB of the gain at 1kHz;
- b. The Total Harmonic Distortion (THD) must not exceed 2% at any frequency between 300Hz and 3.4kHz with any gain controls adjusted to give the maximum permitted audio level at the headset or handset;
- c. The Crosstalk level on any voice circuit must not exceed -60dBm when a 1kHz tone is injected into any other circuit at a level of 10dB above nominal test tone level, with all voice circuits correctly terminated; and

- d. Residual noise and hum on any correctly terminated idle voice circuit must not exceed - 60dBm.

10.5.8.3 The voice transmission quality requirements apply to the voice channel only and do not include microphone and headset characteristics.

10.5.9 Maintenance of Voice Communications Systems

10.5.9.1 Maintenance arrangements must be established for Voice Communications equipment and systems associated with the provision of Air Traffic Control Services.

10.5.9.2 Maintenance procedures must be established for Voice Communications equipment and systems associated with the provision of Flight Information Service (FIS).

10.5.9.3 Regular functional and performance checks, including measurements to verify Voice, output power and a determination of effective dBm for incoming and outgoing voice channels using calibrated measurement equipment, should be undertaken.

10.5.9.4 A record of any functional test, flight checks and particulars of any maintenance, repair, overhaul, system failures, replacement or modification (VCS map change) must be kept in respect of the Voice Communications equipment and systems, as required and the records (communication system log) must be preserved for a period of one year or longer as directed by the AIB or GACA-S&AT.

Sub-section 10.6 ATC Data Link

***Compliance Note:** Data link technology is intended to provide enhancements to the processes used within the provision of Air Traffic Services. In its most simplistic form, the radio communications between Air Traffic Control (ATC) and aircraft could be accomplished by digital data transmission using data link. However the provision of data link facilities may give rise to significant benefits in the following areas:*

- a. Capacity*
- b. Range*
- c. Reliability*
- d. Speed*
- e. Security*

10.6.1 General

10.6.1.1 The provisions of this section are applicable to the use of data link technologies and applications for 'low risk' ATM functions. - i.e., those which are not critical in terms of safety and/or time.

10.6.1.2 This provisions of this section are applicable to both Aeronautical Fixed Services and Aeronautical Radio Stations.

10.6.2 Use of Private Networks

10.6.2.1 The use of private networks for data link applications, such as those provided by ARINC and SITA is permitted.

10.6.2.2 To ensure that the level of safety of the ATM function is maintained or improved during installation, transition and operation of data link equipment, applications and procedures a comprehensive safety assessment of the data link application / system and its interfaces with existing ATC equipment, people and procedures must be performed.

10.6.2.3 Provided the safety assessment concludes that the data link system / application is at least tolerably safe, then the use of private data link networks, may be permitted for the following categories of communications messages:

- a. Meteorological Communications
- b. Flight Regularity Communications
- c. Aeronautical Information Service Messages
- d. Network/Systems Administration

10.6.2.4 Communications in categories assigned a higher priority than those listed above may be permitted if the aeronautical telecommunication service provider provides evidence, in addition to the safety assessment, proving that:

- a. the application is not time critical and
- b. procedures exist for ensuring that the failure of data link systems has no long term, short term, or immediate effect on the ability of the aircraft or ATS unit to complete the communication at an appropriate time.

Sub-section 10.7 Information and Alerting Systems**10.7.1 General**

10.7.1.1 This section sets out the safety requirements for information and alerting systems used at those locations within the Kingdom of Saudi Arabia providing Air Traffic Services.

10.7.2 Flight Data Display

10.7.2.1 Flight data displays (such as flight progress strip boards) must be provided.

10.7.2.2 Shared displays (for example where two radar controllers work side by side with the data display between them) may be used if authorized by the President.

10.7.3 Status Indicators

10.7.3.1 Any equipment or facility which has a direct effect on aircraft safety must have a display showing its status, if not readily apparent, visible to the controller.

***Compliance Note:** Examples of such equipment/facilities are runway arrester gear or barriers, taxiway closures, etc.*

10.7.4 Clocks

10.7.4.1 A clock which is easily visible from each control position must be provided.

10.7.4.2 The time standard must be UTC and must be shown in hours, minutes and seconds and is to be accurate to within ± 15 seconds per day.

10.7.5 Data Processing Systems (DPS)

10.7.5.1 Prior to implementation, each aeronautical telecommunication service provider must ensure that the ATS provider has proven that the system is adequate for its purpose by design or by procedural mitigation.

***Compliance Note:** If the system is not capable of demonstrating the required level of safety, for example because integrity or reliability is not as predicted, then it will be acceptable to include procedures in Part 2 of the ATS procedures manual of the ATS provider required under GACAR Section 11 in order to mitigate deficiencies to ensure that a failure (total or partial) is not hazardous. Included in these procedures will be details of alternative sources of safety-related information.*

10.7.6 Aeronautical Ground Lighting (AGL) Control and Monitoring Equipment

10.7.6.1 The AGL Control and Monitoring System must enable the selection of the required display of lights and provide an indication of the lights displayed to the aerodrome control position.

10.7.6.2 An indication, easily visible from the aerodrome control position(s), showing the actual serviceability status of AGL services (as opposed to the switch position), must be provided. The equipment must indicate when failure or abnormal operation of the AGL service selected for use falls below levels required by the aerodrome license.

10.7.6.3 The serviceability status information required to be passed to pilots must be readily established from the indications visible from the aerodrome control position(s).

Compliance Note: GACAR Section 14 Volume 1 (Ref. ICAO Annex 14 - Volume 1) describes the technical requirements for AGL control and monitoring equipment.

10.7.6.4 Software related aspects of an AGL Control Monitoring System at ATC units must comply with international standards related to Software Safety Assurance in ATS Equipment.

10.7.7 Landing Clearance Indicator (LCI)

10.7.7.1 When Surveillance Radar Approaches terminating at a distance of less than 2 NM from touchdown are conducted, a landing clearance indicator of approved design must be provided.

10.7.7.2 The LCI enables reliable, instantaneous, non-voice communication between the aerodrome controller and the radar controller carrying out the SRA. It usually takes the form of a panel of colored, lighted buttons at each control position.

10.7.7.3 At units where an LCI system is installed instructions on its use must be included by an ATS provider in Part 2 of their ATS procedures manual required under GACAR Section 11.

Compliance Note: Details on the interpretation of the various indications are important, particularly at aerodromes where flying training involving planned go-arounds takes place.

10.7.8 Surface Movement Radar (SMR)

10.7.8.1 Surface Movement Radar equipment must be approved by the President.

Compliance Note: The orientation of the picture in relation to the view from the tower will depend on the tasks carried out by the Controller.

10.7.8.2 At a unit where the controller has clearly defined and fairly narrow tasks to perform, the orientation must be such that the runway on the SMR is aligned with the view of the runway from the control position.

10.7.8.3 At units where the task is broader in nature, the large number of factors having an effect on the alignment of the SMR requires that each installation to be approved by the President.

10.7.9 Visual Signaling

10.7.9.1 A signal lamp with interchangeable colored lenses (white, red and green) and spare bulb must be provided and must be accessible to the controller.

10.7.9.2 The light from a signal lamp must be visible from all points of the maneuvering area sufficiently to enable control of aerodrome traffic.

Compliance Note: Shining the lamp through tinted glass or blinds can affect the perceived color of the signal.

10.7.10 Emergency Services Alerting

10.7.10.1 An audible method of alerting airfield emergency services must be provided as a primary means of emergency call out. A standby means of alerting airfield emergency services, independent of the primary method, must be identified.

10.7.10.2 A means of communicating with other emergency services must be provided.

10.7.10.3 Check-lists of actions to be carried out in the event of an emergency (one check-list

for each category of emergency) must be provided.

10.7.10.4 Checklists must be easily accessible to the controllers likely to use them.

Sub-section 10.8 Automatic Terminal Information Service (ATIS)

Compliance Note 1: *The purpose of an Automatic Terminal Information Service (ATIS) is to reduce Air Traffic Control (ATC) workload by the use of a means other than the controller's VHF air-ground communications frequency to convey current and routine meteorological and aerodrome information to aircraft. ATIS may be implemented by Voice-ATIS and data link (D-ATIS). An aerodrome Voice-ATIS may be provided by the ATS provider, using either a dedicated VHF transmitter or a CVOR/DVOR transmitter. A D-ATIS may be provided by the ATS provider, in conjunction with a data link communication, using a VDL ground station network or by satellite.*

Compliance Note 2: *In the KSA ATIS is provided as an additional Flight Information Service in association with an Air Traffic Control service authorized under GACAR Section 11.*

10.8.1 General

10.8.1.1 This section sets out the engineering requirements for Voice ATIS and Data Link ATIS (D-ATIS) used within the Kingdom of Saudi Arabia in support of an Air Traffic Control service.

10.8.1.2 For the purpose of this section, ATIS is only considered to include the collation of meteorological and aerodrome data, the preparation of messages and the transmission of the messages.

10.8.1.3 The Automatic Terminal Information Service (ATIS/D-ATIS) equipment and systems must provide complete, identified, accurate and uncorrupted voice/data communication of meteorological and other aeronautical information.

10.8.2 Interface to Voice/Data Recording Equipment

10.8.2.1 The equipment and systems used in the provision of a Voice-ATIS or D-ATIS must provide all the necessary signals and information to the Voice/Data Recording Equipment in compliance with the provision of sub-section 10.3.

10.8.2.2 Appropriate material relating to the operation of the ATIS must be developed and included in the ATS procedures manual required for ATS providers under GACAR Section 11.

10.8.3 Voice-ATIS and D-ATIS

10.8.3.1 The ATIS system must be capable of meeting the following operational requirements:

- (a) the ATIS message must relate to a single aerodrome;
- (b) the ATIS message must be updated immediately a significant change occurs;
- (c) the preparation and dissemination of the ATIS message must be the responsibility of the ATS provider authorized under GACAR Section 11; and
- (d) individual ATIS messages must be identified by a letter designator from the ICAO spelling alphabet assigned consecutively in alphabetical order.

10.8.3.2 Voice-ATIS must only be provided in association with an air traffic control service.

10.8.3.3 Voice-ATIS must be provided at aerodromes where there is an operational requirement to reduce ATC VHF air-ground communications workload.

Compliance Note: *The provision of a Voice-ATIS may be limited by the availability of discrete*

VHF frequencies which are in short supply.

- 10.8.3.4 Voice-ATIS broadcasts must comprise:
- one broadcast for arriving aircraft;
 - one broadcast for departing aircraft;
 - one broadcast for arriving and departing aircraft; or
 - two separate broadcasts for arriving and departing aircraft where the combined broadcast would be excessively long.
- 10.8.3.5 Voice-ATIS must be provided on a discrete VHF frequency whenever practicable.
- 10.8.3.6 When a discrete VHF frequency is not available, Voice-ATIS may be provided on the most appropriate terminal navigation aid.
- 10.8.3.7 Voice-ATIS broadcasts, when provided, must be continuous and repetitive.
- 10.8.3.8 Where D-ATIS is provided alongside the existing availability of Voice-ATIS, the content and format of the information must be identical.
- 10.8.3.9 Where D-ATIS is provided alongside the existing availability of Voice-ATIS, when the ATIS requires updating, the Voice-ATIS and D-ATIS must be updated simultaneously.
- 10.8.3.10 Where D-ATIS broadcast includes real time meteorological information, which is within the parameters of the significant change criteria reference of ICAO Annex 3, the content must be considered identical for the purpose of maintaining the same designator.

Compliance Note: *It is likely that interface arrangements will need to be established between the ATS provider, operating the aerodrome Voice-ATIS, and the D-ATIS data link provider to ensure compliance with the requirements of ATIS Voice.*

10.8.4 Collation of Meteorological and Aerodrome Data

- 10.8.4.1 The meteorological data used in the preparation of ATIS messages must be sourced from a MET services provider approved under GACAR Section 3.
- 10.8.4.2 The meteorological data must be extracted from the local meteorological routine (METAR) or special (SPECI) report.
- 10.8.4.3 Where rapidly changing meteorological conditions preclude the inclusion of a weather report, the ATIS message must contain information that the relevant weather information will be given on initial contact with the Air Traffic Control unit.
- 10.8.4.4 The ATS provider must ensure that the accuracy and integrity of the data used in the preparation of the ATIS message is maintained at a level appropriate to the operational requirements.

10.8.5 Preparation of Messages

- 10.8.5.1 Where the Voice-ATIS broadcast messages are not prepared by the aerodrome ATC unit, the organization responsible for this task must immediately make known the information contained in the current broadcast to the ATC unit.
- 10.8.5.2 Voice-ATIS broadcasts must be prepared in the English language.
- 10.8.5.3 The message contents must contain the elements of information as defined under GACAR Section 11 in the order prescribed.

10.8.6 Transmission of Messages Voice-ATISCVOR/DVOR Transmitter

10.8.6.1 The Designated Operational Coverage (DOC) and frequency assignment terms and conditions must be consistent with both the CVOR/DVOR and Voice-ATIS operational requirements.

***Compliance Note:** Radio coverage problems may be found if the CVOR/DVOR is not located on or near the aerodrome providing the Voice-ATIS.*

10.8.7 Broadcast of Auto METAR

10.8.7.1 Broadcast of Auto METAR, utilizing an Automatic Terminal Information Service (ATIS) frequency, must be in conformity with the requirements prescribed in GACAR Section 3 and may be approved for use only at aerodromes where an ATIS facility has been approved and when the ATC watch is closed.

10.8.7.2 The DOC of the ATIS frequency must be valid for the Auto METAR broadcast.

10.8.7.3 The weather report (METAR) must be prefixed with the word 'AUTO' and only the METAR information must be included in the broadcast.

Sub-section 10.9 UHF Radio Equipment and Systems**10.9.1 General**

10.9.1.1 This section sets out the engineering requirements for UHF radio equipment and systems at Base Stations and Land Mobile Stations established or used within the Kingdom of Saudi Arabia in support of Air Traffic Services Ground to Ground Communications at aerodromes.

10.9.1.2 The provisions of this section apply to the equipment categories of fixed (Base Station), vehicle, portable and hand held (Land Mobile Station) comprising equipment types of transmitter, receiver (Base Station) and transceiver (Land Mobile Station).

10.9.1.3 The provisions of this section apply to UHF radio equipment and systems operating on frequency assigned in the UHF Land Mobile Service allocation 450 MHz to 470 MHz, using Frequency Modulation (FM) with 12.5 kHz channel spacing, for analogue voice communications.

10.9.1.4 The UHF radio equipment and systems must provide complete, identified, accurate and uncorrupted voice communications for Air Traffic Services Ground to Ground Communications.

10.9.1.5 The equipment, systems, services and facilities must comply with the applicable international standards, recommended practices and procedures for air navigation services.

10.9.1.6 The equipment, systems, services and facilities must comply with the applicable Radio Regulations of the International Telecommunications Union.

10.9.1.7 Two-way radiotelephony communication facilities must be provided for aerodrome (surface movement) control service for the purpose of controlling vehicles on the maneuvering area, except where communication by a system of visual signals is deemed to be adequate.

10.9.2 Radio Spectrum Management

10.9.2.1 The equipment and systems must be designed and constructed to operate within the Land Mobile Service allocation 450 MHz to 470 MHz with a channel spacing of 12.5 kHz using Frequency Modulation (FM) with ITU emission designator 11K0F3EJN using semi-duplex operation.

***Compliance Note:** The Base Station equipment uses duplex operation and the Land Mobile Station equipment uses simplex operation.*

10.9.2.2 The equipment and systems must be installed, operated and maintained in compliance with the terms of specific location dependent or general frequency assignment(s) and the operational requirements of the Air Traffic Services Ground to Ground Communications being provided.

10.9.2.3 All new Aeronautical Radio Stations must have been assessed as fit for purpose of the provision of Air Traffic Services before a radio license can be issued.

10.9.2.4 UHF Radio Equipment and Systems must comply with the International Standards.

10.9.3 Communications Availability

10.9.3.1 The design, installation, operation and maintenance of equipment and systems must be such as to ensure an availability of communications appropriate for the Air Traffic Services being provided.

10.9.4 Radio System Design

10.9.4.1 Communications of a specified quality of service must be provided within the radio service area appropriate to the services being provided.

10.9.4.2 The antennas must be installed such as to provide vertically polarized emissions.

10.9.5 Equipment Configuration

10.9.5.1 The equipment configuration must be such as to ensure the availability of communications appropriate to the service being provided.

***Compliance Note:** The configuration of equipment includes associated antennas, cables, filters, commutation units and other equipment necessary for the operation of the equipment and systems.*

10.9.5.2 Main and standby equipment may be operated as 'System A' and 'System B' where either may be considered as main while in operational service and the other is considered as standby, awaiting selection in the event of failure of the main equipment or when the main equipment is taken out of service for maintenance.

10.9.6 Power Supply

10.9.6.1 For an Air Traffic Control service, the power supply for the emergency equipment must be independent of that for the main equipment.

10.9.6.2 Users must be provided with an indication of failure of the power supply to the emergency equipment. An ATS provider authorized under GACAR Section 11 must ensure that instructions are provided in Part 2 of their ATS procedures manual for user actions in the event of failure.

10.9.6.3 For an Air Traffic Control service a primary and alternative power supply must be provided to increase the availability of power to equipment and systems in the event of an interruption to one of the power supplies.

10.9.6.4 Change over between supplies should be on a 'no break' basis.

10.9.6.5 The primary and alternative supplies should be independent of each other for a known period of time.

10.9.7 Alarm / Status Indications

10.9.7.1 For an Air Traffic Control service, the system must provide an indication of system failure that may have an effect on the service being provided, in a timely manner, so that actions can be taken to ensure the safe continued provision of an ATC service or if necessary the controlled withdrawal of the service.

10.9.7.2 The significance to the user of the indication of failure must be obvious from the indication given.

10.9.8 Interface to Voice/Data Recording Equipment

10.9.8.1 The equipment and systems at the Base Station must provide all the necessary signals and information to the Voice /Data Recording Equipment in compliance with the provisions of sub-

section 10.3.

10.9.8.2 Automatic recording facilities must be provided on communications channels used for the control of vehicles on the maneuvering area.

10.9.9 Unintentional or Continuous Transmissions

10.9.9.1 The equipment and systems at Aeronautical Radio Stations must not fail in a manner such as to cause unintentional or continuous transmissions.

Section 11 Technical Requirements – Aeronautical Radio Navigation Systems**Sub-Section 11.1 Introduction**

11.1.1 This section contains the standards, rules, procedures and practices for the provision of Aeronautical Radionavigation (ANAV) services that are additional to, or expand upon, or specify additional conditions for, the standards, rules and procedures contained in ICAO Annex 10 (Volumes I-V), Annex 11, Annex 14 (Volumes I and II), PANS-ATM (Doc 4444) and related documents.

11.1.2 These standards, rules and procedures are applicable to all ANAV providers.

Sub-section 11.2 General Requirements for Instrument Landing Systems

Compliance Note: The Instrument Landing System (ILS) provides precision guidance signals to aircraft in the last stages of approach and landing (Localizer with frequency rang 108.00 to 112.00 MHz and Glide path with frequency rang 328.6 to 335.4 MHz. For this purpose the equipment needs a high level of integrity, accuracy and reliability. Other auxiliary equipment is used to support the main equipment. Instrument Landing Systems are classified as Category I, Category II or Category III, in ascending order of accuracy, integrity and reliability.

11.2.1 General

11.2.1.1 This section sets out the minimum requirements for all categories of Instrument Landing System (ILS) service.

11.2.1.2 The ILS equipment must provide a complete, identified, accurate and uncorrupted source of guidance information to aircraft, with levels of integrity and continuity of service which are consistent with the category of service provided.

11.2.1.3 In addition to the requirements prescribed in this section, ILS must comply with the Standards in ICAO Annex 10, Volume 1, Chapter 2 General Provisions for Radio Navigation Aids, and Chapter 3, Section 3.1 Specification for ILS except for the following exceptions:

- (i) reserved

11.2.1.4 Abbreviated requirements for putting an ILS with an established mean time between outages (MTBO) into service are prescribed in sub-section 11.3.

11.2.2 Serviceability Indicators

11.2.2.1 Each ATS provider authorized under GACAR Section 11 and directly responsible for ILS operations (e.g. Approach Controllers) must be provided with:

- a. visual indications showing the serviceability status of all elements of the ILS including power supplies; and
- b. an audible alarm indicating when the visual indications have changed state.

11.2.3 Failure of Status Communications

11.2.3.1 Failure of status communication between the ILS equipment and the remote status indicators must cause an immediate alarm at the remote indicators.

11.2.3.2 For Category II and Category III any systems failure of the status communication must not cause an immediate ILS close-down. For Category I systems, it is acceptable to consider status communication failure as part of the Continuity of Service assessment.

11.2.3.3 Following failure of the status communications, only aircraft on final ILS approach must be permitted to complete the approach. The ILS must then be withdrawn from service in accordance with a documented procedure.

11.2.3.4 If the ILS is configured to close-down the system after a delay following status communications failure, the delay must be long enough for the actions in (c) to be completed.

11.2.3.5 In the event of a status communication failure, a suitably trained technician may be stationed at the ILS building(s) with a suitable means of communication to ATC. The equipment should then operate in local control, supervised by the system monitors. The monitors must not be overridden or inhibited. ATC must be advised without delay of any change in status of the ILS.

11.2.3.6 A reciprocal ILS must not be put into service until the system with faulty status communications is positively disabled and cannot accidentally radiate.

11.2.4 Category and Status Unit

11.2.4.1 In addition to the normal remote control and other indications, Category III facilities, if any, must be fitted with a unit that accepts signals from the ILS equipment, its monitors and the runway direction switch, to automatically provide ATC with indications of the operational category of the ILS.

***Compliance Note:** The precise method of calculation used by the Category and Status Unit will depend on the ILS equipment from which it derives its inputs.*

11.2.4.2 The unit must have an integrity of the same order as that of the ILS.

11.2.4.3 Any change of calculated category must cause an audible alarm to ATC.

11.2.4.4 The unit must have provision to limit the maximum category output to the display.

11.2.4.5 If an ILS fault causes the calculated category to fall, when the fault is cleared, the category must remain at the lower value until upgraded operations manually by an authorized person using a reset button or similar.

11.2.4.6 The unit must only automatically upgrade the category at initial ILS equipment switch-on or runway change.

11.2.5 Interlocking

11.2.5.1 Where systems are installed at opposite ends of the same runway they must be interlocked so that only one system may radiate at one time.

11.2.5.2 The interlocking system must be such that the non-operational system cannot be switched on using either the remote or local control switches.

11.2.5.3 The interlocking system must fail-safe. If the communication link between the systems fails, it must not be possible to make the non-operational system radiate using the local or remote front panel controls.

11.2.5.4 The interlocking must be considered as part of the integrity and continuity of service assessment.

11.2.6 Provision of Standby Equipment

11.2.6.1 Category III systems must have dual equipment so that the system is 'fail operational', regardless of proven MTBO. The non-operational transmitter must radiate into a dummy load and its critical parameters must be monitored.

11.2.6.2 Other categories must have standby equipment with automatic changeover.

11.2.7 Standby Battery Power

11.2.7.1 Category II and III systems, including the remote control equipment, interlock and status displays must be provided with a standby battery power supply. In the event of a mains power failure, this must be capable of sustaining the normal ILS operation for a minimum of 20 minutes.

11.2.7.2 Category I facilities must have standby batteries.

11.2.7.3 Each ATS provider must have a procedure for managing the withdrawal and return of the ILS from/to operational service when standby batteries are or have been in use. Consideration must be given to the designed battery capacity and the fact that discharged batteries may take a significant time to recharge to full capacity following a failure.

11.2.8 Localizer Back Beam

11.2.8.1 Facilities designed to radiate a back beam are not permitted.

11.2.9 Offset Localizers

11.2.9.1 An offset localizer may be installed as required; such an installation must be a Category I facility.

11.2.10 Field Measurements

Localizer Alignment

- 11.2.10.1 The following requirements for Localizer Alignment must be met:
- For CAT I, II and III, if any, systems, alignment measurements at threshold must be taken as soon as possible after commissioning and flight inspections.
 - For CAT I, II and III, if any, systems alignment measurements at threshold must be made at monthly intervals.
 - For CAT III systems, if any, which provide roll out or take off guidance, measurements of bends along the runway to ILS point E must be made at commissioning and at 6 monthly intervals. The commissioning and one check per year should be conducted with an appropriate antenna height consistent with that of an aircraft antenna e.g. 3 to 8 m above the runway. The second check may be made at 15 m above the runway.

Localizer Displacement Sensitivity

- 11.2.10.2 The following requirements for Localizer Displacement Sensitivity must be met:
- Displacement Sensitivity measurements must be made:
 - No closer than half the runway length from the localizer.
 - Between the half and the full sector width points, providing that a proportional relationship is established between that point and the full sector width.
 - For CAT I Localizers using 14 or less radiating elements, field measurements may be made approximately 300 meters in front of the local transmitting aerial.
 - Displacement Sensitivity measurements must be taken as soon as possible after commissioning, and flight inspections.
 - Displacement Sensitivity measurements must be taken at monthly intervals.

Ground Measurements of Displacement Sensitivity instead of Flight Inspection

- 11.2.10.3 The following requirements for Ground Measurements of Displacement Sensitivity instead of Flight Inspection shall apply:
- It is permissible to make routine ground measurement of Displacement Sensitivity instead of Flight Inspection.
 - At commissioning, the displacement sensitivity must be measured by flight inspection. If the ground and air measurements differ by more than 5% the disagreement must be investigated by the aeronautical telecommunication service provider.
 - The flight inspection must still include semi-orbits from which linearity in the course sectors can be examined.
 - When the aeronautical telecommunication service provider wishes to use the ground measurements as standard, it must consider the following information:

- i. Position of the ground measurement points; and
 - ii. Details of the equipment to be used for this measurement.
- (e) The localizer displacement sensitivity must be measured at a time as near as possible to that of the flight inspection. The result of the measurement is needed by the flight inspection service provider as part of the structure measurement calculations.
 - (f) The measurements may be made either in DDM or μA deflection current at the measurement points. For standardization these results must be converted into localizer full sector width, i.e. the theoretical angle between the points at which 0.155 DDM would occur.
 - (g) Each ILS maintenance instructions prepared by the aeronautical telecommunication service provider must show the method of calculating the width angle from the ground measurements.
 - (h) The normal tolerances used for flight inspection must apply.

Localizer Off-Course Clearance

- 11.2.10.4 The following requirement for Localizer Off-Course Clearance shall apply:
- (a) Off course clearance is measured by flight inspection and as such there is not a requirement to measure off course clearance on the ground. Operators may wish to establish a test point in the far field to assist in checking the localizer performance before requesting a flight inspection after engineering work.

Field Test Equipment

- 11.2.10.5 The following requirement for Field Test Equipment shall apply:
- (a) In the event of an accident or incident each aeronautical telecommunication service provider must do all that is reasonable to ascertain that the ILS is operating correctly. For this reason all aerodromes must have equipment suitable for making field measurements available within 12 hours.

Glide Path Measurements

- 11.2.10.6 The following requirement for Glide Path Measurements shall apply:
- (a) Glide path field measurements are not mandatory but would be of great help in proving equipment stability. It is recommended that monthly field checks are made on null reference and sideband reference glide paths.

Field Test Points

- 11.2.10.7 The following requirement for Field Test Points shall apply:
- (a) Points at which field measurements are made must be clearly and permanently marked. These marks must not present a hazard to aircraft and must be immune to disturbance by such operations as grass cutting and snow clearance.

11.2.11 Critical Areas

11.2.11.1 Localizer and Glide path critical areas must be clearly marked and identified. The marking must be visible day and night and must help ensure that no person or vehicle may enter the areas without the permission of air traffic control.

11.2.11.2 Where fencing is used to mark the critical areas, the aeronautical telecommunication service provider operator must ensure the ILS continues to operate correctly.

11.2.11.3 Details of the Localizer and Glide Path critical areas must be included in Part 2 of the ATS procedures manual for the ATS unit, together with any appropriate procedures.

11.2.12 Sensitive Areas

11.2.12.1 Localizer and Glide path sensitive areas must be defined based on ICAO Annex 10 Volume I Standard and Recommended Practices.

11.2.12.2 Details of the Localizer and Glide Path sensitive areas must be included in Part 2 of the ATS procedures manual for the ATS unit, together with any appropriate procedures.

***Compliance Note:** These areas will normally be defined by the system operator or manufacturer. This information is required for positioning of hold points, production of ATC instructions, etc.*

11.2.13 Computer Simulation

11.2.13.1 Where computer simulation is used to define an ILS sensitive area, or to support a case for a system remaining operational during construction work, the following are required:

- a. proof that the version of software being used is the latest issue, or recent written confirmation from the software manufacturer that the version being used has no known safety related problems;
- b. proof that the person making the simulation has received formal training in the use of the simulation program;
- c. evidence to support that the model is suitable for the intended simulation; and
- d. evidence to support the correlation of the modeling tool with far field measurement.

11.2.13.2 Due to the difficulty of simulating lattice structures such as cranes, the President may require confirmatory flight and/or ground inspections during construction work.

11.2.14 Use of Decommissioning Equipment

11.2.14.1 Decommissioned equipment may be installed subject to the following conditions:

- (a) the equipment must be examined by the manufacturer's quality representative or by an agent designated by the manufacturer. A written declaration must show:
 - (a) the equipment is in a satisfactory state for further service; and
 - (b) there are no outstanding safety-related modifications.
- (b) glide path aerals must be brand new or factory refurbished and re-tested to the original factory test specification; and
- (c) all aerial feeder cables must be renewed.

11.2.15 Grass Height

11.2.15.1 When reducing the grass height around the Localizer and Glide Path the aeronautical telecommunication service provider must consider the potential effect of grass height on navigational and visual aids.

Sub-section 11.3 **Abbreviated Method of Putting an ILS with an Established Mean Time between Outages (MTBO) into Service**

11.3.1 **General**

11.3.1.1 This section sets out the requirements for an abbreviated method of putting an ILS with an established mean time between outages (MTBO) into service.

11.3.2 **Eligibility Conditions**

11.3.2.1 The following eligibility requirements apply:

- a. the manufacturer's calculated MTBO must meet ICAO SARPs with a defined confidence level.
- b. in service MTBO data must meet ICAO SARPs with a defined confidence level.
- c. the system(s) considered as part of the In-Service MTBO assessment must be identical system(s) and cover the range of environmental conditions encountered in the KSA.
- d. the systems are installed and maintained to acceptable standards (e.g. manufacturer's installation and commissioning specifications).
- e. an ANAV service provider must ensure that the organization making the installation has a good quality record and can provide evidence of staff competence.

11.3.2 **Requirements**

11.3.2.1 An ANAV service provider must carry out all the necessary tests including commissioning, site acceptance and flight inspection.

11.3.2.2 An ANAV service provider must run the system continuously for 24 hours for CAT I and 300 Hours for CAT II/III, on either transmitter in the case of dual equipment.

11.3.2.3 If there are no outages, the ANAV service provider must put the ILS into service at the appropriate Category.

11.3.2.4 An ANAV service provider must start continuous MTBO monitoring, initializing the figures for:

- a. CAT I Localizer and Glide path at 1250 hours
- b. CAT II/III Localizer at 5000 hours.
- c. CAT II/III Glide Path at 2500 hours.

11.3.2.5 Each ANAV service provider must continue to monitor MTBO using normal processes. A confidence level of 60% may be used.

Compliance Note: 'Outage' in these calculations means a total unplanned loss of signal due to a fault. Automatic changeover to the standby transmitter, after a fixed delay if appropriate, is not classed as a failure.

Sub-section 11.4 ILS Radio Noise Monitoring**11.4.1 General**

11.4.1.1 This section sets out the minimum requirements for ILS equipment and systems.

11.4.1.2 This section is based upon those relevant and applicable ICAO Standards and Recommended Practices.

11.4.2 Equipment Requirements

11.4.2.1 Throughout this requirement, all references to signal voltages are the voltages measured at the aerial when terminated with 50 Ω . When calibrating the equipment, due allowance must be made for cable losses.

11.4.2.2 The following equipment requirements shall apply:

- (a) automatic Scanning must permit ability to bypass up to 5 channels
- (b) frequency range must be for 108.00 - 112.00 MHz
- (c) frequency tolerance must be $\pm 0.005\%$
- (d) channel spacing must be 50 kHz
- (e) the 3dB bandwidth must be between ± 10 and ± 15 kHz. The exact figure must be stated as it is required for analysis calculations.
- (f) Receiver sensitivity must be $2\mu\text{V}$ for 10dB (signal + noise)/noise ratio at 50% Mod AM or FM deviation 30% of IF bandwidth.
- (g) the standard detector must be for amplitude modulation. For normal monitoring this detector must provide the output to the audio storage device.
- (h) the minimum 3dB bandwidth of the receiver and recording equipment must be 300 to 3,400 Hz.
- (i) the receiver must provide adequate immunity to interference from two-signal third order inter modulation products caused by signals outside the band being examined.
- (j) the receiver must measure signal strengths in the range $2\mu\text{V}$ to $100\mu\text{V}$.
- (k) the receiver must be capable of detecting modulation when the signal strength is in the range $2\mu\text{V}$ to $1000\mu\text{V}$.
- (l) interval between successive scans must be between 1 and 2 minutes when no modulation is being recorded. This figure must be quoted since it will be required for the analysis of data. In other cases the total scan time will be determined by the recording time.
- (m) scanning dwell time on each channel.
 - a. for signals greater than Threshold 1 but less than Threshold 2: The receiver must dwell on the channel long enough to allow the time, channel number and signal strength to be logged.
 - b. for signals greater than Threshold 2: The receiver must dwell on the channel long enough to allow the time, channel number and signal strength to be logged, and for demodulated audio signals to be recorded.
- (n) when a signal exceeds threshold 2, the demodulated audio signal must be recorded for a continuous period of approximately 20 seconds.

Compliance Note: To save recording space, if 10 successive scans have found the same channel with a signal exceeding Threshold 2, modulation recording of that channel may be terminated and only the signal strength need be logged.

- (o) channels to be examined at each scan must include all except the operational Localizer frequency or frequencies.

Compliance Note: If a continuous carrier is detected on one or more of the channels being examined, the scanning may step over those channels provided that the presence of the carrier on that channel has been recorded.

- (p) if the equipment can also record interference events on the operational channel. Details must be provided of:
 - a. the mask used to remove the ILS signal.
 - b. the threshold levels used for the noise measurement.
- (q) threshold levels.
 - a. threshold 1 must be adjustable over the range $2\mu\text{V}$ to $10\mu\text{V}$.
 - b. threshold 2 must be adjustable over the range 10 to $20\mu\text{V}$.
- (r) aerial horizontal response must be omnidirectional.
- (s) aerial polarization must be horizontal.
- (t) channel occupancy data must be sent either directly to a printer or stored on computer disk or both.
- (u) modulation information must be stored on a suitable audio recording device.

Compliance Note: Suitable audio devices include such media as standard audio cassettes and solid state digital storage.

- (v) the results must be stored in a format which will facilitate further analysis.

11.4.3 Calibration

11.4.3.1 Documented calibration procedures must be applied to all equipment involved in the measurement of radio noise level. All equipment and standards used in the calibration process must have traceability to national or international standards.

11.4.3.2 When any equipment used is claimed to be self-calibrating, the internal processes involved must be clearly defined. This involves showing how the equipment's internal standard is applied to each of the parameters which it can measure or generate. The internal standard must have traceability to national or international standards.

11.4.3.3 Calibration intervals must be stated in the calibration records. Evidence must be available to support the quoted calibration intervals.

11.4.4 Standard Settings

11.4.4.1 For normal operation, threshold settings must be:

- (a) Threshold 1: $4.5\mu\text{V}$
- (b) Threshold 2: $13\mu\text{V}$

11.4.5 Data to be Recorded

11.4.5.1 For each scan across the frequency band, when any signal exceeds threshold 1, the following parameters must be recorded:

1. The date and time.
2. The frequency or channel number of each channel having a signal exceeding threshold 1.
3. The strength of all signals exceeding threshold 1.

Compliance Note: For signals greater than $100\mu\text{V}$, the absolute signal strength need not be recorded. It is sufficient to state '>100 μV '.

11.4.5.2 Where the signal strength exceeds threshold 2 and modulation is present, the detected modulation must be recorded.

Compliance Note: Modulation is recorded to assist in identifying an offending transmission.

11.4.6 Location of Measuring Equipment***Horizontal position***

11.4.6.1 If a single measurement point is used for the complete airport, then the aerial must be located near the midpoint of the runway. If an alternative location in the approach area is used, the measurements must only apply to that particular approach.

11.4.6.2 Measurements near the midpoint must only be made with equipment that is immune to blocking from the operational localizer.

Vertical position

11.4.6.3 The aerial must be higher than any obstructions in the immediate vicinity but must not be an obstruction to aircraft.

11.4.7 Measurement Interval and Duration of Measurement

11.4.7.1 The measurement must be made on each Cat II runway at intervals not exceeding one year.

11.4.7.2 The total measurement period must be a minimum of 350 hours in any one year. The measurement need not be made in one continuous period.

11.4.8 Report

11.4.8.1 The report must show the total number of times that each channel has signals present with strengths:

- (a) Exceeding threshold 1 but not threshold 2.
- (b) Exceeding threshold 2.

11.4.8.2 The present acceptance limit is an interference rate equivalent to $< 2 \times 10^{-5}$ events per second. An event being a signal $> 13\mu V$. The total rate must be calculated as an average over the total monitoring time. Submitted results must show the calculations used in producing the figures for the interference rate.

11.4.8.3 Modulation recordings must be made available on request.

11.4.8.4 When measurements show that the interference level exceeds limits, the aeronautical telecommunication service provider must take the appropriate corrective measures and GACA-S&AT must be advised immediately.

11.4.8.5 Evidence of the required routine measurements must be available when requested by the President.

Sub-section 11.5 ILS Monitors**11.5.1 General**

11.5.1.1 This section defines the monitor alarm limits and the method of testing those alarms.

11.5.1.2 The equipment must not radiate guidance signals which are outside the standard operational tolerances.

11.5.2 Near Field Monitor

11.5.2.1 Localizers must have a minimum of one near field monitor measuring the course centerline.

11.5.2.2 Glide paths must have a minimum of one near field monitor measuring either the glide path angle or the displacement sensitivity.

***Compliance Note:** Where multiple monitors are used, the signal from the near field monitor aerial may be split and fed into each set of monitors.*

11.5.3 Far Field Monitor

11.5.3.1 Category II and III localizer systems must be fitted with a far field monitor which measures centerline accuracy and displacement sensitivity.

11.5.3.2 The monitor must be installed near the relevant runway threshold.

11.5.3.3 The far field monitor must provide alarms to a remote point, but must not take executive action.

11.5.3.4 A delay must be incorporated in the monitor to prevent false alarms due to aircraft movement.

11.5.3.5 During the time that the ILS is being used to support low visibility procedures, the output of the far field monitor must be recorded and time stamped. The minimum parameters to be recorded must be centerline DDM and displacement sensitivity.

11.5.3.6 The far field monitor output should be recorded and time stamped at all times when the ILS is operational.

11.5.4 Monitor Correlation

11.5.4.1 Any monitors on which the integrity assessment is based must correlate with changes in the far field. This correlation must be demonstrated for each new design of ILS transmitter, antenna or monitor system installed in the aerodrome.

11.5.5 Alarm and Warning Settings

11.5.5.1 Monitor alarm settings must not exceed the limits given in Table 11.5 - 1. This requirement applies to all monitors on which the integrity of the ILS is based.

11.5.5.2 On a system where several sets of monitors have been considered in the integrity assessment, the system must be adjusted to a point where sufficient alarms on those monitors are generated to cause a changeover/shutdown.

11.5.5.3 If flight or ground tests show that the change measured in the field exceeds the limits given in Table 11.5 -1 with the transmitter set to the alarm condition, then the monitor system must be adjusted to tighter limits than those given in Table 11.5 - 1.

Parameter	Category I	Category II	Category III
Localiser			
Alignment at threshold	±1.5% ddm (15µA)	±1.1% ddm (11µA)	±0.9% ddm (8µA)
Displacement Sensitivity	17% of nominal input. The ICAO Annex 10 standard that a localizer width angle must not exceed 6° is interpreted as an 'adjust and maintain' limit. The system alarms will still be set to ±17% of the nominal input. Field measurement is of nominal displacement sensitivity.		
	Localizer with no separate clearance system ±10% of nominal input. If clearance in the region between ±10° and ±35° is at any point <170 µA.		
Modulation Sum SDM	±4%		
	±20% of nominal input		
Clearance	Localizer with a separate clearance transmitter ±10% of the nominal clearance input if clearance in the region between ±10° and ±35° is at any point <170 µA		
Identification modulation	±5%		
Frequency Difference (Dual Frequency)	±3KHz		
RF Level Single Frequency	-3dB provided that coverage is satisfactory when the power is reduced to the alarm limit		
RF Level Dual Frequency	±1dB Unless tests have shown that a wider limit may be used.		
Glide Path			
Alignment	±4% ddm (35µA) Field measurement ±7.5% of the nominal glide path angle.		
Displacement Sensitivity	±25% of nominal input Field measurement is of nominal displacement sensitivity.		
	Glide path with no separate clearance transmitter: ±20% of the nominal displacement sensitivity. If the 'fly up' signal at 0.32 is <200 µA.		
Clearance	±20% of nominal input		
Modulation Sum SDM	±5%		
Frequency Difference (Dual Frequency)	±5 KHz		
RF Level Single Frequency	-3dB provided that coverage is satisfactory when the power is reduced to the alarm limit		
RF Level Dual Frequency	±1dB Unless tests have shown that a wider limit may be used.		
Phase Advance and retard	Sideband reference. Sufficient alarms to cause shutdown. Glide path angle shall not be less than 0.9252. Displacement sensitivity within limits above. Fly-up signal at 0.32 must not be less than 150 µA		
	Null reference and Type M. Sufficient alarms to cause shutdown. Glide path angle and displacement sensitivity within the limits above. DDM and field strength within flight inspection limits at 0.32.		

Table 11.5 -1 Normal Monitor Alarms

11.5.5.4 Monitor limits must not be so tight that equipment instability can cause false shutdowns.

Compliance Note: On a glide path system operating with the correct nominal displacement sensitivity, an angle alarm tolerance of $\pm 5.4\%$ ddm corresponds to a change in angle of .075. The figure of 4% ddm (35 μ A) has been chosen to allow for a system which may be operating near its lower limit of displacement sensitivity.

11.5.6 Changeover and Shutdown Times

11.5.6.1 The maximum total time of false radiation must not exceed the number of seconds shown in Table 11.5 - 2.

Compliance Note: In the case of a common fault, e.g. the aerial system, in a system configured for immediate changeover, the quoted time is the total time from beginning of the fault until final shutdown of the system.

	Category I	Category II	Category III
Localizer	10	5	2
Glide Path	6	2	2

Table 11.5 - 2 Changeover and Shutdown Times (in seconds)

11.5.6.2 For category I and II systems, where immediate changeover is not provided, the delay from the time of shutdown of the main transmitter to the start of radiation from the standby transmitter must be 20 ± 2 seconds.

11.5.6.3 For systems having this delay, the figures given in Table 11.5 - 2 must apply separately to each transmitter of the system.

11.5.7 Localizer Alarm Testing

General

11.5.7.1 At commissioning, or whenever a flight inspection has shown the system to be non-compliant with the limits in sub-section 11.6 and no alarm has been shown by the monitors, the localizer alarms must be checked by ground or flight inspection.

11.5.7.2 The alarm points of all individual monitor units must be measured at commissioning, using independent test equipment. The figures measured and the monitor readings must be recorded as standard figures.

Method of simulating Localizer Alarms

11.5.7.3 Alignment alarm must be tested by adjusting modulation balance.

11.5.7.4 Displacement sensitivity alarm must be tested by adjusting sideband power.

Glide path Alarms Testing

11.5.7.5 At commissioning, or whenever a flight inspection has shown the system to be non-compliant with the limits specified in section 11.6 and no alarm has been shown by the monitors, the glide path alarms must be checked by flight inspection.

11.5.7.6 Following any engineering work involving the aerial distribution unit, feeder cables, aerials or monitor-combining unit, the following glide path alarms must be checked by flight inspection:

- (a) Angle low and width wide simultaneously;
- (b) Phase advance alarm; and

- (c) Phase retard alarm.

Compliance Note 1: *If the monitor phase tests are not successful and transmitter adjustments are required, parts of the normal flight inspection will have to be repeated.*

Compliance Note 2: *On certain systems it is difficult to adjust the aerial phasing so that the system is just at the alarm point. For this reason, it is permissible to make the tests with the monitor near to or just beyond the alarm point. Provided that both the monitors and the flight inspection figures show reasonable symmetry, the behavior at the alarm points can be calculated.*

11.5.7.7 The alarm points of all individual monitor units must be measured at commissioning, using independent test equipment. The figures measured must be recorded as standard figures.

Method of Simulating Glide path Alarms - Alignment and Displacement Sensitivity

11.5.7.8 The alignment and displacement sensitivity alarms must be checked in the following condition:

- i. Width wide and angle low;
- ii. Width normal and angle high;
- iii. Width normal and angle low;
- iv. Width narrow and angle normal; and
- v. Width wide and angle normal.
 - a. Alignment must be adjusted using modulation balance.
 - b. Displacement sensitivity must be adjusted using sideband power.

Method of Simulating Glide path Alarms - Phase

11.5.7.9 For both advanced and retard alarms, the flight inspection must measure the glide path angle, displacement sensitivity, DDM and field strength at 0.32.

Method of Simulating Glide path Alarms - Null Reference

11.5.7.10 Adjustment of Side Band Oscillator phase, which is the same as the relative phase between upper and lower aerials.

Method of Simulating Glide path Alarms - Sideband Reference

11.5.7.11 The system aerial phaser must be adjusted until the monitors show sufficient alarms of any type to cause a shutdown.

Compliance Note: *If the aerial phase control does not have sufficient range to reach the alarm condition, it is permissible to add adaptors or extender cables to give the required phase change.*

Method of Simulating Glide path Alarms - Type M

11.5.7.12 Adjustment of the relative phase between middle, upper and lower aerials, by adjustment of the middle antenna phaser.

11.5.8 Routine Monitor Maintenance

General

11.5.8.1 Checking of alarms must be repeated at intervals not exceeding 6 months.

11.5.8.2 The alarm checking interval may be extended to 12 months if it can be demonstrated with a confidence of 95% that the monitors have a reliability of 0.95 or better.

Compliance Note 1: *A failure is defined as a monitor whose ddm centering or alarm points*

are found to be more than 10% of the alarm value or 1 μ A, whichever is the greater, from the standard values.

Compliance Note 2: *This requires a large sample size (Minimum of 60 with no failures or 95 with one failure).*

11.5.8.3 Monitors used in the assessment need not all be on the same airport, but all must be of an identical type.

11.5.8.4 All equipment monitor readings for all transmitters capable of operating into the aerial must be taken at monthly intervals or as prescribed by the equipment manufacturer or engineering authority.

Localizer

11.5.8.5 On CAT III systems, all system monitor alarm checks must be made using independent test equipment.

Glide path

11.5.8.6 Alarm checks must be made using independent test equipment and not by adjusting the transmitter.

Sub-section 11.6 ILS Flight Inspection Requirements**11.6.1 General**

11.6.1.1 This section defines the:

- (a) flight inspection interval;
- (b) limits to be applied to all parameters measured; and
- (c) types of inspection.

11.6.1.2 The equipment must provide a complete, identified, accurate and uncorrupted source of guidance information to aircraft.

11.6.2 Flight Inspection Interval

11.6.2.1 For ILS facilities, the prescribed interval between successive inspections is 180 days.

11.6.3 Tolerances

11.6.3.1 A tolerance of +20 days is applicable to the prescribed intervals. Each aeronautical telecommunication service provider must strive to ensure that flight inspection takes place as closely as possible to the prescribed intervals. If the previous inspection lasted more than one day, the interval must be calculated from the date when the inspection started.

11.6.3.2 Flight inspections may be made up to 7 days earlier than the due date without affecting the due date for the next inspection. If an inspection is made more than 7 days before the due date, the date of subsequent inspections must be advanced.

11.6.4 Delays due to Adverse Weather

11.6.4.1 Occasionally, prolonged periods of adverse weather may prevent an inspection being completed within the permitted tolerance. If this occurs, the system may continue in operation for a further 25 days provided that a reduced flight inspection has been made within the permitted tolerance interval.

11.6.4.2 The reduced inspection requirements are:

1. Localizer: part orbit $\pm 35^\circ$ at approximately 6 nautical miles for both transmitters.
2. Glide path: Level slice starting at 10 nautical miles, at the height normally used for such a flight on the facility, for both transmitters.

11.6.5 Supplementary Flight Inspections

11.6.5.1 A supplementary flight inspection must be made 90 days ± 20 days after a periodic flight inspection if at that inspection any parameter was found outside the flight inspection tolerances stated in Tables 11.6 – 1, 2 and 3 below and subsequently adjusted.

11.6.5.2 This requirement can be relaxed if ground measurement and equipment monitors confirm the changes seen during the periodic flight inspection. In this case it would be acceptable to carry out more frequent ground monitoring and inspection of the equipment monitor records.

11.6.5.3 Only the parameters found out of tolerance need to be checked by the supplementary flight inspection.

11.6.5.4 A supplementary flight inspection may be requested by the President at any time if the following conditions arise:

- (a) a safety inspector considers that any aspect of maintenance is not being correctly carried out;
- (b) an inspection of equipment monitor records shows any evidence of instability;
- (c) changes have been made within the safeguarded areas; and
- (d) a periodic inspection has shown any unusual, though not necessarily out of tolerance, aberrations in the course structure.

11.6.6 Field Monitors

11.6.6.1 Commissioning flight inspections of localizers and glide paths must be made with all field monitors that can have a significant effect on the signal in space installed in their final positions.

Compliance Note: *An engineering flight inspection may be necessary to establish the position of the glide path field monitor.*

11.6.7 Inspection after Engineering Work

11.6.7.1 If the nature of the types of engineering work involving the aerial distribution unit, feeder cables, aerals or monitor-combining unit require re-inspection that the system must be flight checked before being returned to service.

11.6.8 Analysis of Flight Inspection Records

11.6.8.1 Each aeronautical telecommunication service provider must analyze the flight inspection records and inform GACA-S&AT of any deficiencies in the performance of the navigation aids.

11.6.8.2 With the agreement of the President, an ANAV service provider may delegate the task of examining the flight inspection records to a specialist organization. This may be the same organization that makes the flight inspection. The responsibility for addressing any deficiencies identified remains with ANAV service provider.

11.6.9 Flight Inspection Limits

11.6.9.1 Flight inspection results must conform to the limits given in Tables 11.6 – 1, 2 and 3.

11.6.10 Parameters to be Measured

11.6.10.1 Tables 11.6 – 1, 2 and 3 give details of the parameters which must be measured at each type of flight inspection.

11.6.11 Application of Designated Operational Coverage (DOC)

11.6.11.1 The DOCs associated with the frequency assignments for ATS Communications Facilities and Radio Navigation and Landing Aids at aerodromes, must be published in the KSA AIP.

11.6.11.2 Frequencies for En-route Navigation Facilities must have their DOCs published in the KSA AIP.

Compliance Note: *The requirements for validation of all instrument flight procedures are prescribed under GACAR Part 172.*

Parameter	Commissioning	Annual / Routine	Transmitter to be checked
Alignment Of nominal total angular width	Cat I $\pm 1.5\%$ Cat II $\pm 1.0\%$ Cat III $\pm 0.5\%$	Cat I $\pm 5.0\%$ Cat II $\pm 2.1\%$ Cat III $\pm 1.4\%$	Commissioning 1 & 2 Annual 1 & 2 Routine 1 & 2
Displacement Sensitivity Of the nominal displacement sensitivity	Cat I $\pm 5\%$ Cat II $\pm 3\%$ Cat III $\pm 3\%$	Cat I $\pm 17\%$ Cat II $\pm 10\%$ Cat III $\pm 10\%$	Commissioning 1 & 2 Annual 1 & 2 Routine 1 & 2
Symmetry (either side of course line) of the measured displacement sensitivity	45% to 55%. In cases of disagreement with the ground figures, the ground measurements at threshold shall be used for assessment		Commissioning 1 & 2 Annual 1 & 2 Routine 1 & 2
Modulation Sum SDM sum of the modulation depths of the navigational tones	39% and 41%. Measured when approaching the facility, where the ddm is approximately zero	36% and 44% Measured when approaching the facility, where the ddm is approximately zero	Commissioning 1 & 2 Annual 1 & 2 Routine 1 & 2
Off Course Clearance	Substantially linear increase from the front course line to an angle where the deflection current is 175 μA (0.18 ddm). From this angle to 10° on the same side, the deflection current must not fall below 175 μA (0.18 ddm). From $\pm 10^\circ$ to $\pm 35^\circ$ the deflection current must not fall below 150 μA (0.155 ddm). It is desirable that the deflection current in the region between 10° and 35° should not be below 175 μA (0.18 ddm). Wherever possible, systems should be adjusted to achieve this.		Commissioning 1 & 2 Annual 1 & 2 Routine 1 & 2
Coverage	Usable signals at edge of DOC, $\pm 10^\circ$ from the centerline Usable signals at 17 NM, $\pm 10^\circ$ to $\pm 35^\circ$ from the localizer centerline	Annual only. Usable signals at edge of DOC on the localizer centerline	Commissioning 1 or 2 Annual 1 or 2 Routine None
	Usable signals between $\pm 35^\circ$ from the localizer centerline at or beyond 6NM		Commissioning 1 & 2 Annual 1 & 2 Routine 1 & 2
	Usable signals shall be receivable to the distances specified, at and above a height of 2000 feet above the elevation of the threshold or 1000 feet above the elevation of highest point within the intermediate and final approach areas, whichever is the higher. A usable signal is defined as a signal producing localizer flag current of not less than 275 μA and a ddm conforming to the off course clearance requirements.		
Course Structure	Cat I 30 μA (0.031 ddm) Edge of DOC to point A, then decreasing at a linear rate to 15 μA (0.015 ddm) at point B. 15 μA (0.015 ddm) from point B to point C Cat II / III 30 μA (0.031 ddm) Edge of DOC to point A, then decreasing at a linear rate to 5 μA (0.005 ddm) at point B. 5 μA from point B to the ILS reference datum.		Commissioning 1 or 2 Annual 1 or 2 Routine None
	Cat I 30 μA (0.031 ddm) 8NM from the ILS reference datum to point A, then decreasing at a linear rate to 15 μA (0.015 ddm) at point B. 15 μA (0.015 ddm) from point B to point C Cat II / III 30 μA (0.031 ddm) 8NM from the ILS reference datum to point A, then decreasing at a linear rate to 5 μA (0.005 ddm) at point B. 5 μA from point B to the ILS reference datum. Course structure shall have a probability of 95% or better of not exceeding the limits given below, when assessed over a 40 second interval. NOTE: Guidance on structure assessment may be found in Attachment C to ICAO Annex 10 Volume 1		Commissioning 1 or 2 Annual 1 or 2 Routine 1 or 2

Identification	Clear and no perceptible interference to the basic localizer functions		Commissioning 1 & 2 Annual 1 & 2 Routine 1 & 2
Power ratio (Two frequency systems only)	On the localizer centerline, the course signal must exceed the clearance signal by a minimum of: Cat I/II 10 dB. Cat III 16 dB	N/A	Commissioning 1 or 2 Annual None Routine None
Polarization	Only required at the commissioning of an aerial system which is new. Polarization error when the aircraft is in a roll attitude of 20° shall be no greater than: Cat I 0.016 ddm. Cat II 0.008 ddm. Cat III 0.005 ddm.		As required

Table 11.6 - 1 Localizer Limits

Parameter	Commissioning	Annual / Routine	Transmitter to be checked
Displacement Sensitivity Of the nominal displacement sensitivity	Cat I $\pm 8\%$ Cat II $\pm 6\%$ Cat III $\pm 5\%$	Cat I $\pm 25\%$ Cat II $\pm 20\%$ Cat III $\pm 15\%$	Commissioning 1 & 2 Annual 1 & 2 Routine 1 & 2
Symmetry of upper/lower half sector. Of the measured displacement sensitivity	Cat I 33% to 67%. Cat II 42% to 58%. Cat III 42% to 58%.		Commissioning 1 & 2 Annual 1 & 2 Routine 1 & 2
Mod Sum SDM Sum of the depths of modulation of the navigational tones	78% -82% Measured when approaching the facility, where the ddm is approximately zero.	75% -85% Measured when approaching the facility, where the ddm is approximately zero.	Commissioning 1 & 2 Annual 1 & 2 Routine 1 & 2
Below Path Clearance Normal Operations	The clearance below path should be measured close to the edge of the Designated Operational Coverage (DOC). There shall be a smooth increase in ddm from the glide path angle to an angle where 190 μ A fly-up (0.22 ddm) is reached. This shall occur at not less than 0.32. Where this is achieved at an angle above 0.452, the fly-up must not fall below 190 μ A (0.22 ddm) between this angle and 0.452 or to such lower angle, down to 0.32, as required to safeguard the promulgated glide path intercept procedure. Where coverage between 0.452 and 0.32 is less than the specified datum, but sufficient current is present to remove the flag alarm, the fly-up shall not fall below 190 μ A (0.22 ddm).		Commissioning 1 & 2 Annual 1 & 2 Routine 1 & 2
Course Structure	Course structure shall have a probability of 95% or better of not exceeding the limits given below, when assessed over a 40 second interval. Cat I 30 μ A (0.035 ddm) Edge of DOC to the ILS reference datum to point C. Cat II 30 μ A (0.035 ddm) Edge of DOC to the ILS reference datum to point A, then decreasing at a linear rate to 20 μ A (0.023 ddm) at point B. 20 μ A from point B to the ILS reference datum. Cat III 30 μ A (0.035 ddm) Edge of DOC to the ILS reference datum to point A, then decreasing at a linear rate to 20 μ A (0.023 ddm) at point B. 20 μ A from point B to the ILS reference datum. NOTE: Guidance on course structure assessment may be found in Attachment C to ICAO Annex 10 Volume 1.		Commissioning 1 or 2 Annual 1 or 2 Routine 1 or 2
Biased Structure	The structure of the edges used to calculate the displacement sensitivity should have good correlation with the course structure.		Commissioning 1 or 2 Annual 1 or 2 Routine None

Table 11.6 - 2 Glide Path Limits

Parameter	Commissioning/Annual/Routine	Transmitter
Coverage	The following distances shall be measured whilst on the ILS glide path and localizer course line: Inner Marker 150 m • ± 50 m Middle Marker 300 m • ± 100 m Outer Marker 600 m • ± 200 m	Commissioning 1&2 Annual 1 & 2 Routine 1 & 2
Field strength	No less than 1.5 millivolts per meter at the limits of coverage. Rising to at least 3 millivolts per meter.	Commissioning 1 & 2 Annual 1 & 2 Routine 1 & 2

Table 11.6 - 3 Marker Beacon Limits

Sub-section 11.7 VHF Marker Beacons**11.7.1 General**

11.7.1.1 There must be two marker beacons in each installation. A third marker beacon may be added whenever, in the opinion of an additional beacon is required because of operational procedures at a particular site.

11.7.1.2 Except as provided in (c), the marker beacons must conform to the requirements prescribed in ICAO Annex 10 Volume I. When the installation comprises only two marker beacons, the requirements applicable to the middle marker and to the outer marker must be observed.

11.7.1.3 The marker beacons must produce radiation patterns to indicate predetermined distance from the threshold along the ILS glide path.

11.7.2 Radio Frequency

11.7.2.1 The marker beacons must operate at 75 MHz with a frequency tolerance of plus or minus 0.005 per cent and must utilize horizontal polarization.

11.7.3 Coverage

11.7.3.1 The marker beacon system must be adjusted to provide coverage over the following distances, measured on the ILS glide path and localizer course line:

- inner marker (where installed): 150 m plus or minus 50 m (500 ft plus or minus 160 ft);
- middle marker: 300 m plus or minus 100 m (1000 ft plus or minus 325 ft);
- outer marker: 600 m plus or minus 200 m (2000 ft plus or minus 650 ft).

11.7.3.2 The field strength at the limits of coverage must be 1.5 millivolts per meter (minus 82 dBW/m²). In addition, the field strength within the coverage area must rise to at least 3.0 millivolts per meter (minus 76 dBW/m²).

11.7.4 Modulation

11.7.4.1 The modulation frequencies must be as follows:

- inner marker: 300 Hz;
- middle marker: 1300 Hz;
- outer marker: 400 Hz.

11.7.4.2 The frequency tolerance of the above frequencies must be plus or minus 2.5 per cent, and the total harmonic content of each of the frequencies must not exceed 15 per cent.

11.7.4.3 The depth of modulation of the markers must be 95 per cent plus or minus 4 per cent.

11.7.5 Identification

11.7.5.1 The carrier energy must not be interrupted.

11.7.5.2 The audio frequency modulation must be keyed as follows:

- Inner marker: 6 dots per second continuously;
- Middle marker: A continuous series of alternate dots and dashes, the dashes keyed at the rate of 2 dashes per second, and the dots at the rate of 6 dots per second;
- Outer marker: 2 dashes per second continuously. These keying rates must be maintained to within plus or minus 15 per cent.

11.7.6 Siting

11.7.6.1 The inner marker must be located so as to indicate in low visibility conditions the imminence of arrival at the runway threshold.

11.7.6.2 If the radiation pattern is vertical, the inner marker must be located between 75 m (250 ft) and 450 m (1 500 ft) from the threshold and at not more than 30 m (100 ft) from the extended centerline of the runway

11.7.6.3 If the radiation pattern is other than vertical, the equipment must be located so as to produce a field within the course sector and ILS glide path sector that is substantially similar to that produced by an antenna radiating a vertical pattern.

11.7.6.4 The positions of marker beacons, or where applicable, the equivalent distance(s) indicated by the DME when used as an alternative to part or all of the marker beacon component of the ILS, must be published in accordance with the provisions of ICAO Annex 15 (Appendix 1).

11.7.6.5 When so used, the DME must provide distance information operationally equivalent to that furnished by marker beacon(s).

11.7.6.6 When used as an alternative for the middle marker, the DME must be frequency paired with the ILS localizer and sited so as to minimize the error in distance information.

11.7.7 Monitoring

11.7.7.1 Suitable equipment must provide signals for the operation of an automatic monitor. The monitor must transmit a warning to a control point if either of the following conditions arise:
failure of the modulation or keying; or
reduction of power output to less than 50 per cent of normal.

Sub-section 11.8 Distance Measuring Equipment (DME) Transponders and Flight Inspection Requirements

11.8.1 General

11.8.1.1 This section sets out the technical requirements for all Distance Measuring Equipment (DME) Transponders intended for use in the provision of an air traffic service in the KSA.

11.8.1.2 The DME Transponder equipment must not radiate a signal which falls outside standard operating tolerances or provide false information over its Designated Operational Coverage area (DOC).

11.8.2 System Requirements

11.8.2.1 Except as provided in 11.8.2.2, in addition to the requirements in this section, DME transponder systems must comply with the Standards and in ICAO Annex 10 Volume 1 Chapter 2 General Provisions for Radio Navigation Aids and Chapter 3 Section 3.5 Specification for UHF Distance Measuring Equipment (DME).

11.8.2.2 Reserved

11.8.2.3 The equipment must only transmit on the frequency assigned.

11.8.2.4 The identification signal must be suppressed when the DME is not available for operational service.

***Compliance Note:** The normal identity code may be radiated for short periods during maintenance or flight inspection as necessary.*

11.8.2.5 Standby power supplies must be provided commensurate with the service being supported.

11.8.2.6 Indication of change of status of equipment must be given immediately by visual and audible means to the ATC personnel providing the Approach Control or Aerodrome Control functions for published final approach procedures.

11.8.2.7 The DME must be sited to keep the triangulation error at the point at which the distance is required to a minimum.

11.8.3 DME Flight Inspection Requirements

11.8.3.1 DME flight inspection must be performed to ensure that the DME provides an accurate and uncorrupted source of range information within the Designated Operational Coverage.

11.8.3.2 The following parameters must be assessed for the prescribed transponders and be within limits:

Accuracy. Table 11.8 - 1 provides the accuracy requirements for the various uses of the DME.

Coverage. Throughout the inspection while within the DOC the DME receiver input must not fall below -90 dBm.

Identification. The identification signal must be clear throughout the flight inspection; additionally, where the ident is synchronized with other equipment, the correctness of the keying sequence must be checked.

Performance. False unlocks and instances of interference must be identified on the Flight Inspection report and investigated by the aeronautical telecommunication service provider and the appropriate rectification carried out.

Flight Inspection Interval. Periodicity must be in line with any associated equipment e.g. ILS, VOR or NDB facilities where applicable. Where there are no associated equipment, inspections must be made on Commissioning and in line with any flight inspection requirements of Instrument Flight Procedures supported by the equipment

11.8.4 Flight inspection service provider

11.8.4.1 All DME flight inspections must be made by a flight inspection service provider authorized under section 13 of this appendix.

11.8.5 Analysis of Flight Inspection Records

11.8.5.1 Each ANAV service provider must analyze the flight inspection records and resolve any deficiencies in the performance of the navigation aids.

11.8.5.2 Analysis of flight inspection records can be delegated to a specialist organization. This may be the same organization that makes the flight inspection. The responsibility for addressing any deficiencies identified remains with the ANAV service provider.

Procedure Supported by the DME	Where and how measurement is made	Interval / Tolerance	Transponder
DME associated with precision approach	4NM – 1NM on approach	Comm \pm 0.3 NM Routine \pm 0.1 NM	Both
DME associated with Instrument Approach Procedures (IAP) that are not precision approaches	4NM – 1NM on approach	Comm / Routine \pm 0.1 NM	Both
IFP	On the procedure, spot check at ranges used	Comm \pm 0.1 NM	One TXP
Missed Approach Procedure	On the procedure, spot check at ranges used	Comm / Routine \pm 0.1 NM	One TXP
Direct Arrivals	On the procedure, spot check at ranges used. The orbit as required for DME general below, may be carried out at the appropriate radius.	Comm \pm 0.1 NM	One TXP
Hold	On the procedure, spot check at ranges used.	Comm \pm 0.1 NM	One TXP
DME general	An orbit at a radius of 5 NM or greater at an elevation of 2° from the DME site.	Comm \pm 0.1 NM	A complete orbit on one transponder. Followed by a minimum 20° overlap on the second transponder.
En-route	During radials flown on any associated facility	Comm / Routine \pm 0.1 NM	One TXP

Table 11.8 -1 DME Accuracy Requirements

Sub-section 11.9 Requirements for ILS and ILS/DME Identity Keying**11.9.1 General**

11.9.1.1 This section prescribes the identity keying requirements for all categories of ILS including those systems with an associated DME.

11.9.1.2 An operationally available ILS or DME must radiate an identity code permitting it and its operational status to be positively identified.

11.9.2 Keying Sequence

11.9.2.1 An associated ILS and DME must radiate identity codes which positively identify their association.

11.9.2.2 When a DME is associated with an ILS, the identity keying of both systems must be synchronized. ICAO Annex 10 refers to this as 'associated' code.

11.9.2.3 A complete keying sequence must occupy approximately 40 seconds.

Compliance Note: In the following descriptions the 40 second interval is represented by /4 and the number of times the Morse code is repeated in that interval is shown by the preceding figure. i.e. 1/4 means that the Morse code identity occurs once in each 40 second interval.

11.9.3 Master Equipment

11.9.3.1 The DME or the ILS may be used as the master identity keyer.

11.9.4 System Operation

11.9.4.1 If at any time the master equipment fails, the slave equipment must revert to totally independent keying.

11.9.4.2 If the master keyer is subsequently returned to service, the slave equipment must automatically return to normal slave operation, with no requirement for operations manual resetting at the slave equipment.

11.9.4.3 When a localizer is acting as slave to a DME it must key 3/4. The DME keying must be synchronized to occur where there is an interval in the localizer keying. If the DME fails, the localizer must revert to 4/4 keying with no gap where the DME identity would have been.

11.9.4.4 When a DME is slave to a localizer, it must key 1/4. If the localizer fails, the DME must continue to key 1/4. i.e. the DME must key itself at the correct rate for an independent DME.

11.9.4.5 Regardless of which equipment is master or slave, a failure in one equipment must neither leave the associated equipment without identity nor cause it to close down.

11.9.5 Slave Monitor Information

Compliance Note 1: If the slave equipment fails, there is no requirement for the master equipment to alter its keying sequence.

Compliance Note 2: Certain types of ILS and DME equipment, when used as master, have the facility to accept an input from the slave's status monitor. This signal can be used to alter the keying sequence of the master. If this facility exists, it may be used.

11.9.5.1 If this system is used, the master equipment must automatically return to associated keying when the slave equipment is returned to service.

11.9.6 Independent Operation

11.9.6.1 An ILS with no associated DME must always key 4/4, i.e. the Morse code must be repeated at regular intervals, not less than 6 times per minute.

11.9.7 Use of Letter I Prefix

11.9.7.1 If the DME identity code has an 'I' prefix, the DME must continue to radiate this prefix if the associated localizer fails.

11.9.8 Equipment Out of Service

Compliance Note 1: *It is sometimes necessary to radiate signals from equipment which is not available for operational use. This can occur during commissioning tests or engineering investigations.*

11.9.8.1 Whenever the equipment is not available for operational use, the identity keying must be suppressed.

Compliance Note 2: *Radiation of continuous unkeyed tone is permitted.*

Compliance Note 3: *During commissioning and engineering flight inspections, the normal identity code may be radiated for short periods*

Sub-section 11.10 Tactical Air Navigation (TACAN)**11.10.1 General**

11.10.1.1 This section prescribes the main requirements for tactical air navigation (TACAN).

11.10.1.2 The TACAN equipment must not radiate a signal which falls outside standard operating tolerances or provide false information over its Designated Operational Coverage area (DOC).

11.10.2 System Requirements

11.10.2.1 The equipment must operate in the frequency range from 960 to 1215Mhz.

11.10.2.2 The accuracy of a TACAN system must be within the following tolerance:

Bearing:

- ± 1.5° from 0 to 130 nautical miles;
- ± 2.5° above 130 nautical miles;

Distance:

- ± 0.12NM+0.05% of the slant distance, from 0 to 65 nautical miles,
- ± 0.17NM+0.05% of the slant, above 65 nautical miles.

11.10.2.3 Each operational channel in the TACAN system must be defined by two frequencies (interrogation and reply frequencies), spaced 63 Mhz apart (See Table 11.10 - 1), and by the pulse code for the assigned channel (X or Y channel).

11.10.2.4 TACAN must transmit on a preselected channel in accordance with mode channels Operating frequencies.

11.10.2.5 Each beacon must emit a Morse identify code signal which can be heard in the pilot headset. This code must consist of pulse pairs transmitted at a frequency of 1350 Hz.

11.10.2.6 Each beacon must be identified by means of its channel frequency, its pulse coding and its identity signal. The channel code (operating mode), pulse code and replies delay must be as shown in the Table 11.10 - 2.

X Channels		Y Channels
$I = 1025 \text{ MHz} + (\text{CH}-1)$		$I = 1025 \text{ MHz} + (\text{CH}-1)$
$R = I - 63$	$1 < \text{CH} <= 63$	$R = I + 63$
$R = I + 63$	$64 <= \text{CH} <= 126$	$R = I - 63$
I = Interrogation Frequency (MHz) R = Reply Frequency (MHz) CH = Channel Number		

Table 11.10 - 1 Frequencies TACAN Ground Beacon Channels

Channel Code	Nominal Interrogation Pulse Code (μS)	Transponder Reply Pulse Code (μS)	Transponder Nominal Reply Delay (μS)
X	12	12 ± 0.1	50
Y	36	30 ± 0.1	56

Table 11.10 – 2 Nominal Pulse Code and Reply Delay

11.10.3 TACAN Flight Inspection Requirements

11.10.3.1 TACAN flight inspection must be performed to ensure that the TACAN provides an accurate and uncorrupted source of azimuth and range information within the Designated Operational Coverage.

11.10.3.2 Throughout the inspection while within the DOC the TACAN receiver input must not fall below the value specified in the technical documentation.

11.10.3.3 The identification signal must be clear throughout the flight inspection.

11.10.3.4 Instances of interference must be identified on the Flight Inspection report and investigated by the ANAV service provider and the appropriate rectification carried out.

11.10.3.5 Flight Inspection periodicity must be in line with any associated equipment (e.g. VOR facility) where applicable.

11.10.3.6 Where there are no associated equipment, inspections must be made on commissioning and in line with any flight inspection requirements of Instrument Flight Procedures supported by the equipment.

11.10.3.7 All TACAN flight inspections must be made by a flight inspection service provider authorized under this part.

11.10.3.8 The ANAV service provider must analyze the flight inspection records and resolve any deficiencies in the performance of the navigation aids. Analysis of flight inspection records can be delegated to a specialist organization. This may be the same organization that makes the flight inspection. The responsibility for addressing any deficiencies identified remains with the ANAV service provider.

Sub-section 11.11 Requirements for Conventional and Doppler VHF Omni-Directional Range (CVOR/DVOR) Beacons**11.11.1 General**

11.11.1.1 This section prescribes the technical requirements for all Conventional and Doppler VHF Omni-Directional Range Beacons (CVOR/DVOR) intended for use in the provision of an air traffic service in the KSA.

11.11.2 System Requirements

11.11.2.1 Except as provided in 11.11.2.2, in addition to the requirements below, VOR beacon systems must comply with the Standards in ICAO Annex 10 Volume 1 Chapter 2 General Provisions for Radio Navigation Aids and Chapter 3 Section 3.3 Specification for VHF Omnidirectional Radio Range (VOR).

11.11.2.2 Reserved.

11.11.2.3 The equipment must only transmit on the frequency assigned.

11.11.2.4 The identification must be suppressed when the VOR is not available for operational purposes, e.g. under maintenance.

11.11.2.5 With the exception of ATIS, no other voice communication channel must be transmitted via the VOR system.

11.11.2.6 Standby power supplies must be provided commensurate with the service being supported.

11.11.2.7 Indication of change of status of equipment must be given without delay by visual and audible means to the ATC personnel providing Approach Control or Aerodrome Control functions that use the VOR for published final approach procedures.

Sub-section 11.12 VHF Omnidirectional Range (VOR) Flight Inspection Requirements

11.12.1 General

- 11.12.1.1 This section prescribes the following flight inspection requirements for each VOR:
- parameters that must be measured;
 - profiles that must be flown to demonstrate the VOR is suitable to support instrument Flight Procedures;
 - measurement methods that must be used;
 - flight inspection tolerance limits;
 - flight Inspection types and interval.

11.12.2 Parameters to Be Measured

- 11.12.2.1 During commissioning and routine inspection the parameters in Table 11.12 - 1 must be measured for all available transmitters and be within limits.

Parameter	Limits
Alignment	$\pm 2^\circ$
Bends	$\pm 3.5^\circ$
Roughness and Scaloping	$\pm 3^\circ$
Coverage	90 microvolts per meter. At commissioning only, useable signals up to an elevation angle of 40 degrees.
Modulation 30Hz and 9960Hz	$\pm 2\%$
Voice	Clear
Identification	Clear
Polarization	$\pm 2\%$

Table 11.12 – 1 Parameters to be Measured

11.12.3 Measurement Method

- 11.12.3.1 A checkpoint must be selected during the commissioning inspection at a point in space where the signal is stable. This checkpoint must be used in establishing course alignment, 30 Hz modulation depth, 9960Hz modulation depth and field strength to be recorded on the flight inspection report.
- 11.12.3.2 The mean alignment must be determined by flying a 360 degree orbit of the VOR. The altitude selected for the flight should place the aircraft in the main lobe of the VOR.
- 11.12.3.3 Alignment must be recorded at the reference check point.
- 11.12.3.4 Bends must be determined on all flown radials.
- 11.12.3.5 Roughness and Scaloping must be determined on all flown radials.
- 11.12.3.6 Field strength must be recorded at the reference check point.
- 11.12.3.7 At commissioning useable signals must be established by two level flights, separated by approximately 90 degrees.
- 11.12.3.8 The mean modulation depth must be determined by flying a 360 degree orbit of the VOR. The altitude selected for the flight should place the aircraft in the main lobe of the VOR.
- 11.12.3.9 Modulation must be recorded at the reference check point.
- 11.12.3.10 The vertical polarization effect must be checked when flying a radial at a distance of

10 to 20 NM.

11.12.4 Profiles to be Checked

11.12.4.1 Table 11.12 - 2 prescribes details of the profiles, which must be checked and the frequency of flight inspection for each profile.

Profile	Commissioning	Routine
	Transmitter to be checked	
Radials	1 or 2	1 or 2
Approach Procedures	1 & 2	1 & 2**
Cross check radials	1 or 2 *	None
Intersections	1 or 2 as required	None
Holds	1 and 2 as required	
** For routine inspection of dual transmitter Doppler VORs, where it can be demonstrated that the alignment error between the transmitters is small i.e. ≤ 0.5 degrees, then only one transmitter needs to be checked.		
* Flight inspection of cross-check radials is not required provided there is sufficient flight inspection data to support the use of those radials.		

Table 11.12 - 2 Flight Inspection Profiles

11.12.5 Flight Inspection Interval

11.12.5.1 The prescribed interval between successive inspections is 1 year. This interval may be extended to 5 years if the ANAV service provider can demonstrate that the system is stable and that multipath interference does not affect the guidance signals.

11.12.6 Flight inspection Service Providers

11.12.6.1 All VOR flight inspections must be made by a flight inspection service provider authorized under this part and having approval for VOR inspection.

11.12.7 Analysis of Flight Inspection Records

11.12.7.1 Each ANAV service provider must analyze the flight inspection records and inform GACA-S&AT of any deficiencies in the performance of the navigation aids.

11.12.7.2 With the agreement of the President, the ANAV service provider may delegate the task of examining the flight inspection records to a specialist organization. This may be the same organization that makes the flight inspection.

11.12.7.3 The responsibility for addressing any deficiencies identified remains with the ANAV service provider.

11.12.8 Associated VOR and DME

11.12.8.1 At location where for operational reasons, or because of air traffic control reasons such as air traffic density or proximity of routes, there is a need for a more precise navigation service than that provided by VOR, the aeronautical telecommunication service provider must install and maintain in operation a distance measuring equipment (DME) as a complement to VOR.

11.12.8.2 Associated VOR and DME facilities must be collocated in accordance with the following:

- Coaxial collocation: the VOR and DME antennas are located on the same vertical axis; or
- Offset collocation

11.12.8.3 When associated with a VOR, DME/N coverage must be at least that of the VOR to the extent practicable.

11.12.8.4 The characteristics of the “associated” signal must be as follows:
The identification must be transmitted in the form of dots and dashes (International Morse Code) and must be synchronized with the VHF facility identification code;
Each 40-second interval must be divided into four or more equal periods, with the transponder identification transmitted during one period only and the associated VHF identification, where this is provided, transmitted during the remaining periods.

Sub-section 11.13 Requirements for MF Non-Directional Beacons (NDBs)**11.13.1 General**

11.13.1.1 This section prescribes the technical requirements for MF Non-Directional Beacons (NDBs) intended for use in the provision of an air traffic service in the KSA.

11.13.1.2 It applies to all NDBs including those associated with published Instrument Approach Procedures, also known as Locators, promulgated as NDB(L).

11.13.1.3 The system must radiate a signal which complies with the standard operating parameters and provides correct guidance to users within its rated coverage.

11.13.2 System Requirements

11.13.2.1 Except as provided in (b), in addition to the requirements below, NDB systems must comply with the Standards in ICAO annex 10 Volume 1, Chapter 2, General Provisions for Radio Navigation Aids and Chapter 3 Section 3.4, Specification for non-directional radio beacon (NDB).

11.13.2.2 Reserved.

11.13.2.3 The equipment must only transmit on the frequency assigned. The assigned frequency must be maintained within $\pm 0.01\%$.

11.13.2.4 The power output must be adjusted to give a vertical field strength of 70 microvolts/meter at the limit of the rated coverage, and be maintained within tolerances of +2 dB and -3 dB.

11.13.2.5 Modulation is by on/off keying of an amplitude modulating tone. Each NDB must be individually identified by a two or three letter international Morse code group as assigned and transmitted at a rate corresponding to approximately 7 words per minute. The complete identification must be transmitted at least 3 times in each 30 second period, equally spaced within that period.

11.13.2.6 The facility Identification must be suppressed when the NDB is not available for operational purposes, e.g. under maintenance.

***Compliance Note:** The normal identity code may be radiated for short periods during maintenance or flight inspection as necessary.*

11.13.2.7 The frequency of the modulating tone for identification must be 400 Hz ± 25 Hz.

11.13.2.8 The carrier power of an NDB must not fall by more than 0.5 dB when the identification signal is being radiated.

11.13.2.9 An executive site monitor must be provided to switch off the equipment in use and, if applicable, change over to the standby system in less than 1 minute if:

there is a change in radiated carrier power of more than +2 dB or -3 dB to that required for the rated coverage.

a malfunction or failure of the means of self-monitoring of executive parameters occurs.

11.13.2.10 A Non-Executive Alarm must be generated within three minutes, if the NDB fails to transmit the correct identification code.

11.13.2.11 Indication of change of status of equipment must be given immediately by visual and audible means to the ATC personnel providing Approach Control or Aerodrome Control functions that use the NDB.

11.13.2.12 NDB must be provided with suitable power supplies and means to ensure continuity

of service appropriate to the needs of the service provided.

11.13.2.14 An NDB technician must regularly record the field strength of NDB, as measured at a remote location. Remote measurement of field strength can take place at any point where the NDB ground wave is consistently established.

11.13.3 Flight Inspection

11.13.3.1 General requirements for flight inspection are at sub-section 13.

11.13.3.2 Commissioning flight inspections must be made by a flight inspection service provider authorized by the President under this part for flight inspection of NDBs.

11.13.3.3 Annual flight inspections may be conducted by local pilots holding at least an ATP certificate. The pilot must provide confirmation of the performance of the NDB as described in Table 11.13-1 below. The ANAV service provider must formally record this confirmation.

11.13.3.4 During commissioning and annual inspection the appropriate parameters in the following table must be measured and be within limits. These checks need only be done on one transmitter.

Parameter	Limits	Periodicity and Measurement Method
Accuracy within the DOC	ADF needle oscillations $\leq \pm 10^\circ$. See Note 1	Commissioning Orbit at the DOC or 15NM, whichever is the smaller at Minimum Safe Altitude.
Accuracy on Airways	ADF needle oscillations $\leq \pm 10^\circ$. See Note 1	Commissioning Following notified airways. Where an NDB supports many airways then one airway in each quadrant should be flown.
Accuracy in Holding Patterns	ADF needle oscillations $\leq \pm 5^\circ$. See Note 1	Commissioning Following notified Holding pattern
Accuracy on Instrument Approach Procedures	ADF needle oscillations $\leq \pm 5^\circ$. See Note 1	Commissioning and Annual Following Instrument Approach Procedure
Coverage	>70 microvolts per meter.	Commissioning Orbit at the DOC or 15NM, whichever is the smaller, at Minimum Safe Altitude.
Identification	Correctness, clarity and proper tone.	Commissioning and Annual Throughout the flight inspection.
Station passage	Reversal without excessive ADF needle swing around station passage. ADF needle oscillations $\leq \pm 10^\circ$ throughout the remainder of the radial. See Note 1	Commissioning and Annual Two radials 90 degrees apart. From 5NM to 5NM past the station.
Note 1: Periods of out of limits are acceptable as long as: (a) They are oscillatory in nature rather than one sided and do not exceed 8 seconds for the check of the DOC, Airways and Holding patterns and 4 seconds for Instrument Approach procedures, (b) The pilot reports that the usability of the NDB is acceptable and that the NDB satisfactorily supports the Airway/Holding Pattern/Approach Procedure.		

Table 11.13-1 NDB Performance Requirements

Sub-section 11.14 Requirements for Instrumented Runway Visual Range (IRVR) Systems

11.14.1 General

11.14.1.1 The purpose of this section is to prescribe the performance criteria and safeguarding requirements for IRVR equipment installed in the Kingdom of Saudi Arabia and intended for use in the provision of an air traffic service.

11.14.1.2 These requirements ensure that consideration has been taken of those aspects that affect the safety of services provided and supported by an IRVR facility.

11.14.2 IRVR Requirements

11.14.2.1 The equipment must enable the provision of an accurate indication of the runway visual range to be available to the pilot during the takeoff and landing phases of flight

11.14.2.2 Instrumented Runway Visual Range (IRVR) must be measured, over the range appropriate for the approach categorization, to a minimum accuracy of:

- ±10 Meters from 50 meters to 400 meters.
- ±25 Meters from 400 meters to 800 meters.
- ±10 per cent above 800 meters.

11.14.2.3 All systems must meet these accuracy requirements over background luminance levels in the range 5 to 30,000 Cd.m⁻².

11.14.2.4 For calculating the IRVR value, 20 per cent of the peak beam on axis intensity of the runway light (rounded to the nearest 100 cd) must be assumed.

11.14.2.5 The sensor output must be sampled at a minimum rate of once per second.

11.14.2.6 The equipment must average the recorded extinction coefficient over a period of 1 minute, to effect smoothing of short-term atmospheric variations.

11.14.2.7 The IRVR value presented to the user must be rounded down to the nearest increment specified in section 11.14.7 below.

11.14.2.8 When RVR is increasing, a hysteresis of 1.5 increments must be used to prevent unnecessary fluctuations in the displayed IRVR.

11.14.2.9 The equipment integrity and reliability must be such that the number of safety-related failures must be no more than 10⁻⁵ per operating hour, unless otherwise indicated by a formal and documented hazard analysis.

11.14.3 Equipment Calibration

11.14.3.1 The maintenance and calibration policy, and facilities necessary to maintain performance within the parameters stated in this document, must be documented and implemented.

11.14.4 Equipment Interfaces

11.14.4.1 Technical justification that the safe operation of the equipment is not compromised by any non-passive interfaces installed in or connected to other equipment must be provided.

Compliance Note: *The connection of the IRVR system to any existing approved equipment may require the reassessment of that other equipment.*

11.14.4.2 All interfaces between the IRVR system and other systems must be designed, constructed, installed and tested to an integrity standard appropriate for the more demanding applicable standard.

11.14.4.3 The interfaces to the lighting systems must be fed with tell-back information only.

11.14.4.4 Any tell-back indications from the runway lighting system which indicate that the lighting equipment has malfunctioned or which prevent the status of the runway lighting from being established must render the IRVR information to be invalid.

11.14.4.5 The IRVR system must be provided with a time source which must be synchronized to UTC within a tolerance of ± 5 seconds.

11.14.5 Monitoring

11.14.5.1 IRVR systems must be self-monitoring for correct operation.

11.14.5.2 Any incorrect operation identified by the monitoring must render the IRVR information to be invalid.

11.14.5.3 Displays in operational positions must indicate the serviceability status of the system.

11.14.6 Displays

11.14.6.1 Displays must present the RVR data in the manner described below:
in an alphanumeric format with indication of trend over successive readings;
any changes in system status, including blanking of displayed data, or RVR value, must be presented at operational displays within 5 seconds of the change.

11.14.6.2 Where the IRVR value is presented on a display system that is not dedicated to the function (i.e. where information from a variety of sources is displayed on a single display system), all operational ATC positions must display the IRVR data in the standard alphanumeric format.

11.14.6.3 All displays must be provided with a method of testing the serviceability of the display and backed by procedures to ensure compliance with the stated criticality.

11.14.6.4 Where data is transmitted beyond the aerodrome the ICAO station identification must be included.

11.14.6.5 The data must be displayed with the following resolution:
25 meter intervals from 50 to 400 meters.
50 meter intervals from 400 to 800 meters.
100 meter intervals above 800 meters.

11.14.7 Recording

11.14.7.1 IRVR records must be time stamped against UTC and retained for a minimum period of 30 days. Electronic, magnetic or optical recording devices may be used, but all records must be stored in a readily accessible format. Printed copies of these records must be available on request.

11.14.7.2 The RVR value and status information must be recorded in the event of the following:
change in RVR or trend from any site.
system self-test.
on detection of change of serviceability status (including nature of the fault).
change of runway in use.

change in runway lighting intensity.

11.14.7.3 Change in law used to calculate the given RVR value must be recorded.

11.14.7.4 Transmittance, luminance threshold (Et) and software version must be recorded.

IRVR Assessment Site (LDA – Landing Distance Available)	Category II Runway less than 2000m LDA	Category II Runway 2000m or more LDA	Category III All Runways
TDZ	Required	Required	Required
MID	Required	Required	Required
STP		Recommended	Required

Table 11.14-1 Summary of IRVR System Requirements under Normal Operating Conditions

11.14.8 Siting Criteria

11.14.8.1 Sensor measurements must be used to derive an RVR value that is representative of the pilot's perspective of the visibility along the runway.

11.14.8.2 The location of IRVR sensors must be acceptable to the President.

11.14.8.3 RVR measurements, if they are made, on a runway operating to CAT I must be made at one location representing the Touchdown TDZ area.

Compliance Note: Runway Visual Range (RVR) assessment using Human Observers may be permitted for runways currently operating to CAT I.

11.14.8.4 IRVR measurements on a runway operating to CAT II must be made at two locations, representing the TDZ and midpoint (MID).

11.14.8.5 IRVR measurements on a runway operating to CAT III, if any, must be made at three locations, representing TDZ, MID and STP.

Compliance Note: Particular attention should be paid to the design and location of the sensor heads to ensure an effective representation of the required coverage area.

11.14.8.6 The sensor housing must not affect the accuracy of the atmospheric measurement.

Sub-section 11.15 Requirements for the Global Navigation Satellite System (GNSS)**11.15.1 General**

11.15.1.1 The purpose of this section is to prescribe the minimum performance requirements for ground-based elements of GNSS within the Kingdom of Saudi Arabia.

11.15.1.2 The GNSS must provide position and time data to the aircraft.

11.15.2 GNSS Elements

11.15.2.1 The GNSS navigation service must be provided using various combinations of the following elements installed on the ground, on satellites and/or on board the aircraft:

Global Positioning System (GPS) that provides the Standard Positioning Service (SPS);
 aircraft-based augmentation system (ABAS);
 satellite-based augmentation system (SBAS);
 ground-based augmentation system (GBAS);
 ground-based regional augmentation system (GRAS); and
 aircraft GNSS receiver.

11.15.2.2 Except as provided in 11.15.2.3, in addition to the requirements prescribed below, ground-based GNSS elements and services must comply with the Standards in ICAO Annex 10, Volume I Chapters 3.

11.15.2.3 Reserved.

11.15.3 GNSS Elements Specifications - Ground-Based Augmentation System (GBAS)

Compliance Note: Except where specifically annotated, reference to approach with vertical guidance (APV) means APV-I and APV-II.

Performance

11.15.3.1 GBAS combined with one or more of the other GNSS elements and a fault-free GNSS receiver must meet the requirements for system accuracy, continuity, availability and integrity for the intended operation.

Compliance Note: GBAS is intended to support all types of approach, landing, departure and surface operations and may support en-route and terminal operations. GRAS is intended to support en-route, terminal, non-precision approach, departure, and approach with vertical guidance. The following provisions are developed to support Category I precision approach, approach with vertical guidance, and a GBAS positioning service. In order to achieve interoperability and enable efficient spectrum utilization, it is intended that the data broadcast is the same for all operations.

Functions

11.15.3.2 GBAS must perform the following functions:
 provide locally relevant pseudo-range corrections;
 provide GBAS-related data;
 provide final approach segment data when supporting precision approach;
 provide predicted ranging source availability data; and
 provide integrity monitoring for GNSS ranging sources.

Coverage

11.15.3.3 For **Category I precision approach and approach with vertical guidance**. The GBAS coverage to support each Category I precision approach or approach with vertical guidance must be as follows, except where topographical features dictate and operational requirements permit:

laterally, beginning at 140 m (450 ft) each side of the landing threshold point/fictitious threshold point (LTP/FTP) and projecting out ± 35 degrees either side of the final approach path to 28 km (15 NM) and ± 10 degrees either side of the final approach path to 37 km (20 NM); and

vertically, within the lateral region, up to the greater of 7 degrees or 1.75 promulgated glide path angle (GPA) above the horizontal with an origin at the glide path interception point (GPIP) and 0.45 GPA above the horizontal or to such lower angle, down to 0.30 GPA, as required, to safeguard the promulgated glide path intercept procedure. This coverage applies between 30 m (100 ft) and 3 000 m (10 000 ft) height above threshold (HAT).

11.15.3.4 For **Category I precision approach**:

the data broadcast should extend down to 3.7 m (12 ft) above the runway surface.

the data broadcast should be omnidirectional when required to support the intended applications.

GBAS positioning service

11.15.3.5 The GBAS positioning service area must be that area where the data broadcast can be received and the positioning service meets the signal in space requirements and supports the corresponding approved operations.

Data broadcast characteristics

11.15.3.6 The following data broadcast characteristics must be met:

Carrier frequency. The data broadcast radio frequencies used must be selected from the radio frequencies in the band 108 to 117.975 MHz. The lowest assignable frequency must be 108.025 MHz and the highest assignable frequency must be 117.950 MHz. The separation between assignable frequencies (channel spacing) must be 25 kHz.

Access technique. A time division multiple access (TDMA) technique must be used with a fixed frame structure. The data broadcast must be assigned one to eight slots.

Compliance Note: *Two slots is the nominal assignment. Some GBAS facilities that use multiple VHF data broadcast (VDB) transmit antennas to improve VDB coverage may require assignment of more than two time slots.*

Modulation. GBAS data must be transmitted as 3-bit symbols, modulating the data broadcast carrier by D8PSK, at a rate of 10 500 symbols per second.

Data broadcast RF field strength and polarization

Compliance Note: *GBAS can provide a VHF data broadcast with either horizontal (GBAS/H) or elliptical (GBAS/E) polarization that employs both horizontal polarization (HPOL) and vertical polarization (VPOL) components. Aircraft using a VPOL component will not be able to conduct operations with GBAS/H equipment.*

GBAS/H

11.15.3.7 A horizontally polarized signal must be broadcast.

11.15.3.8 The effective radiated power (ERP) must provide for a horizontally polarized signal with a minimum field strength of 215 microvolts per meter (-99 dBW/m²) and a maximum field strength of 0.350 volts per meter (-35 dBW/m²) within the GBAS coverage volume.

11.15.3.9 The field strength must be measured as an average over the period of the synchronization and ambiguity resolution field of the burst. The RF phase offset between the HPOL and any VPOL components must be such that the minimum signal power defined in Annex 10 Volume

I is achieved for HPOL users throughout the coverage volume.

GBAS/E

11.15.3.10 An elliptically polarized signal should be broadcast whenever practical.

11.15.3.11 When an elliptically polarized signal is broadcast, the horizontally polarized component must meet the ERP requirements in paragraph (f) (2), and the ERP must provide for a vertically polarized signal with a minimum field strength of 136 microvolts per meter (-103 dBW/m²) and a maximum field strength of 0.221 volts per meter (-39 dBW/m²) within the GBAS coverage volume.

11.15.3.12 The field strength must be measured as an average over the period of the synchronization and ambiguity resolution field of the burst. The RF phase offset between the HPOL and VPOL components, must be such that the minimum signal power defined ICAO Annex 10 Volume I is achieved for HPOL and VPOL users throughout the coverage volume.

Power transmitted in adjacent channels

11.15.3.13 The amount of power during transmission under all operating conditions when measured over a 25 kHz bandwidth centered on the adjacent channel must not exceed the values defined in ICAO Annex 10 Volume I.

Unwanted emissions

11.15.3.14 Unwanted emissions, including spurious and out-of-band emissions, must be compliant with the levels defined in ICAO Annex 10 Volume I. The total power in any VDB harmonic or discrete signal must not be greater than -53 dBm.

Navigation information

11.15.3.15 The navigation data transmitted by GBAS must include the following information:
Pseudo-range corrections, reference time and integrity data;
GBAS-related data;
Final approach segment data when supporting precision approach; and
Predicted ranging source availability data.

11.15.4 Resistance to Interference

11.15.4.1 GNSS must comply with performance requirements defined in ICAO Annex 10 Volume I in the presence of the interference environment.

Section 12 Technical Requirements – Surveillance Equipment and Systems**Sub-Section 12.1 Introduction**

12.1.1 This section contains the standards, rules, procedures and practices for the provision of Aeronautical Radionavigation (ANAV) services (Surveillance Equipment and Systems) that are additional to, or expand upon, or specify additional conditions for, the standards, rules and procedures contained in ICAO Annex 10 (Volumes I-V), Annex 11, Annex 14 (Volumes I and II), PANS-ATM (Doc 4444) and related documents.

12.1.2 These standards, rules and procedures are applicable to all ANAV providers.

Sub-section 12.2 Radar Systems

12.2.1 General

12.2.1.1 This section prescribes requirements for primary, secondary and surface movement radar systems and associated equipment, including sensors, external monitor, markers, displays, video maps, and recording.

12.2.1.2 Unless otherwise authorized by the President, all radar systems intended for use in Air Traffic Management or at civil aerodromes in the Kingdom of Saudi Arabia must comply with the provision of this section.

12.2.1.3 AN ANAV service provider must carry out a range of technical and operational assessments during the lifecycle of radar equipment. The scope and degree of any assessment must cover, at least, the following aspects:

- the complexity of the proposed system;
- the experience and credentials of the equipment supplier;
- the safety classification of the system;
- the 'track record' of the equipment; and
- the operational requirement.

12.2.2 Identification of Responsibilities

12.2.2.1 An ANAV service provider must identify the technical and operational responsibilities for the radar equipment and systems.

12.2.2.2 An ANAV service provider must designate an entity in charge of safety management system as an appropriate contact, through which GACA-S&AT would channel requests for data and information.

12.2.3 Hazard Analyses

12.2.3.1 An ANAV service provider must produce figures (drawings and graphics) of how the function of the radar equipment is to fit within the ATC environment. This will consider the effects resulting from a failure or loss of integrity of the equipment and its implications on the safety of the provision of Air Traffic Control services. Such figures would derive the critical components; determine the resultant failure modes and the results of such failures. From such figures, the following aspects will be determined:

- the required reliability and integrity of the system.
- maintainability requirements; e.g. mean time to repair (MTTR).
- degree of design assurance required.
- the accuracy and resolution requirements of the system.
- coverage requirements.
- data handling capacity.
- the Target Level of Safety (TLS) for the operational service.

12.2.4 Frequency Allocation and Clearance to Transmit

12.2.4.1 An ANAV service provider must submit to the Saudi Communications and Information Technology Commission a request for frequency allocation or for clearance to transmit as follows:

- primary (frequency); and
- secondary (clearance to transmit)

12.2.4.2 An ANAV service provider must coordinate the allocation of SSR codes and primary frequency request with the ICAO MID Region Office.

12.2.5 Functional Description

12.2.5.1 An ANAV service provider must prepare a functional description that must explain the function of the radar equipment and must cover:
 system interconnections and interfaces to items outside the sub-systems; and
 performance requirements.

12.2.6 Design Description

12.2.6.1 An ANAV service provider must prepare a design description that must explain how the discrete elements of the system carry out their function. At this stage the assessment will ensure that integrity of the data is maintained throughout the system. Such an assessment would cover an appraisal of both the hardware and software design and include:
 decomposition of the design from functional description to module level. (This ensures the verification of functions).
 an evaluation of hardware reliability.
 an evaluation of failure modes: for example, overload situations, handling of no specified inputs etc.
 description of how design decisions are derived from, or refer to, the initial Hazard Analysis.

12.2.7 Testing Regime

12.2.7.1 An ANAV service provider must ensure data integrity by testing of the system as individual packages and at various stages of integration. This assessment must cover:
 testing of specified inputs for correct output.
 testing of correct operation in fault conditions.
 testing for correct handling of corrupt or non-specified data.
 any testing philosophy used. For example boundary testing, path testing, branch testing etc.

Compliance Note: *It will normally be necessary to evaluate the testing to the level of what tests were undertaken and assessing the results of such tests. The depth of required assessment will reflect the results of the Hazard Analysis.*

12.2.7.2 All tests must be documented and used as evidence on the level of compliance of the system with the technical specifications.

12.2.8 Radar System Site Protection

12.2.8.1 Each radar system must be safeguarded with criteria which are derived from the following as a minimum:
 operational range;
 base of coverage;
 operational usage; and
 equipment manufacturer's recommended clearances to prevent degradation in the system's performance.

12.2.8.2 The criteria for safeguarding must include the following for all radar systems:
 a Sterile Zone around the antenna to permit clean, uninterrupted beam formation:
 which must be precisely defined with respect to a clear reference point on the antenna system;
 which must be derived from the vertical and horizontal beam patterns of the antenna type;
 which must state both the vertical and horizontal extents of the Sterile Zone.
 a safeguarded slope must be defined around the system which must assure the system's performance such that it continues to support the operational requirement:

which must be precisely defined with respect to a clear reference point on the antenna system;
 which must define the gradient of the slope;
 the criteria should also include consideration of the construction, shape, location, orientation and materials used in any application.

12.2.8.3 Each aeronautical telecommunication service provider must identify the Sterile Zone and safeguard slope by diagram coverage with a detailed text description.

12.2.8.4 The safeguard area must cover the airport boundary from ground level.

12.2.9 Flight Trials

12.2.9.1 Prior to entering operational service, each aeronautical telecommunication service provider must arrange a flight trial to confirm that the radar achieves its operational requirements.

12.2.9.2 The system performance as defined in the operational requirements must be confirmed using an aircraft 'target' and a general traffic study. As the system provides a large coverage volume, tests must be conducted to prove the basic volume, with detailed analysis in operationally significant areas. Such significant areas will include, as appropriate:

- radar handover areas.
- holding areas.
- typical airway routes.
- areas with clutter or reflection problems.
- upper and lower bounds of operational cover.
- the approach.

12.2.9.3 The flight trial must assess the radar sensor in all the configurations intended for operational use.

12.2.9.4 The flight trial must determine the accuracy and resolution of the system.

12.2.9.5 The flight trial must contain an appropriate series of maneuvers and transition levels to demonstrate the vertical lobe structure of the radar and this must include maneuvers at 1000, 2000, 4000, 6000, 10000, 20000 feet above the aerodrome reference point and as appropriate to the operational requirements.

12.2.9.6 A 360-degree orbit at a suitable range must be carried out at a level equivalent to the base of required coverage.

12.2.9.7 Target returns registered in each block of airspace must be recorded and analyzed in order to identify areas of anomalous replies.

12.2.10 Accuracy Assessment

12.2.10.1 The flight trial must assess the accuracy of the system in the areas of operational significance. The errors in the collection and recording of data must be calculated and justified. Note: This may include:

- the resolution error in any recording devices.
- the error in the equipment used to determine the aircraft position.

12.2.10.2 The flight trial must produce at least five error profiles in each of the following areas:

- the approach.
- each holding area.
- each radar handover area.

12.2.10.3 In areas requiring separation standards the flight trial must demonstrate that the appropriate Target Level of Safety (TLS) can be achieved for the required separation standards.

12.2.11 Accuracy Assessment for Radar Approach

12.2.11.1 The following accuracy assessment must be achieved for any radar intended for use for such procedures:

angular error must be less than ± 1 degree.

range error must be less than $\pm 55 + 0.05R$ meters where 'R' is the range of the respective range check point.

12.2.11.2 For each Surveillance Radar Approach procedure intended, a minimum of 10 aircraft or helicopter tracked approaches must be carried out.

12.2.11.3 Where 3 NM Surveillance Radar Approach is proposed, for each approach the target position must be recorded at threshold, 0.5 NM, 1 NM, 2 NM, 3 NM, 4 NM and 5 NM from touchdown and compared against the controller reported position.

12.2.11.4 For Surveillance Radar approaches terminating at 5NM or greater, for each approach the target position should be recorded at 0.5 NM, 1 NM, 2 NM, 3 NM, 4 NM and 5NM from touchdown and compared against the controller reported position.

Compliance Note 1: To assist in the selection of appropriate range points these ranges can be ± 0.25 NM.

Compliance Note 2: The following is a suitable method for obtaining the aircraft position:

Bearing by use of theodolite tracking of a suitably equipped aircraft using trained operators from an approved flight check organization.

Range checking by use of visual reporting points.

12.2.11.5 Assessment of maps and permanent echoes (PE) as part of the flight trial the accuracy of the video maps and PE must be confirmed.

12.2.11.6 In the case of the maps a number of significant map features must be chosen and a suitable reference must be determined for each feature.

12.2.11.7 PE should be selected taking the following factors into account:

There should be at least 3 PE, each separated by more than 60 degrees.

Each PE should not extend over more than 2 degrees of bearing.

Each identified PE should be at least 5 degrees away from other fixed clutter.

Each identified PE should be at greater than one third the standard displayed range.

12.2.12 Resolution Assessment

12.2.12.1 The flight trial must assess the resolution capability of the system in terms of the minimum separation standards as required in the operational requirements.

12.2.12.2 The resolution capability of the system must be evaluated in both 'standard' areas and areas of clutter and reflections.

Sub-section 12.3 RADAR Sensor Requirements**12.3.1 General**

12.3.1.1 This section sets out radar sensor requirements for radar equipment installed and operated in the Kingdom of Saudi Arabia.

12.3.1.2 The radar sensor must provide a complete, accurate and uncorrupted source of radar data.

12.3.1.3 Except as provided in 12.3.1.4, in addition to the requirements prescribed in this section, Secondary Surveillance Radar (SSR) systems, including Mode S and surveillance systems utilizing Mode S Extended Squitter must comply with the Standards and Recommended Practices (SARPs) in ICAO Annex 10, Volume IV Chapters 2, 3 and 5.

12.3.1.4 Reserved.

12.3.2 Site Requirements

12.3.2.1 After equipment installation, possible site effects and their impact on coverage must be assessed.

12.3.2.2 Local site obstructions must be shown to be acceptable for the required coverage and operational requirements. This must be provided by a 360 degree representation giving the elevation (in degrees) of any obstruction versus bearing and a 'line of sight' coverage chart for several target heights based on these radar obstructions and using the radar earth curvature.

12.3.2.3 Access to the radar and associated equipment must be restricted such that the availability of the Air Traffic Service is not compromised accidentally or intentionally.

12.3.2.4 The aerial stability limits allocated to the tower must be justified. An analysis of the tower structure must show that limits are met at the stated operating wind speed, ice loading, hail, and sand storm. The assessment method chosen must be in accordance with the relevant standards and requirements in force.

12.3.2.5 The aerial support structure must be constructed to survive the excesses of once in 50 years wind speed.

12.3.2.6 The design and testing regime must demonstrate that the equipment operates as required in the chosen environment.

12.3.3 Transmitter Requirements

12.3.3.1 The following frequency bands must be used:
 590 MHz to 598 MHz (50 cm) - medium/long range radar services.
 1215 MHz to 1365 MHz (23 cm) - medium/long range radar services.
 2700 MHz to 3100 MHz (10 cm) - short/medium range radar services.
 9000 MHz to 9200 MHz and 9300 MHz to 9500 MHz (3 cm) - short range radar services.
 15.4GHz to 15.7GHz (GMR) - very short range radar services.
 34.5GHz to 35.5GHz (ASMI) - very short range radar services.

12.3.3.2 The following stability tolerances must be applied:
 Frequency Band Stability Tolerance
 90 MHz–1365 MHz within 500 ppm
 2700 MHz–9500 MHz within 1250 ppm
 15.4 GHz–35.5 GHz within 5000 ppm

- 12.3.3.3 Details of transmitter frequency stability must be stated.
- 12.3.3.4 A practical trial of ageing effects must show that the inspection intervals are consistent with the required stability.
- 12.3.3.5 The frequency of the SSR transmitter must be 1030 MHz.
- 12.3.3.6 The output transmitter carrier frequency must have a tolerance of ± 0.2 MHz.
- 12.3.3.7 The carrier frequencies of the control transmissions and each of the interrogation transmissions must not differ from each other by more than 0.2 MHz and the polarization of the interrogation, control and reply transmissions must be predominantly vertical.
- 12.3.3.8 For primary radar, the level of any spurious component must be either 50dB down on the mean power in bandwidth or less than 100 mW, whichever results in the least spurious output.
- 12.3.3.9 The bandwidth required must be justified.
- 12.3.3.10 The equipment must generate the output pulse patterns to minimize the bandwidth required.
- 12.3.3.11 The emission classification as defined in the ITU Radio Regulations Article 4 must be stated.
- 12.3.3.12 For SSR, the spurious radiation of CW must not exceed -76 dBW.
- 12.3.3.13 The existing electromagnetic environment in which the equipment is to operate must be assessed to ensure that the proposed equipment will comply with all requirements. Existing services have operating priority.
- 12.3.3.14 All reasonable steps must be taken to reduce the effect of interference.
- 12.3.3.15 For SSR the incorporation of side lobe suppression is required.

12.3.4 Spurious Return Reduction

- 12.3.4.1 All spurious return reduction techniques must be defined and justified.
- 12.3.4.2 For SSR, the response of SSR ground equipment to signals not within the receiver pass band must be at least 60dB below the normal sensitivity.

12.3.5 Accuracy - General

- 12.3.5.1 When used for surveillance radar approach (SRA) purpose (i.e. primary only), the accuracy must be better than 1 degree of bearing and 55 metres, + 5% of target range.
- 12.3.5.2 When used for radar separation, the intended minimum separation standard must be justified.

Compliance Note: Guidance on factors to be considered when determining the minimum radar separation to be employed can be found in ICAO Doc. 9426 ATS Planning Operations manual Part II, Section 2, Chapter 1 and Section 3, Chapter 2.

- 12.3.5.3 To ensure that the equipment provided can support this requirement, the radar accuracy distribution must be defined and justified.
- 12.3.5.4 The worst combination of error distributions must achieve the TLS.

Compliance Note: For the system configurations covered by this document the required TLS, expressed as the probability of horizontal overlap due to loss of accuracy, is generally accepted to be 7×10^{-7} per event (i.e. two adjacent targets) which uses the radar separation minimum. The TLS depends on the operational purpose of the system.

12.3.6 Accuracy Determination

- 12.3.6.1 The radar systems that produce the radar data used for separation must be assessed.
- 12.3.6.2 For a remote secondary surveillance radar (SSR) used in conjunction with a local primary the following errors must be assessed:
- error in slant range correction, if applied.
 - error in prediction of position due to differing scan rates.
 - error due to the curvature of the earth when transferring the centre of one volume to another centre.
 - stability and accuracy of original plots.
 - tolerance error in detected position of site marker.
 - provision of SSR and/or primary marker.
 - allowable error in combination box.
 - the plot delay must be acceptable in respect of the operational requirement (OR). This assessment must consider both the mean delay and the distribution of the delay.
- 12.3.6.3 The error in range and bearing between the following must be less than ± 2 degrees in azimuth and $\pm 3\%$ of target range:
- the aircraft position reported by SSR and primary radar
 - the reported SSR monitor position and the video map.
 - the reported SSR monitor position and the known monitor position.
- 12.3.6.4 The maximum time in store for the radar data must not exceed the time taken for 90 degrees of aerial rotation.

12.3.7 Plot Extractor Effects

- 12.3.7.1 The algorithm chosen to determine the center and run time of the target must be defined and justified.
- 12.3.7.2 The effect of the plot extractor on resolution and the accuracy error budget together with theoretical justification must be defined.

Compliance Note: This is not necessary where the intention is to use the SSR purely as an overlay for height separation purposes.

- 12.3.7.3 The processing precision must be sufficient to meet the error budget for the system accuracy and resolution.
- 12.3.7.4 If plot processing is used (i.e. to decrease the effect of garbling and reflection) any effect on detection must be defined and justified.
- 12.3.7.5 The position of the radar relative to the coverage volume desired must be justified.

Compliance Note: If the radar head is not at the center of the desired cover the error may differ in each sector.

- 12.3.7.6 The distribution of any misalignment errors between two sensors must be justified.
- 12.3.7.7 Where two sensors are not co-sited (for example, assigned services) the analysis must include the position conversion error.

12.3.8 Radar System Beam Width

12.3.8.1 A system beam width plot ± 10 degrees of bore-sight or 40 dB down on peak power, whichever the plot reaches first, must be developed.

12.3.8.2 In systems that rely on multiple beam patterns, the plot must show the interaction of the beam patterns.

12.3.8.3 In systems that have user adjustable beam width, methods recommended for the assessment of changes must be stated.

12.3.8.4 Demonstration of the beam patterns must be carried out on a test range.

12.3.8.5 The effect of beam width on accuracy, resolution, system loading and garbling must be defined and justified.

12.3.9 Rotation Rate

12.3.9.1 The effect of rotation rate on system performance must be defined and justified.

12.3.9.2 A primary radar providing the positional data for the following services must rotate at the following effective minimum turning rates:

general TMA zone and approach work, a rotation rate of 5 RPM.

SRA to 2 NM, a rotation rate of 10 RPM.

SRA to 1 NM, a rotation rate of 15 RPM.

SRA to 0.5 NM, a rotation rate of 20 RPM.

12.3.10 Resolution

12.3.10.1 For 3 NM separation the equipment must resolve two targets at 1 NM separation and for 5 NM separation the equipment must resolve two targets at 3NM, both to a probability of 95% or greater throughout the required azimuth and range as defined in the Operational Requirements.

Compliance Note: *It is likely that any areas not meeting this figure are the result of the relative location of the Radar Sensor to the traffic pattern. Such degradation can only be permitted if special rules are proposed for the separation of traffic for these areas.*

12.3.11 Coverage

12.3.11.1 The radars must have a theoretical coverage, in the areas of the operational requirements, which corresponds to 80% detection of the returns from a 1m² target. This increases to 90% for areas providing Surveillance Radar Approach procedures. For primary targets this theoretical cover must assume Swerling case 1 targets.

Compliance Note: *This coverage requirement applies to both primary and SSR sensors if separation standards between primary, reinforced and SSR only plot positions are applied.*

12.3.11.2 Primary and SSR sensors must have their performance continuously monitored. An alarm must be raised when coverage cannot be met.

12.3.11.3 Where the use of the primary radar system includes Surveillance Radar Approaches the coverage must be suitable for the termination distance.

12.3.12 SSR Coverage

12.3.12.1 For services that use SSR for separation purposes a formal coverage specification must be constructed.

Compliance Note: Where the provision of the SSR service is for an overlay only service, to aid target identification, no formal coverage specification is required.

12.3.12.2 The output power of SSR or primary radar must not exceed the approved level.

12.3.12.3 For the secondary radar system details of the link power budget must be defined. This link budget must show that the system achieves coverage in both range and elevation.

12.3.12.4 Where interrogation side lobe suppression (ISLS) is used, the amplitude of P2 must be between 0dB and +3dB above the nominal greatest side-lobe level. The amplitude of P2 must be greater than 9dB below the nominal level of P1 in the main beam.

12.3.12.5 Where improved interrogation side-lobe suppression (IISLS) is used, in addition to the requirements of 3.8.2.4, the level of P1 must be within 3dB of P2.

12.3.12.6 The control channel response must be greater than 3dB above the response of the interrogator channel outside the nominal bore-sight angle for receiver side-lobe suppression (RSLS).

12.3.12.7 The pulse spacing must comply, where appropriate, with Section 3.1.1.4 and Section 3.1.2 of ICAO Annex 10, Vol. IV, and Chapter 3.

12.3.12.8 The Reply Transmission Characteristics (SIGNALS-IN-SPACE) must comply, where appropriate, with Section 3.1.1.6 of ICAO Annex 10, Vol. IV, and Chapter 3.

12.3.12.9 Interrogator and Control Transmission Characteristics must comply, where appropriate, with Section 3.1.1.7 of ICAO Annex 10, Vol. IV, and Chapter 3.

12.3.12.10 Where the equipment uses reflection suppression, the effects of this on system performance must be defined and justified.

12.3.12.11 The de-garble capacity and performance of SSR extractors for the amount of traffic and the separation standard required must be justified.

12.3.13 Data Handling Requirements

12.3.13.1 Operational requirements must consider the required processing load in terms of:
the number of aircraft targets expected. This must be based on overall load and sector peaks.

This load must include all targets within the coverage of the sensor.

the worst case weather conditions.

any roads within the radar coverage.

any fixed clutter patterns.

12.3.13.2 During operational trials the equipment must monitor the processor and memory loading distribution of each sub-system.

12.3.13.3 The probability of 100% processing load in any sub-system should be less than 0.01.

12.3.13.4 The data precision used must be consistent with the positioning performance required from the system.

12.3.13.5 The system data must achieve the operationally required level of integrity.

12.3.13.6 The equipment must contain error detection systems to ensure appropriate data integrity during operation.

Compliance Note: An integrity loss has the effect of reducing the accuracy of the presented

information.

12.3.13.7 To ensure that any radar data processing equipment connected to the sensor can correctly identify the source of the data, the chosen data transmission standard must support source identification.

12.3.13.8 Identification codes must be unique.

Compliance Note: The allocation of identification codes is entirely at the discretion of the Applicant, with regard to the codes already in use in the system.

12.3.14 Radar Recording

12.3.14.1 Any radar service used in first line distress and diversion must be fitted with radar recording equipment.

12.3.15 Default Parameters

12.3.15.1 All default values must be stated.

Compliance Note 1: Default settings control such items as filter settings, clutter level defaults, fixed arithmetic offsets, feedback loops etc.

Compliance Note 2: This does not apply to arithmetic constants fixed in the equipment design.

12.3.16 Monitoring Requirements

12.3.16.1 All radar systems must have methods available to determine the alignment.

12.3.16.2 For an analogue primary radar the system must use appropriate video outputs to check the range/bearing error based on Permanent Echoes (PE). The controller or maintenance engineer must check such figures at suitable intervals.

12.3.16.3 The system must identify at least three PE, each separated by more than 60 degrees. Each PE must be at a range greater than one third of the standard display range. In addition the separation of each PE from other permanent features must be at least 3 degrees in azimuth and ± 0.5 nautical mile in range.

12.3.16.4 Where an analogue only channel is not provided and therefore PEs cannot be displayed, an active test target (MTI runway marker) must be used for alignment checking.

12.3.16.5 The position of any active test target (MTI runway marker) must be as near to threshold as practical.

Compliance Note: For systems that use SSR in conjunction with primary, there are further options. First, that the SSR system has an independent site monitor. Second, that there is a procedure in place to determine the collimation error between the secondary and the primary data. This procedure can take the form of the ATC operator checking the errors on screen, or equipment that checks the error. Such a check could be part of the Plot Assigner/Combiner equipment.

12.3.16.6 The SSR site transponder and monitoring system must monitor those radar parameters which affect detection, performance, accuracy or resolution.

12.3.17 Remote Control and Monitoring System (RCMS)

12.3.17.1 Based on ICAO Annex 11 provisions, GACAR Section 11 requires that a procedure

be in place that informs ATS units of the operational status of the equipment used for controlling takeoff, departure and approach to land. The system must report any failures that will put restrictions on the performance or abilities of the equipment. How the system achieves this must be defined and justified.

Compliance Note: *An electronic system or a procedural reporting method from the maintenance department or to ATC can be used.*

12.3.17.2 If a failure of a sub-system occurs, the remote control and monitoring system or the operations manual reporting system must record a hard copy of the event. It must indicate, where possible, the cause of the event.

12.3.17.3 The RCMS information required depends on the configuration, and the ATS provider's intention to provide service in reduced redundancy. However, the following minimum information must be available:

- an indication of present operating configuration.
- an indication of unavailable sub-systems.

12.3.17.4 The RCMS must enable the operator to select the correct course of action. The intended operating procedures must be submitted for approval.

12.3.17.5 Any configuration changes undertaken by remote control must not conflict with local control.

12.3.18 Reliability

12.3.18.1 The reliability of the radar sensor as appropriate to the operational requirements must be justified.

12.3.18.2 The expected reliability either from theoretical analysis or a practical trial must be demonstrated. This reliability assessment must extend to the power supplies and landlines. The reliability analysis must be combined with a hazard analysis to produce a functionally based reliability analysis.

12.3.18.3 The reliability assessment must state the method chosen and the chosen environment.

12.3.19 Mean Time to Repair (MTTR)

12.3.19.1 The mean time to repair must be specified and justifiably appropriate to the operational requirements.

12.3.19.2 When operating in reduced redundancy the system provider must show that adequate safety mechanisms exist, including:

- equipment identifies that no standby is available.
- maintenance procedures identify the priority for repair that must occur.
- operating procedures identify the smooth transition to another service type in the case of loss of remaining equipment.

12.3.19.3 The documentation and skills/training necessary to achieve repair times must be defined.

12.3.19.4 The maximum time taken to establish full operating conditions following a power supply interruption must be justified.

Sub-section 12.4 Transponder Protocols**12.4.1 Requirements**

- 12.4.1.1 This section sets out the standards and protocols for radar transponders.
- 12.4.1.2 Interrogation modes (ground to air) for air traffic services must be performed on the modes described in Chapter 2 & 3 of Annex 10, Volume IV. The uses of those modes must be in accordance with the provisions of Annex 10, Volume IV Chapter 2.
- 12.4.1.3 The ATS provider authorized under GACAR Section 11 must establish the procedures for the allotment of SSR codes in conformity with Regional Air Navigation agreements, taking into account other users of the system.
- 12.4.1.4 Appropriate provisions must be made in ground decoding equipment to ensure immediate recognition of Mode A codes 7500, 7600 and 7700.
- 12.4.1.5 Mode A code 2000 must be reserved to provide recognition of an aircraft which has not received any instructions from air traffic control units to operate the transponder.

***Compliance Note:** Mode A/C and Mode S transponders are those which conform to the characteristics prescribed in Annex 10 Volume IV, Chapter 3. The functional capabilities of Mode A/C transponders are an integral part of those of Mode S transponders.*

12.4.2 Systems Having only Mode A and Mode C Capabilities

- 12.4.2.1 The carrier frequency of the interrogation and control transmissions must be 1030 MHz. The frequency tolerance must be plus or minus 0.2 MHz.
- 12.4.2.2 The carrier frequencies of the control transmission and of each of the interrogation pulse transmissions must not differ from each other by more than 0.2 MHz.
- 12.4.2.3 The carrier frequency of the reply transmission must be 1090 MHz.
- 12.4.2.4 The frequency tolerance must be not greater than plus or minus 3 MHz.
- 12.4.2.5 Polarization of the interrogation, control and reply transmissions must be predominantly vertical.
- 12.4.2.6 The interrogation modes, control transmission and technical characteristics of transponders must comply with the provisions of Annex 10, Volume IV, Chapter 3.

***Compliance Note:** The two types of standard length communications protocols are Comm-A and Comm-B; messages using these protocols are transferred under the control of the interrogator.*

- 12.4.2.7 The technical characteristics of Comm-A and Comm-B communications protocols must comply with the provisions of Annex 10, Volume 4.
- 12.4.2.8 Comm-A messages must be sent directly to the transponder and must be completed within one transaction.
- 12.4.2.9 A Comm-B message must be used to transfer information from air to ground and can be initiated either by the interrogator or the transponder. In the case of ground-initiated Comm-B transfers, the interrogator requests data to be read out from the transponder, which delivers the message in the same transaction. In the case of air-initiated Comm-B transfers, the transponder must announce the intention to transmit a message; in a subsequent transaction an interrogator will extract the message.

Compliance Notes:

In a non-selective air-initiated Comm-B protocol all transactions necessary can be controlled by any interrogator.

In some areas of overlapping interrogator coverage there may be no means for coordinating interrogator activities via ground communications. Air-initiated Comm-B communications protocols require more than one transaction for completion. Provision is made to ensure that a Comm-B message is closed out only by the interrogator that actually transferred the message. This can be accomplished through the use of the multisite Comm-B communications protocols or through the use of the enhanced Comm-B communications protocols.

multisite and the non-selective communications protocols cannot be used simultaneously in a region of overlapping interrogator coverage unless the interrogators coordinate their communications activities via ground communications.

The multisite communications protocol is independent of the multisite lockout protocol. That is, the multisite communications protocol may be used with the non-selective lockout protocol and vice versa. The choice of lockout and communications protocols to be used depends upon the network management technique being used.

The broadcast Comm-B protocol can be used to make a message available to all active interrogators.

Sub-section 12.5 SSR External Monitor Requirements**12.5.1 General**

12.5.1.1 This section sets out the required functions, positioning and operating conditions of SSR external monitoring equipment.

12.5.1.2 The external monitor must provide accurate reference information to test the transmission, reception and decoding characteristics of the SSR service in conjunction with the range and azimuth accuracy of the ground interrogator.

12.5.2 Functional Requirements

12.5.2.1 If the SSR service is to be used without a primary radar, an external site monitor must be provided.

12.5.2.2 The external monitoring equipment must continuously monitor those radar parameters which affect detection performance, accuracy or resolution. This includes parameters such as the following:

- target bearing;
- target range;
- peak power;
- Side Lobe Suppression; and
- pulse spacing.

12.5.3 Siting Requirements

12.5.3.1 The positioning of the SSR monitor will depend on the use of the equipment. Where the controller uses the monitor to assess collimation errors the monitor must be sited within the range that the ATS operators can view. The bearing chosen must correspond to an area of airspace commensurate with the operational situation; the position must not conflict with operationally sensitive areas.

***Compliance Note:** This does not imply that the controller should continuously check the position but merely that a suitable range setting must be available to the controller.*

12.5.3.2 Where an equipment sub-system, under the control of the user, uses the monitor to assess collimation errors, the monitor must be within the nominal coverage of the radar. If the monitor is at a range greater than the normal range displayed to the controller, a reporting procedure must be in place.

12.5.3.3 Where a sub-system, not under the control of the user, uses the monitor to assess collimation errors, the monitor must be within the nominal coverage of the radar. If the monitor position is outside the normal defined area displayed to the remote controller, a reporting procedure must be in place. This procedure must report alarms from the system provider to the service user. The originator of the service, not the remote user, must identify and notify the remote users of any collimation errors determined.

12.5.3.4 The SSR monitor must be located at a range greater than 4 km from the radar head, unless otherwise justified.

12.5.3.5 The monitor must be set up to report its true position in range. This allows easier co-ordination with other users. Where operational considerations make this undesirable, the monitor must not be visible from any other operational radar service.

***Compliance Note:** If this is not possible, a written agreement to the installation must be obtained from the owners of the affected systems.*

12.5.3.6 The Mode A code for the SSR Site Monitor must be 7777 unless specific approval is granted by the President for a different code.

Sub-section 12.6 Primary Approach RADAR Markers - Requirements**12.6.1 General**

12.6.1.1 When a primary airport radar is intended to be used for Surveillance Radar Approaches (SRA), a particular configuration of fixed returns or markers is required. This section sets out the requirements for siting of these markers.

12.6.2 Marker Requirements

12.6.2.1 Any radar fitted with a processor to extract fixed clutter will not see passive targets, therefore, one of the following must be provided:

- a raw radar feed for calibration purposes. This feed must be independently aligned with the processed radar feed;
- an active test marker; or
- areas of radar coverage which are inhibited from processing.

12.6.3 Required Marker Sitting

12.6.3.1 There are no requirements for extra markers for an SRA with termination range of 3 NM or greater from threshold.

12.6.3.2 For approach radar services providing SRA less than 5 NM but not less than 3 NM, bracket markers are not required. However, centerline markers, as described in 12.6.3.3 must be provided.

12.6.3.3 There must be two non-permanent centerline markers available. These must be located as follows:

- within 2 degrees of the applicable approach centerline.
- between 3 and 6 NM of the applicable touchdown point.

Compliance Note: For aerodromes with reciprocal approaches, one permanent marker on each approach path may be used.

12.6.3.4 The Bracket Marker Sitting must be as follows:

- there must be two permanent markers available that enable the identification of runway touchdown point. These permanent markers must be positioned equidistant from the runway centerline at the instrument touchdown point.
- the distance from the runway edge must be the minimum commensurate with runway operations but not closer than 15 meters from the runway edge.

12.6.3.5 As this site is within the clear and graded area, the support structure must be frangible and less than 0.9 meters high above local ground level

12.6.4 Use of Markers

12.6.4.1 The sets of markers must allow the controller to confirm the correct position of the SRA approach line.

12.6.4.2 The marker system must contain an active monitor that checks the primary radar performance. Such primary radar monitors must evaluate:

- primary radar spectrum;
- primary radar power level; and
- primary radar beam width.

Sub-section 12.7 RADAR Display Requirements**12.7.1 General**

12.7.1.1 This appendix sets out the technical requirements relating to those safety standards that are concerned with the approved use of radar displays by GACA Air Traffic Control units.

12.7.1.2 This appendix applies to all display equipment used for the presentation of radar derived position and identification data used for the provision of Air Traffic Services.

12.7.1.3 The radar display system must preserve the accuracy, availability and integrity of the input data and reproduce it in an unambiguous and clear manner.

12.7.2 Display Characteristics

12.7.2.1 The following must be assessed to determine suitability/appropriateness for the operational requirement:

- screen area and corresponding displayed range;
- the number of display lines. The number of lines must be greater than 1000 x 1000 (horizontal x vertical);
- linearity and screen astigmatism;
- frame refresh rate. Frame refresh must be 75 Hz (or greater), non-interlaced;
- selection of synthetic phosphor decay;
- ability to display system status information;
- the chosen display brightness and luminance and their variation;
- the ambient lighting;
- the color set must be assessed as appropriate for the operational requirement. some colors must be reserved for future requirements;
- a system must be in place that allows the color set to be calibrated; and
- color calibration checks must be carried out at intervals appropriate to the system stability.

12.7.3 Symbology

12.7.3.1 The symbology set selected must be assessed for suitability to the Operational Requirements.

Compliance Note: *The on-screen positioning of menu selection and video map symbology is of particular importance.*

12.7.3.2 The equipment must not display any symbol indicating the position of particular filtered targets.

12.7.3.3 The equipment must draw the attention of the controller by flashing the associate label if it detects one of the emergency codes listed below:

- 7700 : SOS
- 7600 : RT FAIL
- 7500 : HIJACK

12.7.3.4 An audible alarm must also be sounded for the emergency codes listed in (c).

12.7.3.5 The equipment must display both the emergency code and the previous call sign or code if unconverted.

12.7.3.6 The symbol size must not vary with displayed range.

Compliance Note: *Some features, map features for example, will be scaled according to their significance on the displayed ranges.*

12.7.3.7 Where the display automatically moves the labels to various positions (to prevent label overlapping) the equipment must provide leader lines.

12.7.3.8 The display contrast control must not be made available to ATC staff.

12.7.4 Design

12.7.4.1 The display specification must be related to the operational requirement both in functional and performance terms.

12.7.4.2 Allowable error budgets for the display system must be calculated and justified.

12.7.4.3 The following parameters must be specified and justified in relation to the Operational Requirements, technical specification and hazard analysis, as appropriate:

- resolution;
- accuracy;
- precision;
- Max/Min ranges;
- data load ('analogue' plus 'synthetic') and processing time. If the equipment is subjected to a high data load the operator must be given a warning of the data that is shed. For systems using remote SSR data for overlay, data discard should take place progressively from long range;
- MTBF;
- MTTR;
- input type. Analogue, data formats, data transmission rates;
- environmental performance;
- EMC performance;
- quality standards applicable to equipment design, both hardware and software, must be stated;
- correct identification of radar source by validating radar source code; and
- identification of appropriate data input faults. This information must be indicated within one radar scan interval

12.7.5 Functional Parameters

12.7.5.1 The system must be capable of showing the source of all data that the controller has selected for display on the radar display.

12.7.5.2 If a remote SSR data source is used the radar identification code must be decoded and displayed on the screen.

12.7.5.3 Return to default settings must be achievable via the 'top level' menu.

12.7.5.4 The region of the boundary where composite picture processing is being used must be indicated.

12.7.5.5 The display must be capable of displaying QNH values.

12.7.5.6 Any operations manual changes to this value must be validated by double entry.

12.7.5.7 When it is possible to change the QNH remotely, the equipment must require the change to be drawn to the controller's attention and confirmed on all other displays.

12.7.5.8 When the equipment can filter out targets by area, type or height, the equipment must be capable of displaying the parameters of such filters.

12.7.5.9 Equipment must be fitted with a filter override allowing all targets to be displayed quickly.

12.7.5.10 The brightness range, both overall and for individual screen elements, must be restricted to the range determined in the color assessment trial.

Compliance Note: *It should not be possible to delete radar targets completely by use of this control.*

12.7.5.11 Target and map brightness must be independently variable.

12.7.5.12 The equipment must have the following operator functions as minimum:

- selection of display range;
- display off center;
- choice of maps;
- range rings on/off;
- choice of leader line length, SSR label block rotation and positioning;
- prediction data, code/call sign selectivity;
- choice of character size;
- menu selection/positioning; and
- acceptance of error/alert messages.

12.7.5.13 The equipment must be fitted with facilities to record the data and display settings in accordance with the provisions of sub-section 12.11.

Sub-section 12.8 Aerodrome Traffic Monitor Safety Requirements**12.8.1 General**

12.8.1.1 This section applies to all radar sensor equipment providing data for an aerodrome ATS. The following requirements are applicable for the installation and use of equipment provided for the aerodrome traffic monitor. This section covers all systems using local or remote data.

12.8.1.2 The aerodrome traffic monitor must provide accurate and uncorrupted data for the confirmation of aircraft position and identity.

12.8.2 Performance Requirements

12.8.2.1 In normal operation the aerodrome traffic monitor must not display traffic more than 20 miles and not less than 10 miles from the runway touchdown.

12.8.2.2 The radar position displayed must be within 0.5 NM of the true aircraft position.

12.8.2.3 The radars used for display must detect targets down to at least 200 feet below the minimum sector altitude. In the runway approach zone the radar must detect targets down to 100 feet below the nominal glide angle to the terminating range.

12.8.3 Functional Requirements

12.8.3.1 The display must show the runway centerline.

12.8.3.2 The video map must indicate the threshold position.

12.8.3.3 The equipment must resolve two targets at 1 NM separation.

12.8.3.4 The labels must not cross at 2 NM separation.

12.8.4 Display

12.8.4.1 The screen size must be capable of displaying a circle of at least 6 inches (15 cm) diameter.

12.8.4.2 The display must be readable in all ambient light conditions.

12.8.4.3 The display must be readable over a range of viewing angles, both vertically and horizontally.

12.8.4.4 Displays requiring viewing hoods must not be used.

Compliance Note: High intensity daylight viewing displays and/or brightness controls fitted to the equipment can achieve the same effect.

12.8.4.5 Color must not be used for information coding.

Compliance Note: Displays may use color but only in conjunction with brightness and symbology to aid de-cluttering of screen information.

12.8.4.6 The aerodrome traffic monitor equipment must be positioned so that the operational controller can easily note and act on the information shown.

12.8.4.7 At a unit where the controller has clearly defined and fairly narrow tasks to perform

the orientation must be such that the runway on the aerodrome traffic monitor is aligned with the view of the runway from the control position.

Sub-section 12.9 Ergonomic Aspects of RADAR Display Systems**12.9.1 General**

12.9.1.1 All radar systems require an input device to enable the operator to configure the display as required. This interface clearly affects the efficiency of the operator and can affect the safety of operation. An assessment must be carried out to confirm the adequacy of the chosen design.

12.9.1.2 This section prescribes rules concerning specifying and testing the adequacy of the Human Machine Interface (HMI). It applies to all displays used for presenting Air Traffic Service's (ATS) radar data at aerodromes.

12.9.2 The Specification of the Radar Display HMI

12.9.2.1 The specific operational requirement for the equipment must be defined.

12.9.2.2 A formal ergonomic evaluation must be carried out to ensure that the safety of the ATS is not compromised.

12.9.2.3 The input device must give immediate confirmation of selection.

***Compliance Note:** This does not mean that the equipment must carry out the function selected immediately.*

12.9.2.4 The selection time must correlate with the priority level.

***Compliance Note:** This is defined as the time between first confirmation of activation and function available.*

12.9.2.5 The system must indicate its indeterminate state during the time between confirmation of activation and function available.

12.9.2.6 All input must be prohibited, except cancellation, during this wait period.

12.9.3 Input Devices Technical Requirements

12.9.3.1 The input devices must not mislead or hinder the operator or be capable of unintended action.

12.9.3.2 All menus must be appropriately positioned.

12.9.3.3 Equipment must locate each medium priority function not lower than the third page of any menu.

12.9.2.4 Each page must have an available selection to return up one level, return to top level and exit.

Sub-section 12.10 Video Map Generation Equipment Requirements**12.10.1 General**

Compliance Note: All radar display systems have a method of providing the controller with reference information. This allows a controller to determine the relationship between aircraft position and ground or airspace positions. Although such systems can take various configurations, the procedures surrounding the systems will all take the same form.

12.10.1.1 This section applies to all radar display equipment providing data for ATS providers approved or authorized under GACAR Section 11.

12.10.1.2 This section sets out the standards and requirements covering equipment used to produce or display information making up the fixed radar video map. This includes overhead projection, etched plates, independent video map generators or on-system video maps.

12.10.1.3 This appendix also covers the following areas:
 procedures for the update control of video map data;
 responsibilities for the update of video map data; and
 requirements for the co-ordinate system used for transfer of data.

12.10.1.4 The video map generation equipment must provide complete and accurate reference data for ATS.

12.10.2 Procedure for Production and Update of Video Maps

12.10.2.1 Video map generation must be subject to formal configuration management.

12.10.2.2 Each map or generation of map must be given a unique identifying label. The map as displayed on the equipment must display this label. In addition, documentation must use this label to show the origin and contents of the information used on the map.

12.10.2.3 A suitably qualified engineer must carry out this function.

12.10.2.4 The individual elements to be included on the map must be identified and documented in the operational requirement.

12.10.2.5 The definition of such elements must be in terms of ATS requirements. These elements must include the following:

- visual reporting points;
- adjacent airfields;
- adjacent areas of flying activity e.g., hang gliding sites, parachuting sites, etc.;
- danger areas, prohibited areas etc.;
- limits of controlled airspace;
- runway extended centerlines; and
- map north marker.

Compliance Note: For certain ATS units additional points may be required.

12.10.2.6 The identified features must be referenced to defined geodetic coordinates. In addition, the procedure must state the geodetic system used to define these geographical locations.

12.10.2.7 The procedure must define the conversion of the geographical co-ordinates to the system geometry. It must also state the algorithms or processes used to convert this data.

12.10.2.8 Provisions must be made to check the displayed data for accuracy and completeness.

12.10.2.9 The original production or change request must be compared with the resulting map

information. This must include a procedure for checking the absolute accuracy of the displayed maps. The ATS provider must carry out the verification.

12.10.2.10 The final user must evaluate the whole map prior to introduction to service.

12.10.2.11 A procedure must exist to ensure that the map always contains all operationally significant information.

12.10.3 Responsibilities for Control of Video Maps

12.10.3.1 The video map documentation must identify all posts responsible for the control of the video maps.

12.10.4 Tolerances on Video Map features

12.10.4.1 For a display used for SRA, all features used in the SRA zone must be accurate to within 5% of range scale +55 meters (180 feet) in range and within 1 degree measured from the airfield reference point.

12.10.4.2 For raster scan display systems, all features must be accurate to within the resolution of the display.

12.10.4.3 For all other features accuracy must be within 450 meters (0.25 NM).

12.10.5 Evaluation of Video Maps

12.10.5.1 At least three features of new video maps must have the accuracy assessed as part of the flight trial for the equipment. The tolerance on this accuracy must be better than 900 meters (0.5 NM).

12.10.5.2 The accuracy assessment must ensure that the features shown correspond identically to those displayed at adjacent ATC units.

12.10.5.3 New SRA maps must be assessed for bearing and range error at 6 NM, 5 NM, 3 NM, 2 NM, 1 NM and 0.5 NM as appropriate to the intended SRA termination range. The assessment must be by use of an aircraft with independent positioning equipment on board an aircraft or fixed ground mounted reflection sources

12.10.5.4 Methods independent of the original source must be used for proof of changes which are independent of the original source.

12.10.6 Mapping Co-ordinate System

12.10.6.1 The video maps must be in WGS84 format.

Sub-section 12.11 RADAR Recording Equipment Requirements**12.11.1 General**

Compliance Note: *The use of radar recording equipment falls into three areas:
 The provision of data for post-accident or post incident investigation.
 To provide location data in the event of search and rescue.
 For use in testing the performance of the radar sensor, processor and display system.*

12.11.1.1 This section sets out the standards and requirements relating to radar recording equipment used in the Kingdom of Saudi Arabia.

12.11.1.2 This section applies to all radar sensor equipment providing data for ATS and where radar recording equipment is required.

12.11.1.3 Surveillance data used as an aid to air traffic services must be recorded to comply with the ICAO Standard in Annex 11, section 6.4.1. This includes Primary Radar, SSR, Automatic Dependent Surveillance (ADS), Multilateration and Surface Movement Radar (SMR).

12.11.2 System Performance

12.11.2.1 The data recording system used must not degrade the performance of the radar display and processing system.

Compliance Note: *Degradation includes any effect on the data integrity, the update rate, plot delay or plot handling capacity.*

12.11.2.2 Radar recording equipment must have an accurate time source fitted.

12.11.2.3 This time source must be synchronized with the main station time source and thus to Universal Time (Coordinated)(UTC time).

12.11.2.4 The radar recording time source must be synchronized with the main station time source to a tolerance of within ± 5 seconds.

12.11.2.5 The radar recording equipment must record primary, secondary and surface movement radar data.

Compliance Note: *This applies whether the data is analogue or plot extracted.*

12.11.2.6 The radar recorder must record the following data where received from the radar sensor:

- the plot position relative to a known datum;
- mode A, C and S data, where appropriate;
- type of plot, for example PRI only, SSR only, combined or assigned;
- time of plot; and
- radar source.

12.11.2.7 The recorder must incorporate features to ensure continuity between recordings.

12.11.2.8 The device used for radar recording must not be capable of erasing any recorded data.

12.11.2.9 Erasure equipment should be separate from the recording apparatus.

12.11.2.10 The error rate of the recording equipment must be defined and justified.

Compliance Note: *The recording system may use any suitable recording medium that meets*

the storage time and data interval time specified in this document.

12.11.2.11 The following operating procedures must be in place at sites where radar recorders are mandatory:

- the recorded data must be kept for a minimum of sixty days after the end of the recording, or longer periods as directed;
- suitable storage precautions must be taken for the prevention of the deterioration, theft, damage or tampering with the stored data;
- suitable measures must ensure that:
 - no recording is erased within 30 days;
 - all access to the stored data is recorded;
 - authority under which any recorded radar data leaves the site for replay or duplication is recorded; and
 - the identity of the person or organization taking charge of the recorded radar data is recorded.

Compliance Note: *ATS providers under GACAR Section 11 are required to document and implement operating procedures as well.*

12.11.3 Playback Functions and Facilities

12.11.3.1 The radar recording and radio telephony (RTF) recording equipment must be integrated to allow synchronized play-back.

12.11.3.2 Radar recording and play-back equipment must be integrated into the display equipment.

12.11.3.3 The data recorded must allow the replay equipment to replicate the overall data presented to the controller. This includes the following:

- map in use;
- range in use;
- display brightness;
- error messages;
- display windows;
- system settings, character size;
- range offsets in use; and
- display orientation.

12.11.3.4 Equipment must be provided to allow replay and duplication of recorded data. Duplicate copies must be marked clearly to this effect.

12.11.3.5 The use of replay and duplication functions must not cause a break in the recording

12.11.3.6 The play-back equipment must be capable of producing hard copy of the recorded aircraft tracks.

12.11.3.7 Provisions should be included that enable the replay of recorded radar data near to the control position within a short interval of an event occurring. Actual times may vary with the event and a strategy should be devised to ensure that an appropriate response can be made.

Compliance Note: *To enable, for example, the use of recorded data for search and rescue purposes.*

Sub-section 12.12 Surface Movement RADAR (SMR) Systems Requirements**12.12.1 General**

Compliance Note: *An SMR is usually a form of specialized primary radar with the option of secondary surveillance radar (SSR) elements or dynamic tracking with operations manual labeling.*

12.12.1.1 This section sets out the standards for equipment requirements and operational usage of the Surface Movement Radar (SMR) element.

12.12.1.2 This section only relates to those SMR systems based around the use of a suitable single sensor primary radar.

12.12.1.3 The Surface Movement Guidance and Control (SMGC) System comprises the following elements:

- visual and non-visual aids;
- radio telephony communication;
- operating procedures; and
- control and information facilities.

12.12.1.4 All elements of the SMGC must be located at the SMR control position.

12.12.2 Performance Requirements for SMR

12.12.2.1 The display must be usable in a daylight environment.

12.12.2.2 The equipment must display ranges between 1 NM and 6 NM and have range offset controls.

12.12.2.3 The equipment must suppress information from non-operational areas.

12.12.2.4 The display size must allow discrimination between targets spaced at one quarter of the minimum visual feature size. The display may use colors to aid discrimination between moving and stationary targets and between true data and overlaid information (maps, etc.) however the use of color for information coding is not allowed.

12.12.2.5 The coverage must extend over a range and azimuth sufficient to cover the maneuvering area.

12.12.2.6 The vertical coverage must be suitable for monitoring all airport traffic on the ground.

12.12.2.7 The system must be capable of detecting targets as necessary within the coverage as defined in the operational requirements.

12.12.2.8 Any radar shadowing must be mapped and verified.

12.12.2.9 Operational use must take account of both dynamic and static shadowing.

12.12.2.10 The information update rate must be appropriate to the speed of airport traffic and the minimum visual feature size.

12.12.2.11 The equipment must present the data to the controller within a period equivalent to one quarter of the revolution rate of the aerial.

12.12.2.12 The radar must achieve the required performance in the worst weather in which routine operations are likely to continue.

Sub-section 12.13 Airport Remote Radar Feeds Requirements**12.13.1 General**

***Compliance Note:** For the provision of particular radar data, for example, secondary surveillance radar (SSR), it may be appropriate to use shared data sources. This data is termed 'onward routed radar data'. Such data can be used, for example, to provide additional coverage. The equipment used to convey this remote data from source to destination is termed a radar data link.*

12.13.1.1 This section sets out the aspects that must be considered before installing a radar data link system.

12.13.1.2 These requirements apply to the following data elements:
 target identification;
 target position;
 target type (where appropriate, e.g., vehicles, 'angels' etc.);
 system configuration information. This includes, as appropriate:
 selected polarization;
 radar channel selected;
 pulse length selected;
 radar antenna tilt; and
 radar monitoring and fault indication.

12.13.1.3 The remote radar feed must provide complete and uncorrupted data so that the safety of the Air Traffic Service utilizing it is not compromised.

12.13.2 Radar Data Links General Requirements

12.13.2.1 The suitability of the link must be assessed against the operational requirement and must include the following aspects:

- (a) link integrity and interference;
- (b) link data rate and capacity;
- (c) link distortion and effect on accuracy;
- (d) link delay;
- (f) link reliability; and
- (g) data resolution on link.

12.13.3 Availability, Integrity and Interference

12.13.3.1 The availability of the equipment must be defined and justifiable for the air traffic service being provided.

12.13.3.2 Where radio links are used, the 'line of sight' path of the link must be safeguarded.

12.13.3.3 The possibility of integrity errors arising during any reformatting by the encoder or conversion of the data at a data link interface must be determined.

12.13.3.4 The effects of pick-up of false signals including radio frequency interference, magnetic and electrostatic fields must be determined.

12.13.3.5 Error detection and correction algorithms must be used to check for data corruption.

12.13.3.6 The system must provide warning indications for line loss and system status.

12.13.3.7 Procedures must be in place that require the remote supplier to supply details to the recipient of any optimization or planned outages of the source radar system that may affect the supplied

data. Any changes must be assessed formally to determine the effect on the operational requirement.

12.13.4 Data Link Format, Rate and Capacity

12.13.4.1 Correct operation of all data transformations must be tested under all data formats used.

12.13.4.2 The system must be capable of detecting an overload situation on the link. The system must provide information that allows the display or other system to advise the controller of this situation.

12.13.4.3 The link bandwidth must be determined and shown that it has sufficient capability of transmitting the data required to satisfy the operational requirement.

12.13.5 Link Distortion and Effect on Accuracy

12.13.5.1 The offset drift and dynamic range of the link must be compatible with the data level.

12.13.5.2 The worst case data delay through the system must be defined and be justified as being acceptable.

Sub-section 12.14 Automatic Dependent Surveillance - Broadcast (ADS-B) Requirements

12.14.1 General

12.14.1.1 This section sets out the minimum technical requirements for a 1090 MHz Extended Squitter (1090 ES) Ground Station, which is part of an Automatic Dependent Surveillance – Broadcast (ADS-B) system providing airspace situational awareness to air traffic controllers and other users in non-radar airspaces (NRA).

12.14.1.2 In addition to the requirements below, Automatic Dependent Surveillance – Broadcast (ADS-B) systems and Traffic Information Service- Broadcast, must comply with the Standards and Recommended Practices (SARPs) in ICAO Annex 10, Volume IV, Chapters 3 and 5.

12.14.2 Basic System Requirements

12.14.2.1 The 1090 ES Ground Station is part of a system that provides airspace and airport surface situational awareness to aircraft pilots, air traffic controllers and other users.

12.14.2.2 Automatic Dependent Surveillance – Broadcast (ADS-B) must be a means by which aircraft, aerodrome vehicles and other objects can automatically transmit and/or receive identification, position, velocity and additional data in a broadcast mode via a data link.

12.14.2.3 The ADS-B service must collect position, velocity and status information from systems and sensors on the aircraft and broadcasts this information to other targets and Ground Stations.

12.14.2.4 The Traffic Information Service - Broadcast service, if any, must collect aircraft position information from radar sources and broadcasts it to aircraft.

12.14.2.5 The ADS-B must be automatic with no external stimulus. It must be dependent and relies on on-board navigation sources and on-board broadcast transmission systems to provide surveillance information to other users.

Compliance Note: *The aircraft originating the broadcast will have no knowledge of which users are receiving its broadcast; any user, either aircraft or ground based, within range of this broadcast, may choose to process the received ADS-B surveillance information.*

12.14.2.6 The ADS-B application must be designed to enhance the following Air Traffic Services:

- Air Traffic Control Service and Flight Information Service principally for air traffic control separation services, transfer of responsibility for control, air traffic control clearances and flight information services; and
- alerting services, principally for notification of rescue co-ordination centers and plotting of aircraft in a state of emergency.

12.14.3 Functional Requirements

12.14.3.1 The 1090 ES Ground Station must provide at least the following functions:

- 1090 ES Reception and Decoding: Reception of 1090 MHz RF and extraction of Extended Squitter message s broadcast by ADS-B Out transponders;
- Report Assembly: Compilation of ADS-B reports to be forwarded to third party client ground systems (e.g. ADS-B servers, SDPD, etc.);
- UTC Time Synchronization: UTC time synchronization of the 1090 ES Ground Station for output report time stamping;
- Ground Station Management and Status Reporting: Station management, monitoring and control functions, and service status, including Built In Test Equipment (BITE).

12.14.3.2 The 1090 ES Ground Station must ensure autonomous, reliable and accurate UTC time stamping of the generated ASTERIX reports. For this purpose the 1090 ES Ground Station must include a sufficiently reliable and accurate UTC time reference source, or alternatively it must be able to interface to an external standard UTC time source of equivalent quality. The internal or external time source supplies all the data necessary for the establishment of the UTC times of reception of position and velocity information.

12.14.3.3 The 1090 ES Ground Station must operate unattended and autonomously, except for maintenance and testing activities. It must provide a monitoring, maintenance and control function allowing a local or remote operator to:

monitor the 1090 ES Ground Station status, and the status of each subsystem and service, including BITE and end-to-end system checks; and
perform maintenance, configuration, and control actions.

12.14.3.4 The 1090 ES Ground Station must provide protection against unauthorized access to the system maintenance and control functions.

12.14.3.5 The 1090 ES Ground Station must provide control facilities to allow the commanding changes of mode or state for the Ground Station or a service, as well as software configuration changes of subsystems and services. Addresses and communication protocols must also be configurable.

12.14.3.6 The 1090 ES Ground Station must include a status reporting function, which is able to report the status of the Ground Station and its services to client systems both periodically and on an event driven basis over a ground network. These status reports will use the ASTERIX Category 023 message format.

12.14.3.7 The 1090 ES Ground Station includes a Built-In Test Equipment (BITE) capability, such that there is a continuous monitoring of the operating status of the equipment, which is achieved by the monitoring and analysis of critical system parameters at all relevant system levels.

12.14.4 Additional Requirements

Compliance Note: *The power supply requirements may vary depending upon application and location. The following provisions are provided as guidance to be considered by the implementing authority. It must be noted that it may not be necessary to include each of the following as requirements, but only those that pertain to the power supply being used. Consideration must also be given to the use of Uninterruptible Power Supplies (UPS), with appropriate monitoring as necessary, to meet Operational Availability requirements.*

12.14.4.1 The receiver must be protected from interference from out-of-band signals such as DME.

Compliance Note: *Table 12.14-1 shows receiver out-of-band rejection characteristics that are extensively used. It shows the 1090 ES Ground Station ADS-B message signal level required to provide a 90% Successful Message Reception rate at various frequency offsets from 1090 MHz.*

<i>Out of Band Characteristics</i>	
<i>Frequency Offset from 1090 MHz</i>	<i>Minimum Input Level Above Specified Receiver Sensitivity (90% SMR)</i>
± 5.5 MHz	3 dB
± 10.0 MHz	20 dB
± 15.0 MHz	40 dB
± 25.0 MHz	60 dB

Table 12.14-1 Out of Band Characteristics

Alternative out-of-band rejection characteristics may be used provided that the performance

requirements are met. For example the characteristics shown in Table 12.14-2 may be suitable for a receiver that is used for both ADS-B and multilateration.

<i>Alternative Out of Band Characteristics</i>	
<i>Frequency Offset from 1090 MHz</i>	<i>Minimum Input Level Above Specified Receiver Sensitivity (90% SMR)</i>
± 12.5 MHz	3 dB
± 19.0 MHz	20 dB
± 29.0 MHz	40 dB
± 46.0 MHz	60 dB

Table 12.14-2 Alternative Out of Band Characteristics

12.14.5 Equipment Classes

12.14.5.1 The 1090 ES Ground Station equipment must be classified according to the unit's range capability and the set of parameters that it is capable of transmitting consistent with the following definition of general equipment classes and the specific equipment classes defined in ICAO Annex 10 Volume 5:

Class A extended squitter airborne systems support an interactive capability incorporating both an extended squitter transmission capability (i.e. ADS-B OUT) with a complementary extended squitter reception capability (i.e. ADS-B IN) in support of onboard ADS-B applications;

Class B extended squitter systems provide a transmission only (i.e. ADS-B OUT without an extended squitter reception capability) for use on aircraft, surface vehicles, or fixed obstructions; and

Class C extended squitter systems have only a reception capability and thus have no transmission requirements.

12.14.6 Antenna

12.14.6.1 The antenna pattern must be nominally omnidirectional in the horizontal plane.

12.14.6.2 The antenna gain must be 0 dB with respect to isotropic.

12.14.6.3 The antenna must receive signals on the nominal operating frequency of 1090 MHz.

Section 13 Flight Inspection Service Providers

Sub-section 13.1 Authorization of Flight Inspection Service Providers

13.1.1 General

13.1.1.1 This section contains the standards, rules, procedures and practices applicable to flight inspection service providers and their equipment.

***Compliance Note:** This section is specifically focused on Authorization Procedures for flight inspection services. Sub-section 13.2 – 13.4 prescribe specific flight inspection requirements for specific types of navigational aids. Additional flight inspection requirements for other navigation aids are prescribed in sub-sections 11.5 – 11.6.*

13.1.1.2 A flight inspection service provider authorized under this part must be capable of using flight inspection techniques to measure accurately the signals in space radiated by those navigational aids which they are approved to inspect.

13.1.2 Application Procedure

13.1.2.1 Any request for the authorization of flight inspection service provider must submitted by the aeronautical telecommunication service provider authorized under this part with the required information in a coherent documentary form.

***Compliance Note:** The flight inspection service provider may propose an aircraft or system which is new in concept or not in common use for flight inspection. In such a case, the President may seek advice from other Civil Aviation Authorities and may also initiate a general consultation with the industry.*

13.1.2.2 If a new system or aircraft is proposed or the flight inspection service provider does not have a demonstrable history of flight inspection, the flight inspection service applicant must provide practical demonstrations of capability. The tests will be in two parts and the flight inspection service provider may be required to perform either or both parts:

- a demonstration of position fixing accuracy. This will be evaluated on an established test range. The precise details of this trial cannot be defined until details of the flight inspection service provider's system are known;
- a demonstration of overall system performance. For this trial the flight inspection service provider will make a simulated commissioning inspection of the selected navigational aid. The trial may require several similar flight profiles to be flown to demonstrate the repeatability of measured results.

13.1.2.3 A flight inspection service provider must provide the President with a build state document of the measuring equipment, a complete and formalized list of the current issues of all relevant documentation and an operations manual describing the entire operation.

13.1.2.4 If a flight inspection service provider proposes to make any changes to a flight inspection system, operation, or organization, the President must approve these changes before the organization is permitted to make any further flight inspections.

13.1.2.5 Where authorization for ILS inspection is granted under this appendix it may be limited to the flight inspection of specific categories of ILS.

13.1.2.6 For all flight inspection service providers, the President may require that a practical demonstration of ability is given.

13.1.3 Organization and Quality

13.1.3.1 Any organization intending to perform flight inspection of navigation aids must demonstrate that it is competent, having regard to any relevant previous conduct and experience, equipment, organization, staffing maintenance and other arrangements, to produce accurate and adequate flight inspection results in relation to ATS safety aspects.

13.1.4 Operations manual

13.1.4.1 An operations manual must be provided by each flight inspection service provider to detail the overall flight inspection service provider and its intended operation. The following aspects must be included (or referenced to other documents) in the operations manual, or provided in a coherent documentary system.

13.1.5 Operations Manual Contents

13.1.5.1 The operations manual must include the following:

- scope of flight inspection tasks;
- types of navigational aids to be inspected (for ILS the organization must state the categories of ILS to calibrate);
- Organizational Chart & technical details;
- personnel responsibilities, terms of reference and authority to act;
- procedures for notifying of major organizational changes;
- procedures for notifying the President of the latest state of the flight inspection program;
- procedures for notifying the aeronautical telecommunication service provider of proposed equipment changes and modifications or change of aircraft type;
- details of the aircraft which the organization wishes to use for flight inspection;
- Functional description, technical specification and manufacturer's type number for all major items of the flight inspection system. This must include details of the equipment used for calibrating the system;
- location, characteristic and type of all measurement aeriels on the aircraft;
- technical description of any parts of the system which the applicant has designed or built;
- the design authority for all equipment must be stated;
- procedures for inspection of equipment;
- details of all uses of software and firmware in the measurement system. Also details of software and firmware support;
- details of a log or record system for faults and maintenance of the measuring system;
- documentation control. List of documents held and produced;
- personal training, competency and recurrent checking arrangement;
- details of any internal and external auditing system e.g. auditing of the organization by any other organization not associated with the production of inspection results;
- details of the quality management system;
- details of any formal or implicit approvals which the organization has received from other foreign civil aviation authorities including a list of any navigation aids which the organization regularly inspects under such a formal or implicit approval. This will include:
 - type of navigation aid;
 - location of navigation aid;
 - category of navigation aid (if applicable);
- flight inspection operating instructions for the inspector and flight crew;
- a typical or test flight inspection report;
- a typical or test sample structure measurement for those navigational aids where structure measurements form part of a normal flight inspection;
- a statement showing to 95% confidence, the measurement uncertainty which the organization claims to achieve for each of the measurable parameters;
- details of statistical methods or interpolative techniques which may be applied;
- details of any operating certificates held in respect of aircraft operations;

procedures for the control of sub-contractors; and
a statement of compliance with the flight inspection requirements of this section.

13.1.6 Aircraft

13.1.6.1 The aircraft used must be appropriate for the purpose of flight inspection and must be operated in a way which ensures accurate measurement of all parameters.

13.1.6.2 The aircraft must be a multi-engine type capable of safe flight within the intended operational envelope with one engine inoperative, fully equipped and instrumented for night and instrument flight.

13.1.6.3 The aircraft must be managed by two flying crew members.

13.1.6.4 A cross-wind limit must be set which will allow measurement accuracies to be within the limits required. This limit must be shown in the operating instructions.

13.1.6.5 The aircraft must have a stable electrical system with sufficient capacity to operate the additional electronic and recording equipment.

13.1.6.6 Measures must be taken to reduce propeller modulation to an acceptably low level.

13.1.7 Equipment

13.1.7.1 The purpose of the navigation aid flight inspection is to verify that all parameters of the navigation aid meet the requirements specified in Annex 10 to the International Convention on Civil Aviation and any other specific requirements of this part. The equipment fitted in the aircraft must be capable of measuring all these parameters.

13.1.7.2 The navigation aid measuring equipment must not interfere with the operation or accuracy of the aircraft's normal navigation and general avionics equipment.

13.1.7.3 The flight inspection measurements must be adequately protected against the prevailing electromagnetic environment effects internal or external to the aircraft. Abnormal interference effects must be clearly identified on the inspection results.

13.1.7.4 The inspection system must have the facility for listening to the identity modulation of the navigation aid being inspected.

13.1.7.5 The flight inspection system must include equipment which can determine and record the aircraft's position in space relative to a fixed reference point. The uncertainty of measurement must be commensurate with the parameter being inspected.

13.1.7.6 The flight inspection system must include equipment which can record the measured parameters of the navigation aid being inspected.

13.1.7.7 All recordings must be marked so that they can be correlated with the aircraft's position at the time of the measurement.

13.1.7.8 Aerials must be positioned in such a manner that they are not obscured from the signal during any normal inspection flight profiles.

13.1.7.9 The aerials to be used for tracked structure measurements must be positioned with due regard to the tracking reference on the aircraft. If the aerials and the reference are not in close proximity, this error must be addressed in the measurement uncertainty calculations and in setting the operational crosswind limit. Alternatively, the errors may be corrected using information from the aircraft's attitude sensors and data concerning movement of the aerial's phase center.

13.1.8 Measurement Uncertainty

13.1.8.1 The measurement uncertainty for any parameter must be small compared with the operational limits for that parameter.

13.1.8.2 The measurement uncertainty to 95% probability must be calculated for each of the parameters to be measured. The method of calculation and any assumptions made must be clearly shown.

13.1.8.3 Many measurements are a combination of receiver output and aircraft position. In these cases the figure required is the sum of all the errors involved in the measurement, including aircraft position.

13.1.8.4 For measurements which can only be derived from recordings, the accuracy and resolution of the recording equipment must be included in calculating the expected measurement uncertainty.

13.1.8.5 When modifications are made which will affect the uncertainty of measurement of any parameter, new calculations must be submitted.

13.1.8.6 The uncertainties stated in 13.1.8.5 must be maintained under the specified environmental conditions for a flight inspection procedure. The operator must define the environmental conditions (temperature range, humidity range, etc.).

13.1.8.7 Details of measurement uncertainty with respect to temperature must be available for all the measuring equipment. This may be in the form of test results made by the operator, or manufacturer's specifications. If manufacturer's specifications are quoted, the flight inspection service provider must be prepared to produce manufacturer's test results as evidence.

13.1.8.8 If the measuring equipment requires any warm-up or cooling time, this must be clearly indicated in the operating instructions.

13.1.8.9 The accuracy of marking must be commensurate with the accuracy required in the final figure. Specific requirements are given in the appropriate sub-section of this Part.

13.1.9 Inspection Procedures and Standards

13.1.9.1 All measuring equipment used for flight inspection must be calibrated to defined standards.

13.1.9.2 Clearly defined inspection procedures must be applied to all equipment involved in the measurement of parameters in the appropriate annex to this appendix. All equipment and standards used in the inspection process must have traceability to KSA or international standards.

13.1.9.3 When any equipment used is claimed to be self-calibrating, the internal processes involved must be clearly defined. This involves showing how the equipment's internal standard is applied to each of the parameters which it can measure or generate. The internal standard must have traceability to KSA or international standards.

13.1.9.4 Details of inspection intervals required must be contained in the inspection records. The flight inspection service provider must be prepared to produce evidence in support of the quoted inspection intervals.

13.1.10 Operating Instructions

13.1.10.1 The operating instructions must ensure that all measurements are made to defined and documented procedures.

- 13.1.10.2 This documentation must include concise details of:
the flight profile to be used for each individual measurement;
pre-flight inspection of measuring equipment;
siting of any necessary ground tracking or position fixing equipment.
scheduled maintenance and inspection of the measuring equipment.
operation of the measuring equipment;
production of the flight inspection report;
certification; and
the method of calculating any results which are not directly output by the measuring equipment.

13.1.11 Personnel Training and Qualification Requirements

- 13.1.11.1 All personnel concerned with the flight inspection must be adequately trained and qualified for their job functions.

- 13.1.11.2 The flight inspection service provider must show that all personnel concerned with the flight inspection are adequately qualified for their job functions.

- 13.1.11.3 The flight inspection service provider must have a procedure for ensuring the competence of its personnel. This procedure must have provision for regular assessment of competence.

- 13.1.11.4 Particularly for the inspection of precision approach aids, the flight crew's familiarity with each location to be inspected is considered to be of importance. The flight inspection service provider's procedures and instructions must include details of training and familiarization which will apply to the flight crew.

13.1.12 Flight Inspection Report

- 13.1.12.1 The flight inspection report must clearly and accurately document the measured performance of a navigational aid.

- 13.1.12.2 All flight inspection results must be documented to a report format acceptable to the President. The minimum information to be provided on the report must be:

- station name and facility designation;
- category of operation;
- date of inspection;
- serial number of report;
- type of inspection;
- aircraft registration;
- manufacturer and type of system being inspected;
- wind conditions;
- names and functions of all personnel involved in the inspection;
- results of all measurements made;
- method of making each measurement (where alternatives are available). These may be referenced to the operating instructions;
- details of associated attachments (recordings, etc.);
- details of extra flights made necessary by system adjustments;
- an assessment by the aircraft captain of the navigational aid's performance;
- comments by the navigation aid inspector/equipment operator;
- details of any immediately notifiable deficiencies;
- statement of conformance/non-conformance;
- navigation aid inspector's signature;
- pilot's signature; and
- signature of the individual who is legally responsible (if different from (r) or (s)).

13.1.13 Records and Graphs

13.1.13.1 Records and graphs must be produced in a manner which ensures that system parameters may accurately be deduced from them.

13.1.13.2 If recordings or graphs are used to derive figures for the inspection report, the scales must be commensurate with the permitted measurement uncertainty limits.

***Compliance Note:** If the recordings or graphs are only used to show that results are within designated tolerances, they may be presented on a reduced scale.*

13.1.13.3 The data from which these recordings and graphs are made must be stored with sufficient accuracy that expanded scale plots can be provided on demand.

13.1.13.4 For flights where parameters are evaluated by comparison of the received signal and the output of a tracking device, only the final result need be presented for a normal inspection unless other data has been requested by the aeronautical telecommunication service provider. Position data and raw signal data must be recorded or stored and provided on demand.

13.1.13.5 The minimum identification on each record and graph must be:
serial number;
date;
description of type of flight;
name of airport; and
designation of facility being inspected.

13.1.13.6 The flight inspection service provider must provide for approval, details of the arrangements to be made for archiving data from flight inspection results.

Sub-section 13.2 Flight Check of Instrument Landing Systems**13.2.1 General**

13.2.1.1 This section sets out requirements for flight inspection service operators relating to the flight checking of instrument landing systems.

13.2.2 Aircraft

13.2.2.1 Operations manual flight control using only the mandatory navigation instruments is not considered sufficiently accurate for inspection of the following types of ILS:

Category III systems.

Category II systems.

Category I systems, which the operator wishes to use for auto land in good visibility.

13.2.2.2 For inspection of the above systems the aircraft must be fitted with equipment which will provide repeatable following of the required path.

Compliance Note: Systems considered suitable to this purpose include telemetry of the ground based tracking system's output to a separate instrument in the aircraft, or an autopilot.

13.2.2.3 If an autopilot is used GACA-S&AT must be satisfied that it is capable of safe operation down to 50 feet above the threshold elevation.

13.2.3 Equipment

13.2.3.1 The ILS/DME inspection system must be capable of measuring and recording the following parameters:

Localizer Field strength;

Localizer Modulation Sum (SDM);

Localizer Difference in Depth of Modulation (DDM);

Glide path Field strength;

Glide path Modulation Sum (SDM);

Glide path Difference in Depth of Modulation (DDM);

Marker Beacon Field strength;

Marker Beacon Fly-through Time;

DME Field strength;

DME Distance;

Radio Altimeter height.

13.2.3.2 The recording equipment must be capable of recording any of the ILS parameters listed in paragraph 13.2.3.1.

13.2.3.3 The equipment must measure and record beam structure by comparison of tracking data and the ILS signal, from a distance of at least 4 NM from the runway threshold.

13.2.3.4 It must be possible to annotate the recordings with comments and any other necessary information at the time of making the recording.

13.2.3.5 For beam bend measurements, the total time constant of the measuring and recording equipment must be $92.6/V$ seconds where V is the aircraft velocity in kilometers per hour.

13.2.3.6 If digital sampling/storage is used, the sampling rate must be compatible with this time constant but never less than 4 samples per second for all parameters which are continuously measured.

13.2.3.7 The equipment must be capable of recording a minimum of 4 parameters

simultaneously.

13.2.4 Measurement Uncertainty

13.2.4.1 Maximum permitted measurement uncertainty at 95% confidence level is prescribed as follows:

Compliance Note: Throughout the following tables, the figure of 2dB for field strength is the permitted uncertainty for repeatability of measurement. It is not a requirement for absolute field strength measurement.

(a) *Localizer.* As per Table 13.2-1 below:

	Cat I	Cat II	Cat III
Alignment (average) (related to threshold)	2.0m	1.0m	0.7m
Displacement sensitivity (of the actual figure)	4%	4%	2.5%
Field strength (relative)	2dB	2dB	2dB
Off course clearance	3%	3%	3%
Course/clearance ratio	1dB	1dB	1dB
Course structure Outer limits of coverage to ILS Point A	6 μ A	6 μ A	6 μ A
Course structure ILS Point A to threshold	3 μ A	1 μ A	1 μ A
Modulation sum (absolute mod depth)	1.6%	1.6%	1.6%
Polarization	1.5 μ A	1.0 μ A	1.0 μ A
Modulation balance (CSB)	1.0 μ A	1.0 μ A	1.0 μ A

Table 13.2-1 Localizer Measurement Uncertainty Limits

(b) *Glide path.* As per Table 13.2-2 below:

	Cat I	Cat II	Cat III
Angle (of the glide path angle)	0.5%	0.3%	0.3%
Displacement sensitivity (of the actual figure)	2.5%	2.0%	1.5%
Field strength (relative)	2dB	2dB	2dB
Clearance (of the actual figure)	3%	3%	3%
Course structure	3 μ A	2 μ A	2 μ A
Modulation sum	2%	2%	2%
Modulation balance (CSB)	1.0 μ A	1.0 μ A	1.0 μ A

Table 13.2-2 Glide Path Measurement Uncertainty Limits

- (c) Marker Beacon:
- (1) Field strength (relative) 2dB
 - (2) Distance 10 meters
- (d) Associated DME:
- (1) Field strength (relative) 2dB;
 - (2) Distance 60 meters at threshold and point A
- (e) Uncertainty of Position Marking of Flight Inspection Data:
- (1) Approach Toward a Facility:
 - (i) ± 0.1 NM for markings at each nautical mile;
 - (ii) ± 0.1 NM for marking at ILS point A;
 - (iii) ± 0.05 NM for marking at ILS point B;
 - (iv) $\pm 0.1^\circ$ for marking glide path slice at $1.75 \times$ (glide path angle);
 - (v) ± 20 meters for marking the threshold crossing.
 - (2) Orbital Flights:
 - (i) ± 1.5 Degree.

Compliance Note: A marking accuracy of $\pm 1.5^\circ$ applies to clearance and coverage inspection, it is not sufficient for measuring displacement sensitivity.

13.2.5 Records and Graphs

13.2.5.1 Where chart recordings are used for parameter evaluation, they must have sufficient resolution for this purpose. The minimum requirements are given below:

- (a) **Structure Stability Recordings (deviation current)**
 Localizer. Minimum sensitivity of 1 mm per μA .
 Glide path. Minimum sensitivity of 0.5 mm per μA .
- (b) **Structure Measurements (corrected recordings)**
 Localizer. Minimum sensitivity of 1mm per μA .
 Glide path. Minimum sensitivity of 0.5mm per μA for the initial part of the recording. For Category II & III systems, it must be possible to show the signal characteristic down to threshold crossing. This may require reduced sensitivity depending on available chart width.
- (c) **Other Measurements**
 Many other recordings will need sensitivity changes during the recording to obtain optimum resolution at all times. The chart produced must be capable of displaying at least 450 μA of deflection current without saturation. Sufficient different sensitivities of display must be available to allow signal characteristics to be measured accurately.
- (d) **Position Annotation**
 Records and graphs must be annotated to show the position of the aircraft at the time of making the measurement. The minimum requirements are given below. Required accuracies of annotation are given in paragraph 13.2.4.
 Approaches Towards a Facility. Every nautical mile (referenced to 0 NM at the threshold), ILS points A, B & C, Threshold.
 Glide path Level Flight (on localizer Centerline). Every nautical mile (referenced to 0 NM at the threshold).
 Orbital Flights. Every 5 degrees

Sub-section 13.3 Flight Check of VHF Omnidirectional Radio Range (VOR)**13.3.1 General**

13.3.1.1 This section sets out requirements for flight inspection service operators relating to the flight checking of VHF Omnidirectional Radio Range (VOR).

13.3.2 Equipment

13.3.2.1 The VOR inspection system must be capable of measuring and recording the following parameters:

Alignment Accuracy;
Field strength;
30Hz Modulation depth; and
9960Hz Modulation depth.

13.3.2.2 It must be possible to annotate the recordings with comments and any other necessary information at the time of making the recording.

13.3.2.2 During orbital flights the system must be capable of measuring and recording every 5 degrees.

13.3.3 Measurement Uncertainty

13.3.3.1 Maximum permitted measurement uncertainty at 95% confidence level is given in Table 13.3-1 below:

Parameter	Measurement
Alignment	0.4 ⁰
Field Strength	3dB
Modulation 30Hz and 9960Hz	0.4%

Table 13.3-1 VOR Measurement Uncertainty Limits

13.3.4 Records and Graphs

13.3.4.1 Where chart recordings are used for parameter evaluation, they must have sufficient resolution for this purpose.

13.3.4.2 Records and graphs must be annotated to show the position of the aircraft at the time of making the measurement.

Sub-section 13.4 Flight Check of Non-Directional Beacon (NDB)**13.4.1 General**

13.4.1.1 This section sets out requirements for flight inspection service operators relating to the flight checking of Non-Directional Beacons (NDB).

13.4.2 Equipment

13.4.2.1 The NDB inspection system must be capable of measuring and recording the following parameters:

Accuracy;
Field strength.

13.4.2.2 It must be possible to annotate the recordings with comments and any other necessary information at the time of making the recording.

13.4.2.3 During orbital flights the system must be capable of measuring and recording every 5 degrees.

13.4.3 Measurement Uncertainty

13.4.3.1 Maximum permitted measurement uncertainty at 95% confidence level is given in Table 13.4-1 below:

Parameter	Measurement
Accuracy	1.0
Field Strength	3dB

Table 13.4-1 NDB Measurement Uncertainty Limits

13.4.4 Records and Graphs

13.4.4.1 Where chart recordings are used for parameter evaluation, they must have sufficient resolution for this purpose.

13.4.4.2 Records and graphs must be annotated to show the position of the aircraft at the time of making the measurement.